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Citizens' sustainable, future-oriented energy behaviours in energy transition

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ABSTRACT

This study explored individuals' engagement in the sustainable energy transition in Finland. Using the attitude-behaviour-context model (Guagnano et al., 1995) and Stern's (2000) typology of environmentally significant behaviours, this study tested the assumption that individuals' engagement in transition is a combination of socio-psychological and contextual (socio-economic) variables and that the active engagement requires individuals to have a future orientation, systemic and self-efficacy, subjective knowledge and a pro-environmental attitude. The survey (N = 1012), representative of the 17–75-year-old Finnish population, was analysed with exploratory factor analysis and linear regression. The socio-psychological variables explained a larger portion of variance than the socio-economic variables in all three types of sustainable energy behaviours. The consideration of future consequences, self-efficacy and knowledge were positively associated with all three types of sustainable energy behaviours. Systemic efficacy was positively associated with and the consideration of immediate consequences was negatively associated with private-sphere environmentalism. The results suggest that individuals' consideration of the immediate and distant future should be included in the socio-psychological models of sustainable behaviours. The results also suggest that policymakers need to focus on strengthening citizens' efficacy beliefs, future orientation and knowledge.

1. Introduction

During the summer of 2018, record-breaking heat waves were experienced almost everywhere in the world, and massive evacuations were necessary in the face of extreme weather events (Washington Post, 2018). Japan evacuated millions of people because of unprecedented rains (NY Times, 2018), and California evacuated nearly 20,000 people because of wildfires (NYPost, 2018). In the Nordic countries, the exceptionally hot and dry summer together with the simultaneous release of the 'IPCC Special Report on Global Warming of 1.5 °C' elevated climate discussion back on the agenda (FMI, 2018; IPCC, 2018; SMHI, 2018).

Energy production and consumption are significant sources of carbon dioxide emissions, which contribute to the acceleration of climate change. The energy policy of the European Union (EU) aims to cut greenhouse gas (GHG) emissions by a least 40% below 1990 levels by 2030 (European Commission, 2017). This transition towards a climate-friendly energy system would mean switching to the production and consumption of sustainable energy forms and increasing energy efficiency options in the transport, industry and building sectors (IPCC, 2018).

Finland is an industrialised European country where the energy sector is the most significant source of GHG emissions (Statistics Finland, 2017). Finns are very concerned about climate change: About 20% considered it as the single-most serious problem facing the world, with the EU average being 12% (European Commission, 2017). Finns wish to see a transition towards more sustainable energy sources (Vainio et al., 2019). However, there is a significant gap between climate attitudes and sustainable energy behaviours. The energy consumption per household in Finland is the second highest in the EU (Eurostat, 2016), and the household carbon footprint grew by 12% in 2000–2016 (Nissinen and Savolainen, 2019).

The strategies that aim for the adoption of climate-friendly

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energy forms and technologies are insufficient without changes in individuals' behaviour and the understanding of factors that shape it (Kowalska-Pyzalska, 2018). To increase the possibility of a successful energy transition in the timeline that limiting global warming to 1.5 °C requires (Schaeffer et al., 2015), it is necessary to increase citizens' sustainable energy behaviours (Koirala et al., 2018; Ruotsalainen et al., 2017).

Individuals have an impact on the sustainable development of energy production and consumption in multiple ways (Stern, 2000). As consumers, they consume energy directly in their households and vehicles, which has an impact on what kind of energy is produced, who produces it and where it is produced. Consumer choices are also indirectly related to energy because manufacturing material products and services requires energy with embedded emissions. Moreover, individuals can have an impact on the context. As citizens, they can influence policies by voting for their representatives. Individuals can influence public opinion by discussing and writing about energy-related issues in their daily lives, social media and newspapers. Citizens can also influence the public's and decision makers' attitudes through environmental activism.

The socio-technological transition involves changes operating at multiple, interrelated levels (Geels, 2004). Therefore, individuals' private-sphere consumer behaviours, as well as public-sphere behaviours, shape and are strongly shaped by context: existing technologies, infrastructures, regulations, financial costs and convenience (Stern, 1999, 2008). For example, households' adoption of renewable energy systems is influenced by demographic and socio-economic factors, such as education, income level, age (Sardianou and Genoudi, 2013) and investment costs (Rouvinen and Matero, 2013). National and local contexts matter, and the barriers and drivers to sustainable energy behaviours vary among countries even within Europe (Heiskanen and Matschoss, 2017).

Even though energy transitions are strongly dependent on individuals' behaviours (Upham et al., 2018), the roles of social-psychological processes have been given little attention in energy-transitions literature (Bögel and Upham, 2018). In order to fill this research gap, this study explored individuals' engagement in sustainable energy transitions, which is defined as a future-oriented, collective, bottom-up process operating at multiple levels (Geels, 2004). The gap between individuals' climate attitudes and energy behaviours suggest that the consideration of future consequences is an important aspect, which so far has not been included in the theoretical models of individuals' energy-related behaviours (Brown and Sovacool, 2018). Therefore we tested how the model including individuals' consideration of future consequences of ones' own behaviour, as well as other socio-psychological variables and socio-economic variables, is related to different forms of sustainable energy behaviours. A nationally representative survey of the adult population living in Finland was analysed.

2. Theoretical framework

The study of individuals' energy behaviours requires an integrated approach that takes into account both contextual and socio-psychological factors (Steg and Vlek, 2009). Therefore, we applied the attitude-behaviour-context (ABC) model (Guagnano et al., 1995), which accounts for the interaction between contextual and socio-psychological variables in individuals' energy behaviours. According to the ABC model, behaviour (B) is an outcome of socio-psychological (or attitudinal) variables (A) and contextual variables (C). Moreover, the strength of the association between socio-psychological variables and behaviour is dependent on the contextual variables: The stronger the association between contextual variables and behaviour, the less that behaviour is dependent on socio-psychological variables (Stern, 2008).

2.1. Environmentally significant behaviour

We used the definition of environmentally significant behaviour by Stern (2000). According to this definition, behaviour is environmentally significant if it has a positive impact on the environment or it has been undertaken with the intention to benefit the environment. This definition acknowledges that there are different types of environmentally significant behaviours. Environmental activism means active involvement in environmental organizations and demonstrations. Non-activist public-sphere behaviours include support for public policies. Private-sphere environmentalism includes consumer behaviours, such as the purchase, use and disposal of products that have an environmental impact. There is evidence that non-activist policy support and private-sphere behaviours are relatively more dependent on the social-psychological variables than environmental activism (Stern, 1999).

