Influence of interventions and internal motivation on Swedish homeowners' change of on-site sewage systems

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Abstract

This article reports results from a questionnaire administered to Swedish homeowners (N=1481) investigating factors that influence them, as users and owners of on-site sewage systems (OSS), to environmentally improve their OSS. Social and psychological factors were based on previous research into pro-environmental and compliance behaviors and a previous interview study. The results suggest that the most important motives are to benefit, to act when outcomes are fair, and to avoid inconvenience. Less important motives are to act when outcomes are fair and to act of concern for the environment. Perceived efficacy in decreasing the environmental impacts of current OSS and it the OSS is changed, and perceived ability to change their OSS are also among the strongest predictors of readiness to change an OSS. However, among homeowners who changed their OSS to do ones duty and achieve long-term safety were ranked highest. The results support the expectations of goal-framing theory that motives related to "gain" would be focal in situations of unfavorable cost-benefit ratios. Similarly, the importance of fair outcomes and efficacious rules is consistent with general findings in research on social dilemmas.

Keywords:

Small-scale wastewater treatment; eutrophication; goal-framing theory; regulatory compliance; principal component analysis; multiple regression analysis

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1 Introduction

What encourages homeowners to environmentally improve their on-site sewage systems (OSS)? The answer to this is very important for the efforts for reducing nutrient loads, mainly phosphorous and nitrogen, to the marine environment. The costs of improving or changing OSS, which can be relatively high, fall on the individual homeowner, who only rarely receives any economic paybacks. Although there are rules and standards for OSS, enforcement by the authorities is inconsistent, offering homeowners the opportunity to avoid making environmentally necessary changes.

The general aim of this study was to investigate which factors influence Swedish homeowners to decide to improve their OSS. We analyzed the role of various motives on decisions about changing their OSS under current policy and management regime, and went some way to analyze the effectiveness of current regulations and enforcement actions. Knowledge of these factors will provide insight into increasing the effectiveness of current policy and management measures.

In this paper we analyze the results of a questionnaire sent to a random sample of homeowners with OSS listed in the Swedish property registry. As dependent variables we measured whether respondents had changed their OSS, and their readiness to change in the short and long term. Respondents who had changed OSS were asked about the importance of various motivational and contextual factors, interventions, and information sources to their decision to change OSS. To explain readiness to change OSS we tested factors derived from goal-framing theory (Lindenberg and Steg, 2007; Steg and Vlek, 2009), literature on compliance with government regulations (May and Winter, 1999; Winter and May, 2001; May, 2005), and studies of trust and fair institutions (e.g., Braithwaite and Levi, 1998; Levi and Stoker, 2000; Rothstein and Teorell, 2008).

The paper is organized as follows: first, we present the background to the research; second, we briefly review relevant research into homeowners' decisions to change to environmentally improved techniques and the motivational factors that underlie compliance behavior; third, we describe the factors tested in the study, the sampling procedure, and the items used in the questionnaire; fourth, we present results from the data analysis. In the final sections we discuss the results and draw some general conclusions.

1.1 Background to the research

Marine eutrophication, caused by nutrient loading, is a global environmental problem, particularly severe in the enclosed Baltic Sea (Larsson et al., 1985; Diaz and Rosenberg, 2008; HELCOM, 2009). The situation has been recognized by the Baltic Sea riparian states through the establishment of the Baltic Sea Action Plan and by Europe through the Water Framework directive (European Commission, 2000; HELCOM, 2007). Sweden have management plans and plans of measures aiming for substantial ecological improvements by the year 2015 (HELCOM, 2007; SEPA, 2008b; (e.g.) Southern Baltic Sea Water Authority 2010).

In Sweden OSS are prioritized for improvement because of their significant contribution to nutrient loads – 15% of phosphorous and 5% of nitrogen loads in Swedish water courses originate from OSS (SEPA, 2009b; Ek et al., 2011). Furthermore, few improvements have been made in OSS, particularly in existing housing (Ejhed et al., 2004), and therefore the potential for decreased nutrient loads is relatively large. For instance, in the case of phosphorous loads, the removal rates could increase from 5%-15% to 90%-95% if the best available technologies were used (SEPA, 2008a; Ek et al., 2011). About half of the OSS in Sweden, or about 350 000 OSS, are estimated to be in the lower end of that range (Ejhed et al., 2004; Ek et al., 2011).

Ultimately, there is a need to encourage homeowners with OSS to improve their systems to meet current environmental targets and to contribute to a long-term solution to eutrophication. This may mean homeowners will need to, for instance, change from two- to three-chambered sludge separators and add an infiltration bed or to install a small-scale wastewater treatment plant. While such changes can contribute to collective benefits (e.g., a less polluted sea), they also costs the individual homeowner about €5000 to €15000, and provide little, if any, private economic payback. Furthermore, restrictions on the choice of technology (e.g., due to soil type or other environmental conditions) constrain homeowners' options, and may thus reduce their willingness to invest in a new OSS. Current measures in Sweden include changed legislation and new rules, and enforcement to persuade or coerce homeowners to change their OSS. The unpleasantness or inconvenience associated with noncompliance with the rules can sometimes be very effective, but overly stringent rules and too formal enforcement can also provoke reactions (Ölander and Thøgersen, 1995; Winter and May, 2001), which increase the workload of enforcing authorities. It also puts the long-term viability of the system of persuasion at risk, since such system requires the approval of at least a majority of those affected by them.

Recently, the Swedish government has introduced a 50% tax deduction on the installation of a new OSS (MoF, 2008). Assuming a labor cost of SEK 25,000, that deduction would reduce the

investment by approximately 10% for the most expensive OSS and 30% for the least expensive OSS (Avloppsguiden, 2009). Some municipalities also offer a rebate of the inspection fee (small percentage of the cost) to motivate homeowners to change their OSS. The Swedish Environmental Protection Agency (SEPA) also ran a national information campaign (2010−2011), in cooperation with participating municipalities to raise homeowners' awareness of the problems with OSS and eutrophication and the regulations that apply to homeowners using OSS (SEPA, 2009a). Municipalities have also formed a national network Avloppsguiden, aiming to exchange experiences about enforcement practices among environmental authority inspectors, but also aiming to be an information source for homeowners, available on the net (www.avloppsguiden.se), about OSS regulations, available technologies, and how to go about changing OSS.