2.2. Socio-psychological variables

2.2.1. Pro-environmental attitude

An attitude is defined as a positive or negative predisposition towards an attitude object (Ajzen and Fishbein, 2000). Several studies have reported a positive but weak association between pro-environmental attitude and behaviour (Kollmuss and Agyeman, 2002). There is also evidence that sometimes the association between attitude and behaviour is indirect or moderated by other variables. For example, a positive attitude towards energy conservation in combination with self-efficacy increased individuals' intentions to reduce energy use in households (Abrahamse and Steg, 2011). Environmental knowledge and pro-environmental attitudes have been found to be interrelated and to strengthen each other (Bamberg, 2003).

2.2.2. The consideration of future consequences

Sustainability transitions require individuals to consider the future consequences of their daily behaviours and choices and accept that these behaviours may have immediate costs (e.g. time or money spent) (Arnocky et al., 2013). The consideration of future consequences has been defined as the perceived importance of future outcomes when compared to immediate outcomes (Strathman et al., 1994). A low perceived importance of immediate-future consequences is an important predictor for pro-environmental behaviours (Arnocky et al., 2013), such as the preference for biofuels (Khachatryan et al., 2013). Moreover, the distant-future time perspective increases attitude-behaviour consistency for future-oriented behaviours, whereas the salience of the immediate-future perspective decreases it (Rabinovich et al., 2010). There is also evidence that the immediate concerns are more important than the future considerations in families' energy choices (Shove et al., 2012), suggesting that everyday concerns may be a barrier to sustainable energy choices.

2.2.3. Efficacy beliefs

Individuals' engagement in future-oriented or pro-environmental behaviours has been associated with self-efficacy, which has been defined as the belief that one has control of producing given attainments (Bandura, 1997). Self-efficacy has been found to be directly associated with pro-environmental behaviours (Tabernero and Hernàndez, 2011).

Further, sustainability transitions are collective, multi-level processes where the impacts of individuals' behaviours are dependent on the functioning of the socio-technological system.

Individuals' willingness to engage in such processes has been associated with the belief that the collective or system-level changes are effective in making a transition (Bandura, 2000; Lorenzoni et al., 2007), which in this study is called systemic efficacy.

2.2.4. Subjective knowledge

Individuals' engagement in pro-environmental behaviours has often been associated with knowledge about environmental problems and solutions; however, the association is not clear (Hines et al., 1987; Vainio and Paloniemi, 2014). While some studies show that environmental knowledge encourages sustainable energy behaviour, more studies have recognized that knowledge is *not* an important facilitator of sustainable energy behaviour (Steg et al., 2015). In other words, while knowledge might be a precondition for sustainable energy behaviour, it may not be a strong enough facilitator of behaviour by itself. Further, different kinds of knowledge are associated with behaviours in different ways. Action-related knowledge and knowledge about the effectiveness of particular behaviours were directly associated with pro-environmental behaviour, whereas system knowledge was indirectly related to behaviour (Frick et al., 2004; Pohjolainen et al., 2016; Vainio and Paloniemi, 2013).

Further, there is a distinction between objective knowledge, which refers to what individuals actually know, and subjective knowledge, which refers to individuals' beliefs about their own knowledge (Moorman et al., 2004). They have been shown to correlate positively, and the correlations often fall between 0.3 and 0.6 (Aertesens et al., 2011), suggesting that they are interrelated but have different constructs. For example, subjective knowledge, but not objective knowledge, has been found to be associated with technology acceptance (House et al., 2004).

2.3. Contextual variables: socio-economic variables

Contextual variables are of many kinds, such as the availability of technologies and facilities, existing policy incentives and socio-economic variables (Steg and Vlek, 2009; Šćepanović et al., 2017; Thøgersen, 2005). Contextual variables may facilitate or inhibit individuals' sustainable energy behaviours (Boomsma et al., 2019). Socio-economic variables, such as income, household size, years of education, gender and age, have been associated with pro-environmental behaviours (Abrahamse and Steg, 2011; Kollmuss and Agyeman, 2002; Trotta, 2018). Further, socio-economic variables have been found to predict household energy use more strongly than socio-psychological variables (Abrahamse and Steg, 2009, 2011; Poortinga et al., 2004). Instead, changes in energy use, which require cognitive effort, are dependent on socio-psychological variables (Abrahamse and Steg, 2009).

The effect of socio-psychological variables on energy behaviours is sometimes moderated by the socio-economic variables so that the effect of socio-psychological variables is different in specific socio-economic groups (Barr et al., 2005; Klöckner and Nayum, 2017). Private-sphere energy behaviours have been found to be dependent on gender and income, and therefore, policy instruments may have different impacts on men vs. women (Carlsson-Kanyama and Lindèn, 2007) and low-income vs. high-income groups (Martinsson et al., 2011).

3. The Finnish energy system

Over the last decades, the Finnish energy system has developed into a combination of nuclear power, coal, oil, natural gas, peat, hydropower, wood and more recently wind power. Solar power is also entering the market in more than just stand-alone applications, and heat pumps, biogas and other small-scale energy production forms are emerging (Statistics Finland, 2018). Sustainability measures in previous decades have included energy conservation methods such as stricter insulation regulations for buildings, reduction of pollution through end-of-the-pipe solutions and the widespread use of combined power and heat production, which together with district heating has created an efficient energy system, particularly in cities (Sitra, 2017). The more recently emerged need for carbon-neutral energy has been met only partially (Statistics Finland, 2019).

For electricity production, new nuclear power plants are being built. Finland banned the use of coal in energy production from April 2029 onwards (Finlex 416/2019). Hydropower has very limited expansion potential in Finland. Wind power is growing, and its share could increase rapidly with new technology (Rinne et al., 2018). Solar energy is also entering the market. Nevertheless, bioenergy has often been considered to have the highest potential to produce sustainable energy in Finland (Prime Minister's Office, 2015). This applies also to the transport sector, where the Finnish government has set a target of 20% share of biofuels by 2020, while the EU target is 10%.

There are high ambitions for the increased use of bio-based energy. Biodiversity protection has long caused concern over the increased use of wood, and these concerns have been repeatedly related to renewable energy promotion. Recent discussions have emphasized the need to maintain carbon sinks, which has threatened Finland's possibilities to use wood extensively for energy (Seppälä et al., 2017). A group of Finnish researchers announced in September 2018 that the government's current forest policy will continue to diminish carbon sinks until the end of the century (Yle, 2018). Thus, the planned forest loggings would make the emission cuts made in other sectors pointless (BIOS, 2018).

Heating accounts for about one-fourth of energy consumed in Finland (Statistics Finland, 2018). Ground source heat pumps have become popular in individual houses, and their use in industrial scale is beginning, but they have had limited recognition in the policy agenda (Lauttamäki, 2018). In general, distributed and decentralised energy forms, with their potential to both contribute to the energy palette and to engage consumers in energy markets as active prosumers, have not been realised in Finland (Ruggiero et al., 2015).

4. Hypotheses

The aim of this study was to explore individuals' engagement in the sustainable energy transition. Following the ABC model (Guagnano et al., 1995), this study tested the assumption that individuals' engagement is a combination of socio-psychological and socio-economic variables and that the active engagement of individuals in a sustainability transition requires them to have a mind-set that includes a pro-environmental attitude, future orientation, self-efficacy and systemic efficacy and subjective knowledge. More specifically, eight hypotheses were tested.

4.1. Attitude

H1. A pro-environmental attitude is positively associated with sustainable energy behaviours (Abrahamse and Steg, 2011).

4.2. The consideration of future consequences

H2a. The consideration of *future consequences* is positively associated with sustainable energy behaviours (Arnocky et al., 2013; Khachatryan et al., 2013).

H2b. The consideration of *immediate consequences* is negatively associated with sustainable energy behaviours (Arnocky et al., 2013).

4.3. Efficacy beliefs

H3a. *Self-efficacy* is positively associated with sustainable energy behaviours (Tabernero and Hernàndez, 2011).

H3b. *Systemic efficacy* is positively associated with sustainable energy behaviours (Bandura, 2000; Lorenzoni et al., 2007).

4.4. Knowledge

H4. Action-related subjective knowledge is positively associated with sustainable energy behaviours (Frick et al., 2004; House et al., 2004).

4.5. Overall model

H5a. Private-sphere behaviours and non-activist public behaviours are associated with socio-psychological variables more than environmental activism (Stern, 1999, 2008).

H5b. The socio-economic variables explain a bigger portion of variation in sustainable energy behaviours than socio-psychological variables (Stern, 2008).

5. Material and methods

5.1. Participants

The data were collected through an online questionnaire using the consumer panel of a commercial marketing research company, representative of the 17–75-year-old Finnish-speaking internet users living in Finland (N = 1012) in the fall of 2017. Compared to the adult population of the same age range living in Finland, the participants were a little more likely to be men and to have a high level of education (Table 1).

Table 1
Comparison of the distribution of age, gender, highest education level and area of residence between the Finnish population and the data sample.

	Finnish population (%)	Data sample (%)
Gender (among 17–75 years of age) [a]		
Women	49.8	44.0
Men	50.2	56.0
Age groups [a]		
17–25	14.3	10.1
26–35	17.5	18.0
36–45	16.7	20.1
46–55	17.6	17.3
56–65	18.1	16.4
66–75	15.8	18.2
Highest education (among 20–74 year olds) [b]		
Basic level	19.9	5.7
Secondary level	45.6	11.7
Lowest level tertiary	10.5	29.6
Lower-degree level tertiary	12.5	30.5
Academic	11.5	24.0
Region (among 17–75 year olds) [a]		
Helsinki-Uusimaa	30.7	34.2
Southern Finland	21.2	22.6
Western Finland	24.9	19.7
Northern and Eastern Finland	23.2	23.5
Housing [c]		
Rental dwelling	32.2	30.9
Owner-occupied housing	64.1	66.7
Other [c]	3.7 [d]	2.4 [e]

[a] Source: Statistics Finland (2017).
[b] Source: Statistics Finland (2016).
[c] Percentages for household-dwelling units in the Finnish population; percentages for the respondents in the data sample.
[d] Includes unknown housing.
[e] Includes right-of-occupancy housing and part-ownership dwelling.

5.2. Measures

The analysed variables were part of a longer questionnaire that gathered information about the factors motivating individuals to be part of the energy transition. If not otherwise mentioned, variables were measured using a 5-point scale (1 = 'fully disagree' to 5 = 'fully agree'), and the variables made up of many items were used as mean scores (Table 2).

Self-reported sustainable energy behaviours. The participants were requested to indicate how frequently they engaged in 37 behaviours, on a 6-point scale (0 = 'not personally relevant', 1 = 'never', 2 = 'almost never', 3 = 'occasionally/sometimes', 4 = 'quite often', 5 = 'very often'). The items were grouped in the questionnaire into six groups: energy consumption (6 items); consumption choices (4); mobility and transport (5); energy contracts, own energy production and investments in sustainable energy companies (6); discussing and writing about energy-related issues (8); influencing energy-related issues in organizations (5); and influencing energy-related issues by voting in elections (3). The '0' responses were used as missing values in the mean scores; however, they were included separately in the analyses when it was relevant to the research hypothesis.

Pro-environmental attitude was measured with the item 'Considering the seriousness of climate change, it has received too little attention in the Finnish energy policy decision making'.

Consideration of immediate and future consequences. We used the most recent version of the consideration of future consequences (CFC) scale, including 14 items (Joireman et al., 2012). The respondents indicated whether or not each statement was characteristic of them. The scale contains two subscales: consideration of immediate consequences (CFC-immediate) and consideration of future consequences (CFC-future) (Joireman et al., 2008).

Self-efficacy and systemic efficacy. Using the definition of efficacy by Bandura (1997), self-efficacy related to energy production was defined as the belief that one can personally have an influence on energy production in Finland. It was measured with two items: 'I believe that I can influence from *which sources* the energy is produced in Finland' and 'I believe that I can influence *who produces* energy in Finland'. Systemic efficacy related to renewable energy production was defined as the belief that environmental sustainability can be improved by means of renewable energy production. It was measured with two items: 'I believe that production of renewable energy can reduce the negative environmental and climate impacts of energy production' and 'I believe that renewable energy production can improve the sustainability of energy production'.

Action-related subjective knowledge was measured with six items. First, the respondents indicated whether they had sufficient knowledge of the following issues in order to engage actively in energy-related behaviours: (1) different forms of energy, (2) new energy technologies and (3) the energy transition occurring in the coming decades. Second, the respondents evaluated whether they, in their own opinion, knew about these three issues more than other people did.

The following *socio-economic variables* that have been shown to

Table 2
Bivariate correlations, means/percentages, standard deviations and Cronbach alphas of the main variables.

		1.	2.	3.	4.	5.	6.	7.	8.	9.
1.	Environmental activism									
2.	Private-sphere environmentalism	0.33***								
3.	Non-activist public-sphere behaviours	0.26***	0.28***							
4.	Pro-environmental attitude	0.15***	0.34***	0.17***						
5.	CFC-immediate	−0.10**	−0.40***	−0.22***	−0.22***					
6.	CFC-future	0.21***	0.46***	0.31***	0.29***	−0.49***				
7.	Self-efficacy	0.28***	0.26***	0.18***	0.16***	−0.09**	0.24***			
8.	Systemic efficacy	0.11***	0.44***	0.21***	0.38***	−0.28***	0.44***	0.24***		
9.	Action-related subjective knowledge	0.29***	0.10**	0.16**	−0.01	−0.04	0.22***	0.18***	0.03	
Mean/% (binary variables)		1.39	3.32	3.53	3.32	2.50	3.61	2.39	4.03	2.69
Standard deviation		0.56	0.69	1.40	1.23	0.70	0.61	1.02	0.87	1.00
Cronbach α		0.85	0.80	0.96	–	0.86	0.82	0.89	0.88	0.95

**p < 0.01, ***p < 0.001.

be associated with sustainable energy behaviours were included in the analyses: age, gender, level of education (academic vs. other), subjective economic situation of household (1 = 'serious economic problems' to 5 = 'gets along very well'), household size (lives alone vs. does not live alone) and number of children.