2 Previous research on influencing factors

2.1 Homeowners changing to environmentally improved technologies

Research into homeowners changing to environmentally improved technologies is fairly abundant, though most research has focused on the adoption of renewable energy technologies, district heating systems, and energy-efficiency measures (e.g., Mahapatra and Gustavsson, 2008; 2009; 2010; Nair et al., 2010; Sopha et al., 2011). While this research studied similar actors and their decisions were superficially similar to those of homeowners deciding about changing their OSS (i.e., homeowners invested in environmentally improved technologies), the contexts have important differences. For example, investments in renewable energy technology or energy-efficiency measures are almost always associated with an economic payback, and this is not the case for investments in OSS. Moreover, in the case of renewable energy technologies in Sweden, the government intervenes primarily through informational and economic instruments, rather than specifying emission standards directly restricting individuals' space of action. Studies of households' curbside recycling behavior (e.g., Hage et al., 2009; Bouvier and Wagner, 2011; Saphores et al., 2012) show relatively high compliance despite no economic payback; however there were also practically no economic costs of recycling. Studies on the adoption of OSS exist, but they tend to focus on attitudes towards particular technologies (e.g., urine separation systems) and the decision between several technologies instead the more general decision to upgrade the OSS (Schmidtbauer, 1996; Pahl-Wostl et al., 2003; Panebianco and Pahl-Wostl, 2006; Andersson, 2008).

2.2 Motivational factors of relevance for changing OSS

Because the decision to change OSS has a particular context and because of the lack of research into homeowners' decisions about changing their OSS we investigated a broad set of

motivational factors, informed by research into pro-environmental behavior and compliance behavior, including studies on trust and fair institutions. Building on a recent explanation of pro-environmental behavior, goal-framing theory (Lindenberg and Steg, 2007), Steg and Vlek (2009) proposed a framework consisting of (1) interacting motives to engage in different behaviors; (2) contextual forces enabling and constraining behavior; and (3) interventions, informational or structural in nature, that can remove barriers (e.g. high prices) or support norm-guided behavior (e.g. environmental information). Motives are central in explaining individuals' behavior because they frame how a person perceives various aspects of a situation, which behavioral options are considered, how these are evaluated, and ultimately how the person acts. According to goal-framing theory (Lindenberg and Steg, 2007: 119) motives can be categorized as hedonic ("to feel better right now"); gain-oriented ("to guard and improve one's resources"); or normative ("to act appropriately"). The strongest motives influence behavior the most, while weaker motives, though pushed into the background, may alter the order of preferable options. Context relates to structural factors, such as the social, natural or infrastructural conditions in which an individual operates that can potentially reinforce or weaken a goal frame. Structural factors may be difficult or impossible for regulators to influence, as in the case of soil type at particular properties. Other structural factors, such as the cost of different courses of action, may be easier to influence through taxes or subsidies. Context is importance in decisions about OSS because of the physical conditions, relatively high cost of improvement, and lack of private economic payback, which amount to heavy behavioral constraints. In such a situation, the goal frame is expected to be gain and normative motivation is expected to play a background role (Lindenberg and Steg, 2007). Policy and management actors can thus influence the context, but can also strengthen or weaken a goal frame more directly by sending signals, for example, about appropriate behavior (Steg and Vlek, 2009).

One of the distinctions made in research about compliance is between informal and formal means of regulatory enforcement (Winter and May, 2001). More informal and non-deterrent means of enforcement, i.e., information and communication, can lead to compliance through normative and social motivation. More formal enforcement means, i.e., injunctions and sanctions, may sometimes be needed to instigate action, especially when costs are high; however, formal enforcement may be perceived as coercion and may decrease willingness to comply (Winter and May, 2001). Previous research (Levi and Stoker, 2000) suggests that a *combination* of informal means of enforcement (i.e., awareness-raising communication) and more formal means (i.e., injunctions, sanctions) may persuade individuals to comply with prescribed behavior. Further, formal means are most effective when deterrent means are "kept in the background" (Levi and Stoker, 2000: 492).

Research emphasizing the importance of trust in authorities and fair institutions gives further guidance about the conditions in which interventions influence behavior. Political trust is defined as the level of citizens' trust in political institutions, such as the government, public authorities, and public officials (Levi and Stoker, 2000). Although the trust people generally place in politicians and political institutions affects how they think about particular authorities, the most important drivers of behavior "are their judgments concerning particular authorities" (Levi and Stoker, 2000: 495). Importantly, the level of trust in political institutions depends a great deal on the quality of institutional arrangements, especially on procedures that are seen to be fair and commitments that are kept (Braithwaite and Levi, 1998; Levi and Stoker, 2000; Rothstein and Teorell, 2008). The more people trust that political institutions and fellow citizens can enforce the social contract and maintain fair procedures and that their fellow citizens will conform to the regulations , the more likely it is that they will contribute to the common good themselves (cf. Torgler and Schneider, 2005; Frey and Torgler, 2007; Hammar et al., 2009; Torgler et al., 2009). In a similar vein, individuals may object to contributing to a common good because they do not find it fair that they have to contribute as much as others. This raises issue of distributive justice. It is common to distinguish between three principles of distributive justice: equality, equity, and need (Deutsch, 1975). Equality implies that everyone has the same obligation to contribute, while the equity and need principles allow exemptions based on individual circumstances. Those who adhere most strongly to the equality principle may thus be expected to be the most ready to change their OSS in the future.

Our previous study (Wallin et al., 2011) supported the claim that public institutions should act fairly to ensure compliance; it was important to homeowners that they received fair treatment by the regulatory authorities. Furthermore, awareness of the problem, the rules, and the risk of being charged for non-compliance seemed important for compliance with the regulations, as shown in a previous study by the authors and by others studying compliance behavior (Winter and May, 2001; Wallin et al., 2011).

Studies have shown that actors in the social environment may influence homeowner decision-making through providing information and advice (Mahapatra and Gustavsson, 2008; Wallin et al., 2011). Homeowners may, for instance, take advice from manufacturers or installers of the technology or search for available information at authorities' or private organizations' websites. Homeowner characteristics and circumstances may also be important to consider. Studies of homeowners' decisions about energy systems have shown that age and income may be important (Henning and Lorenz, 2005; Sernhed and Pyrko, 2006). Of particular interest are groups at the ends of the age and income scales, e.g. elderly people or those with the lowest and highest incomes, as suggested by Sernhed and Pyrko (2006) in their study of homeowners

converting to district heating systems. A previous change of OSS may be important, but because it is an infrequent investment rather than a recurrent behavior, previous change should be expected to make homeowners less willing to change their OSS, at least in the near future perspective, as shown in the case of homeowners' willingness to convert to district heating (Henning and Lorenz, 2005).

2.3 Aim and scope of present study

The specific aims of this paper are (1) to identify and investigate the effect and relative strength of motivational factors on homeowners' decision to change their OSS, (2) go some way towards investigating the effect of official interventions, and (3) to investigate what sources of information and advice influence homeowners who change their OSS.

In the paper we address the aims by investigating the motivational factors underlying homeowners' intentions and actual decisions to change their OSS. In most of the investigated cases a change of OSS implies a higher nutrient removal potential since a large share of the technical systems used today have a low nutrient capture. Furthermore, there are large uncertainties regarding the nutrient capture potential of todays' dominant technologies in the short-term but much less in the long-term (Eveborn et al., 2012). This implies that ensuring environmentally well-functioning OSS requires homeowners to take recurring actions to improve their OSS. Therefore, we investigate both homeowners' actual decisions to change their OSS and their willingness to change OSS. Further, we use two time frames in order to capture both immediate and long-term readiness to change OSS.

3 Method

3.1 Sampling and procedure

The questionnaire was mailed to 3615 homeowners in Sweden with OSS, randomly sampled from the Swedish property registry. After 10 days a first reminder was sent and after another two weeks a second reminder was sent together with a new questionnaire. No rewards were given to respondents of the questionnaire.

3.2 Items

The questionnaire items were developed using previous research, as presented in section 0. A pilot questionnaire was sent to 100 homeowners to test the questions for, for example, uninterpretable response patterns or too many missing values. No major changes were made to the study questionnaire.

Two sets of items were included as dependent variables:

Change of OSS. One item asked whether and when homeowners had changed their OSS (on a scale of 0 [no], 1 [yes, before 1990], and 2-5 [yes, on five-year intervals from 1991 to 2010]). In the analysis, a dichotomous version (no/yes), a 3-category version (no; yes, > 15 years ago; yes, ≤ 15 years ago), and a 4-category version (no; yes, > 15 years ago; yes, between 6 and 15 years ago; yes, ≤ 5 years ago) of the variable were used. The dichotomous version of the variable was also used as a control for explaining readiness to change OSS, because past change may influence readiness to change again.

Readiness to change OSS. Two items were used to measure readiness to change OSS in the short term (within 5 years), and in the long term (between 6 and 30 years). The scale ranged from +3 (I would definitely change OSS) to -3 (I would definitely not change OSS).

Homeowners who had changed their OSS responded to the following sets of items, included as independent variables to explain why homeowners had changed their OSS:

Importance of motivation, contextual factors, and interventions. Homeowners who had changed OSS were asked to indicate on a scale of 1 (not at all important) to 7 (very important) how important a particular set of factors had been to their decision. 18 items were used to measure aspects of the situation that influenced homeowners' decision to change their OSS. These included reasonability of costs, scale of reconstruction work needed, if it felt convenient today, avoided inconveniencies (such as smell and spread of infectious disease), long-term safety, environmental impact, recycling of nutrients, whether other homeowners were changing their OSS, and whether homeowners considered it their duty to change OSS. We also asked about the influence of perceived constraints due to soil conditions at the property; advice from inspectors; advice from contractors; advice from relatives, neighbors, colleagues and similar persons; demands from authorities; whether the change was done in cooperation with others; the tax deduction; and possible municipal subsidies.

Importance of information sources for the change of OSS. Homeowners who had changed their OSS were also asked to rank on a scale of 1 (not at all important) to 7 (very important) the influence of various sources of information: inspectors; the municipal homepage; contractors (making the installations); the Swedish Environmental Protection Agency; OSS consultants (who may advice homeowners regarding technology choice and the dimensioning aspects of installing an OSS); relatives, neighbors, colleagues and similar persons; OSS manufacturers; OSS sellers/suppliers; estate-agents; the Avloppsguiden; popular media; and environmental associations.

The following sets of items, included as independent variables, were responded to by all homeowners and were used to develop a set of motivational factors to be used as candidates for explaining homeowners' intentions to change OSS:

Importance of factors for changing OSS in the future. All homeowners were asked to rank on a scale of 1 (disagree completely) to 7 (agree completely) whether they would change their OSS in the future given a number of scenarios. Ten different scenarios were described: cheaper technologies; decreased costs of operation and maintenance; smells, leakages or other inconveniencies; long-term safety; increased use of the OSS; environmental impacts; risk of infectious disease; improved technologies; treatment below regulated standards; and whether other homeowners changed their OSS.

Trust, general. On a scale of 0 (no trust) to 10 (complete trust), one item measured horizontal trust (people in general) and one measured vertical trust (institutions such as the police, courts, universities).

Trust, OSS-related. On a scale of 1 (no trust) to 5 (complete trust), 13 items measured trust in particular public institutions and OSS-sector actors. The actors included were: inspectors; the municipality; contractors; Swedish environmental authorities; SEPA; OSS specialists; relatives, colleagues, neighbors, and similar persons; technology manufacturers; estate agents; technology suppliers; the Avloppsguiden; popular media; and environmental associations.

Fairness. Six items presented scenarios that respondents were asked to rank for fairness on a scale of 1 (very unfair) to 5 (completely fair). Two items were ranked on the principle of equality, which holds that requirements should be the same for all, and two were ranked on the principle of equity, in which requirements should be adapted to how much the OSS is utilized. Two other items measured fairness according to need, in which requirements are adapted to the homeowner's economic capability.

Environmental concern. On a scale of 1 (disagree completely) to 7 (agree completely), 10 items measured whether it was important to care for the environment, that other people cared for the environment, and particularly that care for the environment should be shown by changing OSS.

Perceptions about OSS, its impacts, and the effectiveness of rule enforcement. On a scale of 1 (disagree completely) to 7 (agree completely), 13 items (e.g., "an OSS that meets the requirements has low environmental impact") measured beliefs about OSS, including environmental load reductions, costs, the effectiveness of regulation, and likes and dislikes concerning regulations and changing the OSS.