5.3. Data analysis

The analysis proceeded in two steps (Fig. 1). First, the items measuring sustainable energy behaviour were grouped using exploratory factor analysis (EFA), maximum likelihood and varimax rotation. We chose the EFA to extract three factors to identify the three types of environmentally significant behaviours described by Stern (2000). The key items that best represent each factor were selected using the criteria recommended by Howard (2016). The items should load onto their primary factor above 0.40 and onto alternative factors below 0.30, and there should be a difference of 0.20 between their primary and alternative factor loadings. Only the items that met all the criteria were included in the final model (Table 3). For example, the items related to citizens' own energy production (i.e. prosumerism) and investments in sustainable energy companies did not load to any factor and therefore were excluded from the final model. This model explained 51% of total variance (goodness-of-fit: $\chi^2 = 945.84$, df = 168, $p < 0.001$). The items loading at least 0.40 on their primary factor were included in the mean scores for measuring the three types of sustainable energy behaviours.

Second, the research hypotheses about associations among the self-reported sustainable energy behaviours, socio-psychological variables and socio-economic variables were tested with linear regression.

6. Results

6.1. Exploratory factor analysis of sustainable energy behaviours

The first factor, *Environmental activism,* concentrated on energy behaviours aiming to affect energy policy through activist behaviours. The highest loadings on this factor were contacting authorities, participating in a demonstration and contacting members of Parliament. The second factor, *Private-sphere environmentalism,* concentrated on everyday consumer behaviours such as lowering the temperature at home and switching electronic devices off when they are not in use. The third factor, *Non-activist public-sphere behaviours,* included voting in parliamentary, municipal and European Parliament elections. The three types of sustainable energy behaviours correlated moderately with each other (Table 2).

The participants engaged most often in non-activist public-sphere behaviours where the biggest response category was 'very often' (almost 40% of the responses) (Fig. 2). Private-sphere environmentalism was reported to be almost as common, even if about half of the respondents reported engaging only sometimes with it. Environmental activism was considerably rarer: only slightly over 20% reported to have ever engaged in it.

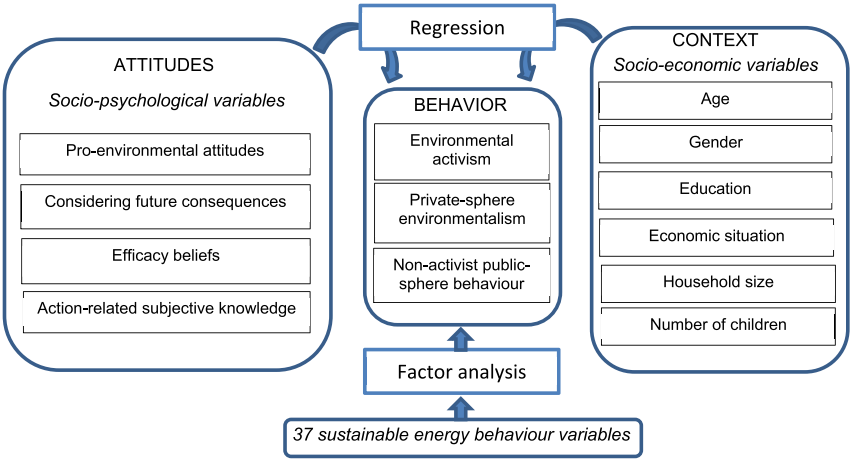

Fig. 1. Research approach.

Table 3
The results of a factor analysis (maximum likelihood, varimax rotation) indicating factor loadings ≥0.10 for the self-reported sustainable energy behaviours. Factor loadings ≥0.40 are displayed in boldface.

Items	Factors		
	1. Environmental activism	2. Private-sphere environmentalism	3. Non-activist public-sphere behaviours
Contacting authorities	**0.71**		
Participating in a demonstration	**0.69**	0.16	
Contacting members of Parliament	**0.67**		
Writing letters to the editor of a newspaper	**0.66**		
Participating in nonviolent direct environmental activism	**0.64**	0.13	
Writing about energy issues in social media	**0.62**	0.10	0.11
Working in a non-governmental organization	**0.60**	0.11	0.12
Sharing information with acquaintances in social media	**0.55**	0.20	0.13
Supporting financially an organization that promotes sustainable energy and/or environment	**0.50**	0.29	
Discussing with energy company representatives	**0.49**		0.12
Actively reducing consumption in general	0.13	**0.79**	
Purchasing products with environmental labels	0.18	**0.74**	0.11
Following a plant-based diet	0.14	**0.60**	
Lowering temperature at home		**0.55**	
Choosing low-energy devices		**0.54**	
Switching off electronic devices when not in use		**0.54**	
Purchasing electricity produced with renewable energy	0.14	**0.48**	
Reducing airplane trips	0.15	**0.45**	
Monitoring one's own energy consumption		**0.43**	
Influencing energy issues by voting in parliamentary elections	0.15	0.20	**0.94**
Influencing energy issues by voting in municipal elections	0.17	0.21	**0.93**
Influencing energy issues by voting in European Parliament elections	0.20	0.15	**0.86**
% of variance	27.56	13.72	9.73

6.2. Hypothesis testing

Hypotheses were tested with linear regression (Table 4). A pro-environmental attitude was positively associated with all three types of sustainable energy behaviours, as expected (H1).

The consideration of future consequences was positively associated with all three types of sustainable energy behaviours, as expected (H2a). The consideration of immediate consequences was only associated with private-sphere environmentalism. The association was negative, as expected, and therefore, H2b was partially confirmed.

Self-efficacy was positively associated with all three types of sustainable energy behaviours, as expected (H3a). Systemic efficacy was only associated with the private-sphere environmentalism, and therefore, H3b was only partially confirmed.