Perceived ability to change the OSS and to control the consequences. On a scale of 1 (disagree completely) to 7 (agree completely), 10 items covered the obstacles and opportunities in changing an OSS and the respondent's perceived ability to change OSS. Items included the availability of good alternatives, the costs, whether a change in OSS would decrease environmental impacts, expected remaining living time in the house, sufficiency of treatment

with current OSS, and perceived ability to change OSS (e.g. “it is not possible for me to change my OSS”).

The following items were included as independent variables in explaining why homeowners’ changed their OSS and were used as control variables in explaining homeowners’ intentions to change OSS:
Interventions. On a scale of 1 (no) and 2–5 (yes [2, 5, 15, more than 15 years ago]), 6 items measured whether and when homeowners had been affected by inspections, had received recommendations or injunctions to change the OSS, had received information from a current national information campaign, had been offered municipal connection, or knew they could receive a tax deduction for making a change. In the analysis both a dichotomous (no, yes) and a 3-category version (no; yes, < 15 years ago; yes > 15 years ago) of the variable was used.

The following items were used as control variables when explaining readiness to change OSS:
Homeowner characteristics and circumstances. Age (year of birth) and household monthly income (8 income categories from 1 (SEK0 to SEK30,000) to 8 (> SEK151,000) were used as control variables. The normal use of the house was also included as a control variable, ranked from 1 (1 to 3 months) to 4 (9 to 12 months).

3.3 Analysis

The analysis had three parts. First, we analyzed the data for homeowners who changed OSS to determine their reasons for changing their OSS and the importance of various information sources to their decisions. The relationships between authorities enforcement actions and changes to OSS was investigated with a chi-square test to analyze how often homeowners by such interventions (usually inspections, but also injunctions) had also changed OSS. Since we hypothesized that homeowners might take action after only an inspection campaign only, without receiving an injunction, *inspection campaign* was layered above of *injunctions* in the cross-table. A distinction was made between homeowners who had changed OSS recently (in the past 15 years) and homeowners who had changed OSS much earlier (more than 15 years ago). The importance of various reasons and information sources to the decision to change OSS was investigated using descriptive statistics. Principal component analysis (PCA) was applied to the chosen items to investigate how many dimensions were needed to explain variance between homeowners who had changed OSS. This simplified interpretation and enabled us to describe the heterogeneity of the homeowners.

Second, data for all homeowners in the sample was used to explain their readiness to change OSS. PCA was used to explore which latent variables could explain readiness to change OSS. The following sets of items were included (described in more detail in section 0): *importance of factors for changing OSS in the future*; *trust (general); trust (OSS-related); fairness, environmental concerns; perceptions about OSS, its impacts, and the effectiveness of rule enforcement;* and *perceived ability to change the OSS and to control the consequences*. Oblimin rotation of the component matrix was applied. Models with 9, 10, or 11 components (Eigen values > 1) were investigated. Further reduction of the number of components was not meaningful. Cross-loading variables, low-loading variables (< 0.4), and variables that did not match other variables in content, within a component, were removed. A random split test was used in choosing a component model. Since only the model with 10 components passed the test, it was chosen for further analysis. New variables were formed from the components by computing mean values of the variables loading on each component. All new variables had Cronbach's alpha > 0.6, with most about 0.8-0.9, indicating high internal consistency.

Third, readiness to change OSS, in both the short- and long-term, was investigated using the new variables from the PCA and background factors corresponding to interventions, past change of OSS, and homeowner characteristics. Bivariate correlations, ANOVA, and t-tests were used to investigate the influence of different background factors and what sub-groups and categories should be included in the regression model. Interaction effects were not included in the regression. The regression analysis was done block-wise, with interventions added first, then past change of OSS, homeowner characteristics, and finally the motivational factors resulting from the second analysis step. Within each block, the variables were entered stepwise, combining forward selection ($p_{enter} < 0.05$) and backward elimination ($p_{remove} < 0.1$).

4 Results

4.1 Participants

Of the homeowners in the sample, 1615 homeowners responded to the questionnaire (46% of the sample). After removing homeowners with connection to the municipal WTTP (n=51) and homeowners who had built new houses and therefore had installed a new OSS (n=72), the remaining 1481 respondents (42%) were used in the further analysis. Data on current OSS among the respondents was used to judge whether the sample was representative of the population. A fair similarity was found (Table 1). The exception was the alternative phosphorus filter, possibly because phosphorus filter is an ambiguous term– all infiltration beds and soil filters are to some extent cleaning the wastewater from phosphorus.

Table 1 Frequency of reported treatment technologies in this survey compared to estimates by Ek et al. (2011) of currently used treatment technologies by homeowners in Sweden.

	This survey		Available estimates	
	N	%	N	%
Sludge separator with/without gravel bed	306	22	133,051	19
Sludge separator with infiltration bed/compact filter	687	49	393,246	57
Small-scale wastewater treatment plant	42	3	13,660	2
Closed septic tank/urine separation system/composting toilet	349	25	143,809	21
Phosphorus filter	22	2	765	0.1
Don't know	75			
Total	1481			

4.2 Explaining change of OSS among homeowners who have already changed OSS

4.2.1 Factors influencing change of OSS and important information sources

The most important (M > 5.5) factors influencing change of OSS were long-term safety and doing one's duty, followed by convenience, demands from authorities, and reasonable costs (M about 5 or higher), as illustrated in Table 2. Environmental impact was another relatively important factor. Important information sources (M > 4) were inspectors and contractors. The tax deduction and other economic subsidies were unimportant to the homeowners. However, the tax deduction was introduced only recently and economic subsidies might not have affected many homeowners, so these figures may not reflect the actual effects of these incentives.

Table 2 Mean values, medians and standard deviations of the stated importance of factors influencing change of OSS, among homeowners who have changed OSS.

Items	M	Median (grouped)	N	SD
Long-term safety	**5.58**	6.16	443	1.82
I did my duty	**5.55**	6.12	448	1.81
Convenient today	**5.18**	5.80	427	2.04
Demands from authorities	**5.02**	6.23	470	2.53
Cost was reasonable	**4.94**	5.23	428	1.84
Environmental impact	**4.83**	5.30	422	2.14
Follow others example	**4.70**	5.15	437	2.16
Risk of infectious diseases	**4.52**	4.94	407	2.21
Constrained by soil conditions	**4.50**	4.92	435	2.31
Avoiding inconvenience, e.g. risk of smell	**4.40**	4.69	409	2.18
Advice from inspectors	**4.03**	4.37	403	2.57
Least re-construction	3.84	3.92	403	2.30
Advice, contractor	3.00	1.95	397	2.28
Recycling of nutrients	2.68	1.80	399	2.11
Advice, from relatives, neighbors, colleaguesetc.	2.53	1.75	391	1.99
Cooperation with neighbors	1.64	1	385	1.44
Tax deduction	1.54	1	369	1.46
Other subsidies	1.49	1	368	1.64

The scale was 1 (not important at all) to 7 (very important)

Table 3 Mean values, medians and standard deviations of the stated importance of different information sources, among homeowners who have changed OSS.

Items	M	Median (grouped)	N	SD

Inspectors	**5.01**	5.75	418	2.19
Contractors (installers)	**4.21**	4.48	380	2.19
Relatives, neighbors, colleagues etc.	3.47	3.51	361	2.06
OSS Manufacturers	3.26	3.17	320	2.07
Municipal homepage	2.96	2.25	315	2.13
OSS Consultants	2.76	1.90	275	2.10
SEPA	2.63	1.84	275	1.98
Environmental NGOs	2.48	1.76	266	1.90
OSS Sellers/suppliers	2.46	1.77	283	1.88
Avloppsguiden	2.45	1.68	256	1.97
Popular media	2.38	1.77	285	1.74

The scale was 1 (not important at all) to 7 (very important)

The most important information sources were the authority inspectors and contractors, followed by relatives, neighbors and colleagues, and manufacturers. The national knowledge bank, Avloppsguiden, supposed to guide homeowners in the process of changing OSS, was a notably unimportant source of information.

PCA was used to investigate the underlying dimensions of the two partially overlapping sets of items. Before the PCA was conducted, the variables *collaboration with neighbors*, *tax deduction*, *economic subsidy,* and *estate agents* were excluded because of their very small variances. The PCA resulted in a six-component model (Appendix A, Table A.1) explaining 64.9% of total variance, implying that there are differences among homeowners who have changed OSS in the stated importance of different factors influencing them. The PCA showed one component consisting of items related to costs and benefits and was named accordingly. Another component consisted of items that related to achieving a convenient and safe situation and avoiding an inconvenient situation (e. g. smell, infectious disease). However, to avoid environmental impact contributed to this component as well. The item "I did my duty" did not contribute to any dimension in the result, possibly because of its little variance and the fact that few other items, similar in content, was part of the PCA. The PCA showed the three categories of sources of advice and information were: advice, demands and information from authorities; advice and information from contractors; and advice and information from close acquaintances (i.e., relatives, neighbors, colleagues and others). The latter was called close acquaintances despite that also the item "OSS consultants" was contributing to this component. However, this item had lower factor loading than the other items. In addition, one underlying dimension gathered very different kinds of sources of information. Possibly, this dimension suggests a category of sources that become influential upon homeowners own initiative, such as searching OSS suppliers' webpages. The component was named *normally passive OSS actors*.

4.2.2 Official interventions and change of OSS

The extent to which official interventions (i.e., information from inspection campaign and injunctions) actually influence homeowners to change their OSS was investigated using cross-tabulation and chi-square tests (described in section 3.3.). The chi-square test showed that

counts were not equally distributed within the 3 groups defined by the 3 categories of *inspection campaign*, for which the 3 categories of *injunction* are crossed with the 3 categories of *have changed OSS* (χ^2 [4, n=892] = 42.51, p<0.001; χ^2 [4, n=56] = 11.61, p<0.05; χ^2 [4, n=414] = 32.76, p<0.001). Nor were the counts equally distributed across the three groups defined by the categories of *inspection campaign* across the three categories of *have changed OSS* (χ^2 [4, N=1362] = 128.67, p<0.001). However, counts are low (< 5) for category 1 (yes, more than 15 years ago) for *inspection campaign* and *injunction* across the categories of *have changed OSS*. Hence, conclusions cannot be drawn about the relationship between official interventions and actual changes to OSS for homeowners who were reached by an inspection campaign or injunctions more than 15 years ago.

The result of the cross-tabulation (Appendix A, Table A.2) shows that 21% of homeowners who were neither affected by an inspection campaign nor received an injunction, changed or installed a new OSS in the past 15 years. Since this figure could be explained by homeowners who built new or renovated their homes and therefore were in contact with the authorities through their applications for building permits, we made the same comparison controlling for this circumstance. However, 17% of homeowners still had installed an OSS without having been inspected nor issued an injunction, in the past 15 years. Thirty-two percent of homeowners affected by an inspection but not an injunction, in the past 15 years changed their OSS; 63% of those affected by both inspections and an injunction in the past 15 years changed their OSS and 29% did not change their OSS.

4.3 Explaining readiness to change OSS

4.3.1 Motivational structure

In this step of the analysis we investigated the dimensionality of the items related to social-psychological factors. Using PCA, the number of dimensions was reduced through a 10-component model with a total explained variance of 66.3%. The structure of the components and the factor loadings of the various items are shown in Appendix A, Table A.3. The first component comprised expressions of being concerned about environmental impacts in general and in particular with OSS and was named *environmental concern*. The second component comprised items describing decreasing costs of operation and maintenance, improved technology, increased use, and reasonable costs, which are about getting something in return while changing OSS, and was named *to benefit*. The third component included items describing situations of smell, leakage or being detected as non-compliant by the authorities, which was interpreted as if homeowners want to avoid situations of inconvenience and the component was named accordingly: *to avoid inconvenience*. The trust-related items formed two components, the fourth component in which trust was directed towards actors close to the homeowners and the

seventh component in which trust was directed mainly towards public actors and institutions (*political trust*). The 6 items intended to measure the three fairness principles formed a fifth component, *qualified fairness,* comprising both the equity and the need principles. We interpreted this dimension to represent a fairness principle according to which people justified exempting some groups from contributing equally to the common good.

Three components were interpreted as different types of behavioral control: the sixth component, *efficacy if the OSS is changed*, describing the perceived ability to control consequences, such as the environmental impact, if the OSS is changed; the eighth component, *efficacy with current OSS*, describing the perceived ability to control consequences with current OSS; and the tenth component describing the perceived ability to change the OSS. The ninth component, disbelief in the effectiveness of the regulations, comprised expressions of regulations being insufficient and ineffective.