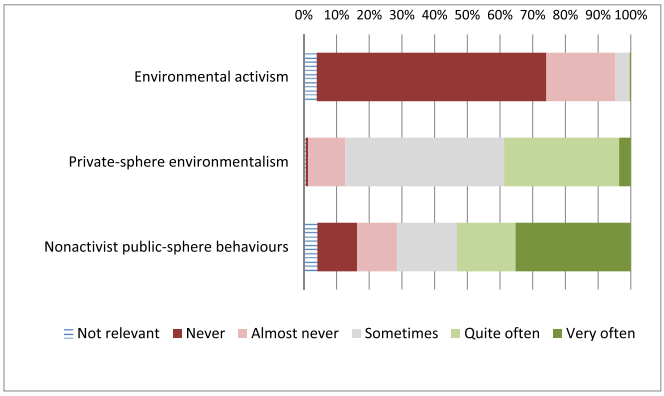

Fig. 2. The distributions of self-reported sustainable energy behaviours.
Note. The values are the mean scores of the items measuring self-reported behaviours. Each mean score has been divided into six categories following the original response categories: 'very often' (range 4.51–5.00), 'often' (3.51–3.40), 'sometimes' (2.51–3.50), 'almost never' (1.51–2.50), 'never' (1.00–1.50) and 'not relevant' (0.01–0.99).

Action-related subjective knowledge was positively associated with all three types of sustainable energy behaviours, as expected (H4).

The socio-psychological variables explained the biggest portion of variance in private-sphere behaviours, whereas they explained a considerably smaller portion of variance in both activist and non-activist public-sphere behaviours. Therefore, H5a was only partially confirmed. The socio-psychological variables explained a considerably bigger portion of variance than the socio-economic variables did, and therefore, H5b was rejected.

7. Discussion

This study explored individuals' self-reported engagement in the sustainable energy transition using a nationally representative survey of the adult population living in Finland. The results complement previous findings on sustainable energy transitions as well as those related to environmentally significant behaviours.

7.1. Energy-related behaviours

The three factors of sustainable energy behaviours made with EFA correspond well to Stern's (2000) typology of environmentally significant behaviours. However, some items that were expected to load on the *Non-activist public-sphere behaviours* factor, such as 'Sharing information with acquaintances in social media' and 'Supporting financially an organization that promotes sustainable energy and/or environment', loaded on the *Environmental activism* factor, suggesting that there may be cultural differences in the definitions of activist and non-activist public-sphere behaviours.

The respondents engaged most often in non-activist public-sphere behaviours, and the private-sphere environmentalism was reported to be almost as common. Environmental activism, on the other hand, was considerably rare. These findings are slightly different from a previous study reporting that Finnish citizens

Table 4
The associations between socio-psychological and socio-economic variables and self-reported sustainable energy behaviours. Linear regressions with standardized coefficients (β) and standard errors.

	Environmental activism		Private-sphere environmentalism		Non-activist public-sphere behaviours	
	β	S.E.	β	S.E.	β	S.E.
Socio-psychological variables:						
Pro-environmental attitude	0.10**	0.02	0.12***	0.02	0.07*	0.04
Consideration of future consequences						
CFC-future	0.10*	0.04	0.23***	0.04	0.19***	0.09
CFC-immediate	0.00	0.03	−0.16***	0.03	−0.05	0.08
Efficacy beliefs						
Self-efficacy	0.21***	0.02	0.12***	0.02	0.11**	0.04
Systemic efficacy	−0.03	0.02	0.23***	0.02	0.05	0.06
Action-related subjective knowledge	0.27***	0.02	0.09**	0.02	0.08*	0.05
Socio-economic variables:						
Age	0.07*	0.00	0.21***	0.00	0.09*	0.00
Gender: female	0.03	0.04	0.15	0.04	−0.02	0.10
Education: academic	0.00	0.04	−0.08***	0.04	0.10**	0.09
Economic situation of household	−0.10**	0.02	−0.02**	0.02	−0.01	0.06
Household size: does not live alone	0.04	0.04	0.07**	0.04	0.04	0.10
Number of children	−0.02	0.01	0.03	0.01	0.00	0.03
Total adjusted R^2	0.17***		0.42***		0.14***	
Adjusted R^2 for socio-psychological variables	0.16***		0.35***		0.12***	
Adjusted R^2 for socio-economic variables	0.00		0.08***		0.03***	

*p < 0.05, **p < 0.01, ***p < 0.001.

considered private-sphere consumer behaviours as a more efficient way of influencing energy policy than through representative democracy (Ruostetsaari, 2018). However, about half of the respondents reported making sustainable energy choices only sometimes. The respondents may not have considered environmental sustainability as part of their daily energy choices, or they may have other considerations that are more important to them than environmental sustainability (Brown and Sovacool, 2018), such as comfort or well-being (Gaspar et al., 2017).

Prosumerism (i.e. residents' own small-scale production and possible sharing of energy into grids as well as decentralised energy production in cooperatives) has been considered an important element in increasing the democratisation of energy production (Parag and Sovacool, 2016; Ruotsalainen et al., 2017; Szulecki, 2018). However, the respondents took this type of action very rarely, and the themes failed to load to any of the three factors, suggesting that these developments still rest with a small number of forerunners in Finland (Nygrén et al., 2015; Ruggiero et al., 2015).

7.2. Socio-psychological variables

A pro-environmental attitude was associated with all three types of pro-environmental behaviours, and the consideration of future consequences was positively associated with all three types of sustainable energy behaviours, as expected. Similar findings have been reported in previous studies (Abrahamse and Steg, 2011; Arnocky et al., 2013; Khachatryan et al., 2013).

The consideration of immediate consequences was negatively associated with private-sphere environmentalism, as expected (Arnocky et al., 2013). This finding suggests that the consideration of immediate consequences is a barrier to making sustainable private-sphere choices, which is also in line with the findings of Shove et al. (2012). However, the consideration of immediate consequences was not associated with either type of public-sphere behaviour, and therefore, immediate concerns do not appear to prevent the respondents from engaging in environmental activism and supporting environmental policies through voting. In other words, public-sphere behaviours may not require individuals to make immediate sacrifices whereas private-sphere consumer choices do, which may explain this finding.

Self-efficacy was positively associated with all three types of sustainable energy behaviours, which is in line with previous research on the association between self-efficacy and pro-environmental behaviour (Tabernero and Hernàndez, 2011). However, systemic efficacy was only associated with private-sphere environmentalism and not with public-sphere behaviours. It is possible that the motivation to engage in public-sphere behaviour may derive both from the positive as well as negative perception of the energy system. On one hand, engagement in public-sphere behaviours may be associated with a perception that an energy system can change, and on the other hand, dissatisfaction with the current system may give rise to the motivation to change it. Therefore, individuals with both a high and low perceived systemic efficacy may be motivated to engage in public-sphere behaviours, which is an issue that needs to be explored in the future. In general, there is a need to study systemic efficacy beliefs, which have received considerably less attention than self-efficacy.

Action-related subjective knowledge was positively associated with all three types of sustainable energy behaviours, as expected (Frick et al., 2004; House et al., 2004). This finding is in line with previous findings about the association between action-related knowledge and pro-environmental behaviour (Frick et al., 2004).