The 10 components from the PCA are potential candidates as explanatory motivational factors for readiness to change OSS. Index variables were formed by computing the mean of the variables loading on each component. All components had high Cronbach's alpha (0.6–0.9) suggesting high internal consistency and suitability to form index variables from the variables loading on each component. After constructing the new variables and recoding the variables to interval scales (1–5 or 1–7), most index variables had distributions approaching normality, the exceptions being *efficacy with current OSS* and *avoiding inconvenience,* with relatively skew distributions. Furthermore, items that were not similar in content to other items were included in the further analysis if they showed high correlation with readiness to change OSS. This led to the inclusion of one item, called *fair outcomes* (i.e., to be ready to change OSS under the condition that others change OSS), in the analysis because of its high correlation with readiness to change OSS and its dissimilarity to the other principal components. Table 4 shows means, standard deviations, and correlations for the new variables.

Table 4 Correlation and mean statistics for the two dependent variables and the 11 independent variables to be used in the regression analysis.

		M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Readiness to change, short-term[a]	-1.42	1.97	-												
2	Readiness to change, long-term[a]	-0.45	2.07	-	-											
3	Environmental concerns[b]	5.63	1.16	0.10**	0.07**	1										
4	Benefits[b]	3.86	1.93	0.36**	0.41**	0.18**	1									
5	To avoid inconvenience[b]	5.61	1.68	0.22**	0.32**	0.30**	0.49**	1								
6	Political trust[c]	3.70	0.93	0.10**	0.11**	0.26**	0.14**	0.25**	1							
7	Qualified fairness[c]	3.09	0.93	-0.05	-0.13**	0.01	0.03	-0.07*	-0.01	1						
8	Efficacy if the OSS is changed[b]	3.15	1.79	0.30**	0.24**	0.09**	0.26**	0.14**	0.10**	0.04	1					

9	Trust in OSS actors on the action level[c]	3.08	0.70	0.07*	0.03	0.13**	0.05	0.13**	0.29**	0.05	0.08**	1				
10	Efficacy with current OSS[b]	5.96	1.58	-0.42**	-0.23**	0.12**	-0.14**	-0.03	0.05	0.03	-0.23**	0.02	1			
11	Disbelief in effectiveness of regulation[b]	3.14	0.81	0.10**	0.08**	0.42**	0.19**	0.23**	0.15**	0.03	0.23**	0.04	-0.03	1		
12	Ability to change OSS, general[b]	4.57	1.62	0.31**	0.33**	0.12**	0.26**	0.25**	0.13**	-0.09**	0.28**	0.08**	-0.14**	0.12**	1	
13	Fair outcomes [b]	2.88	1.10	0.28**	0.28**	0.21**	0.43**	0.34**	0.13**	0.09**	0.26**	0.14**	-0.12**	0.24**	0.10**	1

**. Correlation is significant at the 0.01 level (2-tailed test).

*. Correlation is significant at the 0.05 level (2-tailed test).

[a] Scale: -3 - +3

[b] Scale: 1-7

[c] Scale: 1-5

4.3.2 Past change of OSS

A *t*-test was applied to investigate whether a past change of OSS influenced readiness to upgrade the OSS. The results shows a reduction in both the short- and long-term readiness to change OSS (ΔM, short-term = 0.70, $t[1447] = 6.72$, $p < 0.001$; ΔM = 0.71 $t[1420] = 6.38$, $p<0.001$). Homeowners who have changed OSS are less ready to change OSS than homeowners who have not yet changed their OSS.

An ANOVA, controlled for how long ago the change occurred, was performed to investigate whether differences in readiness to change OSS between homeowners who had or had not changed their OSS were significant. The different groups, defined by when the OSS had been changed, had equal variance in their readiness to change in the short-term have equal variances in their readiness to change in the short-term ($F[3] = 36.78$, $p < 0.001$), but not in their readiness to change in the long-term ($F[3] = 0.858$, $p = 0.46$). The results further showed that there was a difference in readiness to change OSS in the short-term between homeowners who had changed their OSS less than 15 years ago and homeowners who had changed their OSS more than 15 years ago or had not changed it at all ($F[3] = 23.55$, $p < 0.001$). Readiness to change OSS is thus lower among homeowners who have changed OSS within the last 15 years.

4.3.3 Homeowner characteristics

Homeowners' age (min = 23, max = 94, M = 60.12, SD = 12.86, n = 1428) had a significant negative correlation with readiness to change OSS, in both the short- and the long-term ($r = −0.141$, $p < 0.01$ and $r = −0.283$, $p < 0.01$, respectively). The annual use (i.e., houses can be utilized more as summer homes or more as permanent homes) also had an influence. The mean readiness to change OSS, dropped significantly for homeowners who used the house for more than half the year (ΔM, short-term = 0.39, $t[1421] = 3.61$, $p < 0.001$; ΔM, long-term = 0.32, $t[1394] = 2.73$, $p < 0.001$). The mean readiness to change OSS was also lower for homeowners with lower household income. However, the difference in means between groups with different incomes was only significant for the comparison of homeowners with the lowest incomes to all

others (ΔM, short-term = 0.34, t[1393] = 3.10, $p < 0.002$; ΔM, long-term = 0.67, t[1368] = 5.86, $p < 0.001$).

4.3.4 Regression analyses of readiness to change OSS on the proposed motivational factors

The regression analysis of readiness to change OSS was done block-wise, with official interventions added first, then past change of OSS, homeowner characteristics, and finally the motivational factors resulting from the second analysis step (section 4.3.1). The variables were added step-wise, using a combination of forward selection and backward elimination (section 0). First, the results suggest that most homeowners do not change OSS without first being reached by inspections. This was our initial expectation, supported by the findings of the previous analysis (section 0). A first block included dummy variables indicating recent (the last 5 years) experience of inspection, recommendations and injunctions from the authorities, an offer to connect to the municipal grid, experience of an national information campaign (SEPA, 2009a), and knowledge about tax deductions. Second, for homeowners who have changed OSS, the influence of interventions seems to be weaker (section 0). Recent (within 15 years) change of OSS was added as a dummy variable in a second block. Third, homeowner characteristics, i.e., age, income, and annual use of the house, were added because previous analysis steps had suggested their importance (section 0). Based on the result of previous analyses we chose to use dummy variables for the categories low income and summer home and included them together with age in a third block. Fourth, we investigated whether the addition of motivational factors offered additional explanation of readiness to change OSS.