7.3. Overall model

Socio-psychological variables explained the biggest portion of variance in private-sphere behaviours, whereas they explained a considerably smaller portion of variance in both activist and non-activist public-sphere behaviours. In previous studies, private-sphere and non-activist public-sphere behaviours have been associated with socio-psychological variables more than with environmental activism (Stern, 1999, 2008). There are at least two possible explanations for differences in the findings. First, the consideration of future consequences and systemic efficacy beliefs were found to be strongly associated with private-sphere behaviours in particular, which have not been measured in previous studies on individuals' energy-related behaviours. These variables could also in part explain the larger explanatory power of the

regression model for the private-sphere behaviours when compared to the models for public-sphere behaviours. Second, this study focused on socio-economic variables, whereas previous studies have measured other contextual barriers, which may explain the differences in the findings.

The general finding was that the socio-psychological variables explored in the study explained the larger portion of variance than the socio-economic variables in all three types of sustainable energy behaviours. This finding is different from previous studies where it has been reported that the main determinants of energy behaviours are socio-economic (Abrahamse and Steg, 2009, 2011; Poortinga et al., 2004). The ABC model suggests that the fewer contextual barriers there are, the more important socio-psychological variables become in explaining pro-environmental behaviour (Guagnano et al., 1995). There are at least three potential explanations for this difference. First, it has been acknowledged there are considerable differences among countries in the barriers to sustainable energy behaviours (Heiskanen and Matschoss, 2017). Considering the socio-economic variables, it is possible that Finland represents a high-income society with relatively small socio-economic differences, and therefore, it is possible that the socio-economic barriers to sustainable energy behaviours in Finland are relatively less important than in some other countries. In addition, because many energy sustainability actions are not costly but rather save consumers' money, economic barriers may have little importance. Second, the results may depend on which socio-psychological and socio-economic variables have been included. As far as we know, the consideration of future consequences has not previously been included in the studies of energy behaviours, and their association with sustainable energy behaviours was strong, which in part may explain the findings. Third, there is evidence that the socio-psychological variables are more strongly associated with self-reported than actual energy behaviours (Huebner et al., 2016).

7.4. Limitations

The following limitations should be kept in mind when interpreting the results and drawing conclusions. We measured self-reported behaviours, which are subject to social desirability bias (Chung and Monroe, 2003). The same concern applies to the measurement of subjective knowledge because biases lead individuals to rate their level of knowledge higher than it actually is (Reser et al., 2014). Moreover, we measured subjective knowledge at a rather general level and therefore cannot be sure about what areas this knowledge exactly concerns. In addition, a considerable portion of variation in linear regressions was not explained by the socio-psychological and socio-economic variables included in the study. While this is common in studies using socio-psychological variables, it is possible that the sustainable energy behaviours are potentially associated with other variables that were not measured in this study, which is an issue that requires more research. However, similar explanatory power, as well as significant variation in that related to socio-psychological variables for different types of environmentally significant behaviours, has also been reported in previous studies (e.g. Abrahamse and Steg, 2009; Stern et al., 1999). In general, more research comparing self-reported and actual energy behaviours is needed.

8. Conclusions

The results increase the scientific understanding of individuals' energy-related behaviours in sustainability transitions. In particular, the understanding of the association between individuals' future considerations and their energy behaviours is novel, and the findings suggest that they should be included in the socio-psychological models of sustainable behaviour.

The relationships between future considerations and other socio-psychological variables need to be established with other studies. Here, research on futures consciousness might be relevant. According to Ahvenharju et al. (2018), futures consciousness can be crystallized to five dimensions: time perception, agency beliefs, openness to alternatives, systems perception and concern for others. Interestingly, the socio-psychological variables explored in this study partly overlap with four of these dimensions. Agency beliefs and systems perception relate to self-efficacy and systemic efficacy. Time perception addresses the problematics between short-term and long-term future consequences of behaviour. Concern for others includes concern for the environment, too. In future environmental behaviour studies, the openness to alternatives provides an important topic for analysis. Clearly, there is not one possible future but many. Empirical research is needed to investigate whether individuals engaging in pro-environmental behaviours are more likely to see the future as alternative pathways than those whose pro-environmental behaviours are less frequent.

Currently, many energy policies almost exclusively focus on removing the structural barriers to climate change mitigation (e.g., European Commission, 2017; Ministry of Economic affairs and Employment of Finland, 2017). These policies do not address one important barrier: the widening gap between citizens' pro-environmental attitudes and energy use. Therefore, energy policies need to adopt a holistic view that includes both structural and socio-psychological barriers.

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References

Abrahamse, W., Steg, L., 2009. How do socio-demographic and psychological factors relate to households' direct and indirect energy use and savings? J. Econ. Psychol. 30 (5), 711–720.
Abrahamse, W., Steg, L., 2011. Factors related to household energy use and intention to reduce it: the role of psychological and socio-demographic variables. Hum. Ecol. Rev. 30–40.
Aertsens, J., Mondelaers, K., Verbeke, W., Buysse, J., van Huylenbroeck, G., 2011. The influence of subjective and objective knowledge on attitude, motivations and consumption of organic food. Br. Food J. 113, 1353–1378.
Ahvenharju, S., Minkkinen, M., Lalot, F., 2018. The five dimensions of futures consciousness. Futures 104, 1–13.
Ajzen, I., Fishbein, M., 2000. Attitudes and attitude-behavior relation: reasoned and automatic processes. Eur. Rev. Soc. Psychol. 11, 1–33.
Arnocky, S., Milfont, T.L., Nickol, J.R., 2013. Time perspective and sustainable behavior: evidence for the distinction between consideration of immediate and future consequences. Environ. Behav. 46, 556–582.
Bamberg, S., 2003. How does environmental concern influence specific environmentally related behaviors? A new answer to an old question. J. Environ. Psychol. 23, 21–32.
Bandura, A., 1997. Self-efficacy: the Exercise of Control. Freeman, New York.
Bandura, A., 2000. Exercise of human agency through collective efficacy. Curr. Dir. Psychol. Sci. 9, 75–78.
Barr, S., Gilg, A., Ford, N., 2005. The household energy gap: examining the divide between habitual and purchase-related conservation behaviors. Energy Policy 33, 1425–1444.
Boomsma, C., Jones, R.V., Pahl, S., Fuertes, A., 2019. Do psychological factors relate to energy saving behaviours in inefficient and damp homes? A study among English social housing residents. Energy Research & Social Science 47, 146–155.
Brown, M.A., Sovacool, B.K., 2018. Theorizing the behavioral dimension of energy consumption: energy efficiency and the value-action gap. In: Davidson, D.J., Gross, M. (Eds.), The Oxford Handbook of Energy and Society. Oxford University Press, pp. 201–222.
Bögel, P.M., Upham, P., 2018. Role of psychology in sociotechnical transitions studies: review inrelation to consumption and technology acceptance. Environmental Innovation and Societal Transitions 28, 122–136.
Carlsson-Kanyama, A., Lindèn, A.-L., 2007. Energy efficiency in

residences—challenges for women and men in the North. Energy Policy 35, 2163–2172.
Chung, J., Monroe, G.S., 2003. Exploring social desirability bias. J. Bus. Ethics 44, 291–302.
European Commission, 2017. Climate Change. *Special Eurobarometer* 459. TNS Opinion & Social.
Frick, J., Kaiser, F.G., Wilson, M., 2004. Environmental knowledge and conservation behavior: exploring prevalence and structure in a representative sample. Personal. Individ. Differ. 37, 1597–1613.
Gaspar, R., Antunes, D., Faria, A., Meiszner, A., 2017. Sufficiency before efficiency: consumers' profiling and barriers/facilitators of energy efficient behaviours. J. Clean. Prod. 165, 134–142.
Geels, F.W., 2004. From sectoral systems of innovation to socio-technical systems: insights about dynamics and change from sociology and institutional theory. Res. Policy 33, 897–920.
Guagnano, G.A., Stern, P.C., Dietz, T., 1995. Influences on attitude-behavior relationships: a natural experiment with curbside recycling. Environ. Behav. 27, 699–718.
Heiskanen, E., Matschoss, K., 2017. Understanding the uneven diffusion of building-scale renewable energy systems: a review of household, local and country level factors in diverse European countries. Renew. Sustain. Energy Rev. 75, 580–591.
Hines, J.M., Hungerford, H.R., Tomera, A.N., 1987. Analysis and synthesis of research on responsible environmental behavior: a meta-analysis. J. Environ. Educ. 18, 1–8.
House, L., Lusk, J., Jaeger, S., et al., 2004. Objective and subjective knowledge: impacts on consumer demand for genetically modified foods in the United States and the European Union. AgBioforum 7, 113–123.
Howard, M.C., 2016. A review of Exploratory Factor Analysis decisions and overview of current practices: what we are doing and how can we improve? Int. J. Hum. Comput. Interact. 32, 51–62.
Huebner, G., Shipworth, D., Hamilton, I., Chalabi, Z., Oreszczyn, T., 2016. Understanding electricity consumption: a comparative contribution of building factors, socio-demographics, appliances, behaviours and attitudes. Appl. Energy 177, 692–702.
IPCC, 2018. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways. In: The Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty. WMO and UNEP.
Joireman, J., Balliet, D., Sprott, D., Spangenberg, E., Schultz, J., 2008. Consideration of future consequences, ego-depletion, and self-control: support for distinguishing between CFC-immediate and CFC-future sub-scales. Personal. Individ. Differ. 48, 15–21.
Joireman, J., Shaffer, M., Balliet, D., Strathman, A., 2012. Promotion orientation explains why future oriented people exercise and eat healthy: evidence from the two-factor consideration of future consequences 14 scale. Personal. Soc. Psychol. Bull. 38, 1272–1287.
Khachatryan, H., Joireman, J., Casavant, K., 2013. Relating values and consideration of future and immediate consequences to consumer preference for biofuels: a three-dimensional social dilemma analysis. J. Environ. Psychol. 34, 97–108.
Klöckner, C.A., Nayum, A., 2017. Psychological and structural facilitators and barriers to energy upgrades of the privately owned building stock. Energy 140, 1005–1017.
Koirala, B., Araghi, Y., Kroesen, M., Ghorbani, A., Hakvoot, R.A., Herder, P.M., 2018. Trust, awareness, and independence: insights from a socio-psychological factor analysis of citizen knowledge and participation in community energy systems. Energy Research & Social Science 38, 33–40.
Kollmuss, A., Agyeman, J., 2002. Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior? Environ. Educ. Res. 8, 239–260.
Kowalska-Pyzalska, A., 2018. What makes consumers adopt to innovative energy services in the energy market? A review of incentives and barriers. Renew. Sustain. Energy Rev. 82, 3570–3581.
Lauttamäki, V., 2018. Ground-source heat on facilities' heating market in Finland from the times of energy crisis in the 1970s until 2030. In: Annales Universitatis Turkuensis Ser Economica, vol. 29. University of Turku, Finland.
Lorenzoni, I., Nicholson-Cole, S., Whitmarsh, L., 2007. Barriers perceived to engaging with climate change among the UK public and their policy implications. Glob. Environ. Chang. 17, 445–459.
Martinsson, J., Lundqvist, L.J., Sundström, A., 2011. Energy saving in Swedish households. The (relative) importance of environmental attitudes. Energy Policy 39, 5182–5191.
Ministry of Economic affairs and Employment of Finland, 2017. Government Report on the National Energy and Climate Strategy for 2030. Publications of the Ministry of Economic Affairs and Employment 12/2017.
Moorman, C., Diehl, K., Brinberg, D., Kidwell, B., 2004. Subjective knowledge, search locations, and consumer choice. J. Consum. Res. 31, 673–678.
Carbon footprint and raw material requirement of public procurement and household consumption in Finland – results obtained using the ENVIMAT-model. In: Nissinen, A., Savolainen, H. (Eds.), Suomen ympäristökeskuksen raportteja 15, 2019 (In Finnish with English abstract).
Nygrén, N.A., Kontio, P., Lyytimäki, J., Varho, V., Tapio, P., 2015. Early adopters boosting the diffusion of sustainable small-scale energy solutions. Renew. Sustain. Energy Rev. 46, 79–87.
Parag, Y., Sovacool, B.K., 2016. Electricity market design for the prosumer era. Nature Energy 1.
Pohjolainen, P., Tapio, P., Vinnari, M., Jokinen, P., Räsänen, P., 2016. Consumer consciousness on meat and the environment - exploring differences. Appetite 101, 37–45.
Poortinga, V., Steg, L., Vlek, C., 2004. Values, environmental concern, and environmental behaviour: a study into household energy use. Environ. Behav. 36, 70–93.
Prime Minister's Office, 2015. Finland, a Land of Solutions. Strategic Programme of Prime Minister Juha Sipilä's Government. Government Publications, 12/2015.
Rabinovich, A., Morton, T., Postmes, T., 2010. Time perspective and attitude-behaviour consistency in future-oriented behaviours. Br. J. Soc. Psychol. 49, 69–89.
Reser, J.P., Bradley, G.L., Ellul, M.C., 2014. Encountering climate change: seeing is more than believing. Wiley Interdisciplinary Review of Climate Change 5, 521–537.
Rinne, E., Holttinen, H., Kiviluoma, J., Rissanen, S., 2018. Effects of turbine technology and land use on wind power resource potential. Nature Energy 3, 494–500.
Rouvinen, S., Matero, J., 2013. Stated preferences of Finnish private homeowners for residential heating systems: a discrete choice experiment. Biomass Bioenergy 57, 22–32.
Ruggiero, S., Varho, V., Rikkonen, P., 2015. Transition to distributed energy generation in Finland: prospects and barriers. Energy Policy 86, 433–443.
Ruostetsaari, I., 2018. Political consumerism as a means in influencing energy policy and solving environmental problems: the Case of Finland in 2007-2016. International Journal of Economy, Energy and Environment 3, 21–31.
Ruotsalainen, J., Karjalainen, J., Child, M., Heinonen, S., 2017. Culture, values, lifestyles, and power in energy futures: a critical peer-to-peer vision for renewable energy. Energy Research & Social Science 34, 231–239.
Sardianou, E., Genoudi, P., 2013. Which factors affect the willingness of consumers to adopt renewable energies? Renew. Energy 57, 1–4.
Šćepanović, S., Warnier, M., Nurminen, J.K., 2017. The role of context in residential energy interventions: a meta review. Renew. Sustain. Energy Rev. 77, 1146–1168.
Schaeffer, M., Rogelj, J., Roming, N., Sferra, F., Hare, B., Serdeczny, O., 2015. Feasibility of Limiting Warming to 1.5 and 2°C. Climate Analytics, Berlin, Germany.
Seppälä, J., Asikainen, A., Kalliokoski, T., Kanninen, M., Koskela, S., Ratinen, I., Routa, J., 2017. Main Messages from Researchers Concerning the Climate Impacts of Forest Utilization. The Finnish Climate Change Panel Report, 1/2017.
Shove, E., Pantzar, M., Watson, M., 2012. The Dynamics of Social Practice: Everyday Life and How it Changes. Sage, London.
Statistics Finland, 2016. Population Structure. Statistics Finland's PX-Web Databases.
Statistics Finland, 2017. Educational Structure of Population. Statistics Finland's PX-Web databases.
Statistics Finland, 2018. Final Energy Consumption by Sector. Statistics Finland's PX-Web databases.
Steg, L., Vlek, C., 2009. Encouraging pro-environmental behaviour: an integrative review and research agenda. J. Environ. Psychol. 29, 309–317.
Steg, L., Perlaviciute, G., van der Werff, E., 2015. Understanding the human dimensions of a sustainable energy transition. Front. Psychol. 6, 805.
Stern, P.C., 1999. Information, incentives, and proenvironmental consumer behavior. J. Consum. Policy 22, 461–478.
Stern, P.C., 2000. Toward a coherent theory of environmentally significant behavior. *J. Soc. Issues* 56, 407–424.
Stern, P.C., 2008. Environmentally significant behavior in the home. In: Lewis, A. (Ed.), The Cambridge Handbook of Psychology and Economic Behaviour. Cambridge University Press, New York, NY, US, pp. 363–382.
Strathman, A., Gleicher, F., Boninger, D.S., Edwards, C.S., 1994. The consideration of future consequences: weighing immediate and distant outcomes of behavior. J. Personal. Soc. Psychol. 66, 742–752.
Szulecki, K., 2018. Conceptualizing energy democracy. Environ. Pol. 27, 21–41.
Tabernero, C., Hernàndez, B., 2011. Self-efficacy and intrinsic motivation guiding environmental behavior. Environ. Behav. 43, 658–675.
Thøgersen, J., 2005. How may consumer policy empower consumers for sustainable lifestyles? J. Consum. Policy 28, 143–178.
Trotta, G., 2018. Factors affecting energy-saving behaviours and energy efficiency investments in British households. Energy Policy 114, 529–539.
Upham, P., Dütschke, E., Schneider, U., Oltra, C., Sala, R., Lores, M., Klapper, R., Bögel, P., 2018. Agency and structure in a sociotechnical transition: hydrogen fuel cells, conjunctural knowledge and structuration in Europe. Energy Research & Social Science 37, 163–174.
Vainio, A., Paloniemi, R., 2013. Does belief matter in climate change action? Public Underst. Sci. 22, 382–395.
Vainio, A., Paloniemi, R., 2014. The complex role of attitudes toward science in pro-environmental consumption in the Nordic countries. Ecol. Econ. 108, 18–27.
Vainio, A., Varho, V., Tapio, P., Pulkka, A., Paloniemi, R., 2019. Citizens' images of sustainable energy transition. Energy 183, 606–616.