Table 5 shows the result of the block-wise regression analysis with readiness to change OSS in the short-term as the dependent variable. Including only the official intervention variables explained 10% of the variance. Adding past action increased the explained variance to 17%, while adding homeowner characteristics increased the explained variance to 19%. The most important of the background factors were *municipal connection offered* and *changed OSS recently*. When the motivational factors are added the explained variance increases to 40%. The most important motivational factors were *efficacy with current OSS*, *to benefit*, and *ability to change OSS*. *Efficacy with current OSS* had a negative regression coefficient while the rest of the variables had positive coefficients.

According to the regression model of readiness to change OSS in the near future, homeowners most ready to change OSS were offered municipal connection, reached by an inspection campaign, received a recommendation to change OSS, did not change OSS during the last 15 years, and were younger than average. Furthermore, the homeowners most ready to change are those who also perceived that they were less efficacious with their current OSS and more efficacious with a changed OSS. They also perceived that they were able to take action and to

benefit was important to them. If homeowners perceived that the outcomes were fair (that other homeowners would also change OSS) and if homeowners were concerned about the environment, this further strengthened their readiness to change OSS.

Table 5 Results of the regression analysis explaining readiness to change OSS in a near future (within 5 years).

	Models/Blocks							
	M1. Interventions		M2. M1 + Past change		M3. M2 + Homeowner characteristics		M4. M3 + Motivational factors	
	B	t	B	t	B	T	B	t
Background factors								
Municipal connection within 5-10 years offered	0.25[a]	8.52	0.24[a]	8.58	0.23[a]	8.36	0.18[a]	7.47
Recommendation to change OSS, the last 5 years	0.09[b]	3.01	0.15[a]	4.80	0.16[a]	5.14	0.10[a]	3.75
Reached by inspection, the last 5 years	0.10[b]	3.02	0.11[a]	3.52	0.10[a]	3.29	0.07[c]	2.47
Changed OSS recently (<15 years ago)			-0.28[a]	-9.43	-0.28[a]	-9.60	-0.19[a]	-7.27
Homeowner age					-0.15[a]	-5.29	-0.08[b]	-3.03
Motivational factors								
Efficacy with current OSS							-0.27[a]	-10.71
To benefit							0.15[a]	5.60
Ability to change the OSS							0.12[a]	4.56
Efficacy if the OSS is changed							0.10[a]	3.89
Fair outcomes							0.09[a]	3.33
Environmental concern							0.06[c]	2.26
Model statistics	M1		M2		M3		M4	
R^2	0.10		0.17		0.20		0.40	
R^2 adj	0.10		0.17		0.19		0.40	
sig. F	0.021		0.000		0.000		0.024	
F	30.90		43.91		37.92		55.79	
Df	1081		1081		1081		1081	
sig. F	0.000		0.000		0.000		0.000	

Only variables that are significant when all blocks have entered the model are shown.
The table shows un-standardized regression coefficients (B).
There is no severe multicollinearity (0.78 < tolerance < 0.99, 1 < VIF < 1.3).
The Durbin-Watson test result was 1.44, thus slightly below the recommended range (1.5-2.5).
[a] = $p < 0.001$
[b] = $p < 0.01$
[c] = $p < 0.05$
[d] = $p < 0.1$

Table 6 shows the result of the block-wise regression analysis with readiness to change OSS in the long-term as dependent variable. Including only *intervention* variables explained 7% of the variance. Adding *past action* increased explained variance to 8%, while adding *homeowner characteristics* led to a total of 17% for the background factors. The most important background factors were recent *recommendation to change* and recent *injunction to change* followed by *homeowner age*.

When the motivational factors were added, the explained variance increased to 34%. The most important motivational factors were *to benefit* and *ability to act. Efficacy with current OSS* and *qualified fairness* (i.e., it is fair for some people to take less action) had a negative regression coefficient while the rest of the variables had positive coefficients.

The regression model of readiness to change OSS in the long-term had some important differences from the model for readiness to change OSS in the short-term. In the model of long-term readiness, the intervention variables related to inspections were the most important and the opportunity for a municipal connection was less important. Homeowner characteristics, especially age, increased in importance. Among motivational factors, *qualified fairness* and *to void inconvenience* appeared among the significant explanatory variables, while *environmental concerns* turned insignificant. The most important motivational factors were *to benefit* and *ability to act*, followed by *fair outcomes* and *to avoid inconvenience*.

Table 6 Results of the regression analysis explaining readiness to change OSS in the long-term (5 to 30 years later).

	Models/Blocks							
	M1. Interventions		M2. M1 + Past change		M3. M2 + Homeowner characteristics		M4. M3 + Motivational factors	
	B	t	B	T	B	t	B	t
Background factors								
Municipal connection within 5-10 years offered	0.17[a]	5.59	0.16[a]	5.52	0.15[a]	5.17	0.10[a]	30.87
Injunction to change OSS, the last 5 years	-0.25[a]	-5.40	-0.23[a]	-5.06	-0.24[a]	-5.52	-0.18[a]	-4.48
Recommendation to change OSS, the last 5 years	0.22[a]	4.75	0.24[a]	5.14	0.26[a]	5.86	0.21[a]	5.11
Changed OSS recently			-0.14[a]	-4.66	-0.16[a]	-5.49	-0.12[a]	-4.32
Homeowner age					-0.27[a]	-9.18	-0.19[a]	-6.94
Summer home					0.10[a]	3.65	0.06[c]	2.15
Motivational factors								
To benefit							0.19[a]	6.27
Ability to change the OSS							0.14[a]	4.90
Fair outcomes							0.10[a]	3.57
To avoid inconvenience							0.10[a]	3.44
Efficacy with current OSS							-0.06[c]	-2.30
Qualified fairness							-0.07[b]	-2.69
Efficacy if the OSS is changed							0.06[c]	2.16
Model statistics	M1		M2		M3		M4	
R^2	0.07		0.09		0.18		0.35	
R^2 adj	0.07		0.08		0.17		0.34	
sig. F	0		0		0.025		0.031	
F	19.78		20.19		28.23		36.81	
Df	1065		1065		1065		1065	
sig. F	0.000		0.000		0.000		0.000	