Web references

BIOS, 2018. Suomen ilmastopolitiikka kriisissä. http://bios.fi/suomen-ilmastopolitiikka-kriisissa/. (Accessed 6 November 2018).
Eurostat, 2016. Final energy consumption in households per capita. https://ec.

europa.eu/eurostat/web/products-datasets/-/sdg_07_20. (Accessed 7 November 2018).
Finlex 416/2019. Laki hiilen energiakäytön kieltämisestä (Law on prohibiting the use of coal in energy use). https://www.finlex.fi/fi/laki/alkup/2019/20190416. (Accessed 16 May 2019).
FMI, 2018. Temperature and Precipitation Statistics from 1961 Onwards. Finnish Meteorological Institute. https://en.ilmatieteenlaitos.fi/statistics-from-1961-onwards. (Accessed 6 November 2018).
NYPost, 31.7.2018. Northern California wildfires prompt evacuation orders for nearly 20K people. https://nypost.com/2018/07/31/northern-california-wildfires-force-evacuation-orders-for-nearly-20k-people/. (Accessed 6 November 2018).
NY Times, 7.7, 2018. Japan reels from heavy rains; dozens killed and millions urged to evacuate. https://www.nytimes.com/2018/07/07/world/asia/japan-rain-landslides.html. (Accessed 6 November 2018).
Sitra, 2017. Combined heat and power production. https://www.sitra.fi/en/cases/combined-heat-power-production/. (Accessed 31 October 2018).
SMHI, 2018. Månads- årstids- och årskartor. Swedish Meteorological and Hydrological Institute. https://www.smhi.se/klimatdata/meteorologi/kartor/monYrTable.php?myn=8&par=tmpAvv. (Accessed 6 November 2018).
Statistics Finland, 2019. Total Consumption of Energy Increased by 2 Per Cent in 2018. http://www.stat.fi/til/ehk/2018/04/ehk_2018_04_2019-03-28_tie_001_en.html. (Accessed 31 May 2019).
Washington Post, 5.7.2018. Red-hot planet: all-time heat records have been set all over the world during the past week. https://www.washingtonpost.com/news/capital-weather-gang/wp/2018/07/03/hot-planet-all-time-heat-records-have-been-set-all-over-the-world-in-last-week/?utm_term=.eda9421d2604. (Accessed 6 November 2018).
Yle, 5.9, 2018. Ympäristöasiantuntijat Lyttäävät Hallituksen Ilmastopolitiikan – Metsien Lisähakkuut Nollaavat Kaikki Muut Ilmastohankkeet. https://yle.fi/uutiset/3-10389057. (Accessed 6 November 2018).