Only variables that are significant when all blocks have entered the model are shown.
The table shows un-standardized regression coefficients (B).
There is partial multicollinearity (Tolerance ~1). However, the tolerance is about 0.4 for two variables, injunction and recommendation to change OSS, indicating moderate multicollinearity.
[a] = $p < 0.001$
[b] = $p < 0.01$
[c] = $p < 0.05$

5 Discussion

The aim of this study was to investigate which factors contribute to explain variations in homeowners' behavior, in terms of actual changes of OSS and readiness to change OSS. Regarding the influence of official interventions, we found that 17% of the homeowners who changed their OSS in the past 15 years had no prior contact with authorities through building permit applications, inspections or being issued an injunction. The rates of OSS change following an inspection or a combination of inspection and injunction support our expectations prior to conducting the survey. Inspections are needed, but inspections without placing injunctions do not seem as effective as if injunctions are placed. Among homeowners who had only had an inspection, 32% changed their OSS, suggesting that being informed may be a sufficient condition for many to change their OSS. This is in line with research into compliance behavior that individuals can be motivated to act through information and communication approaches without formal injunctions and sanctions (Winter and May, 2001). Homeowners also ranked moral obligation (i.e., *I did my duty*) high among the reasons to take action suggesting that once realizing the need for action they are willing to change OSS because it is right. Among homeowners who had been affected by both inspection and injunction, 63% changed their OSS, suggesting that formal means may still be needed to ensure that most homeowners change their OSS. However, this is not telling about why the enforcement succeed and not. This is an area for further research and could provide valuable knowledge for the actors working with enforcement.

We found a set of motivational factors influencing homeowners' readiness to change their OSS and their relative strength. The regression model of readiness to change showed significant correlations between readiness to change OSS and the explanatory factors *to benefit, to avoid inconvenience, environmental concern, fair outcomes*, and *qualified fairness*. Further, the factors *ability to act* and *efficacy with current OSS* and *efficacy if the OSS is changed* had significant correlations with readiness to change OSS. The importance of the motive *to benefit* is consistent with the expectations of goal-framing theory that motives related to "to gain" will be focal when cost-benefit ratios are unfavorable (Lindenberg and Steg, 2007). Social motives were relatively less important and the results showed two kinds of social motives related to fairness. First, we found the motive *fair outcomes* implying that homeowners tend to be ready to change OSS under the condition that others change their OSS. That is, people are constrained in their decision-making when wanting outcomes to be fair amongst the involved parties (Wilke, 1991). Second, the results showed a negative correlation between qualified fairness and readiness to change OSS, or in other words, the less the homeowners thought that individuals could be exempted from contributing equally the higher were their readiness to change. Personal

environmental norms were also important for the readiness to change OSS. However, the motive *environmental concerns* were among the relatively less important ones and appeared only in the regression model of readiness to change in the short-term. The motive *to avoid inconvenience* appeared only in the regression model of readiness to change in the long-term.

Perceived environmental efficacy with current OSS is negatively correlated with readiness to change OSS. Moreover, the perceptions about the efficacy with a changed OSS are positively, but only weakly, correlated with readiness to change. Thus, the more homeowners perceive themselves to be able to change OSS the higher their readiness to change their OSS. At the same time, the results (see Table 4) also suggest that homeowners in general rank themselves very high on efficaciousness in terms of environmental impact of their current OSS and somewhat low on whether they would be more efficacious by changing OSS. So even though homeowners in general seem to overestimate the function of their current OSS, if they believe that there are environmental consequences of their current OSS and that it is furthermore possible to influence the consequences, they may become more ready to change their OSS. However, this does not seem to be because homeowners value the environment, since correlations between the measures of efficaciousness and environmental concerns are low (see Table 4).

The relatively weak influence of environmental concerns may be problematic from an environmental policy point of view. Much effort is currently spent on informal means of enforcement that rests on the assumption that increased awareness of consequences and ways to avert the consequences individuals will take action. Though such efforts may be important, complementing other government and official interventions, the results suggest that they should not be relied upon too much in this case. Instead the results suggest that homeowners are guided by the motives to benefit and to act when they perceive that outcomes are fair. When benefits are largely missing and there are uncertainties regarding other behaviors the individual might find arguments to slip away from taking action. An important factor in this regard should therefore be the rates of inspection of existing OSS, which is connected to the rate of homeowners making improvements.

In some contrast to the results of the analysis of homeowners' readiness to change their OSS, the result showed that homeowners <u>who had changed their OSS</u> took action from other kinds of motives. Homeowners ranked to do ones duty, convenience, and long-term safety among the highest. These different results may suggest that the relative importance of factors explaining actual change of OSS might be different from those explaining readiness to change OSS. As suggested by goal-framing theory motives can be abandoned when they do not provide sufficient guidance and other motives that provide guidance can be activated (Barbopoulos

2012; Lindenberg and Steg 2007). The present study suggests which motivational factors that might be present while further studies are required in order to draw conclusions regarding activation and deactivation of motives in different situations.

Among other factors, we note that important information sources besides the authorities were the contractors, while the national website Avloppsguiden is ranked as an unimportant information source by the respondents. The importance of authorities and technology installers confirms our earlier study (Wallin et al., 2011) and the results are very similar to those of Mahapatra et al. (2011) on the adoption of innovative heating systems. Thus, the actors that homeowners meet in the process of changing OSS, both institutional and non-institutional actors, can serve as important sources of influence. From an environmental management point of view it might therefore be important to increase the competence of such actors and to ensure that they are well-informed so that ambiguities about changing OSS are reduced for home-owners.

6 Conclusions

The aim of this paper was to identify motivational factors underlying homeowners change of OSS. The most important motive underlying homeowners' intentions to change OSS is to benefit in terms of, e.g., economic benefits or a generally improved function of the OSS. The second most important motives concern whether outcomes are seen as fair and whether others are exempted from taking action. Furthermore, the extent that homeowners believe they are efficacious in changing the environmental impact by improving their OSS is also explaining willingness to change OSS. However, environmental concerns are only weakly predicting intentions. The findings thus support claims in research on pro-environmental behavior that motives related to "gain" (cf. Lindenberg and Steg, 2007) will be the most important when cost-benefit ratios are unfavorable.

A secondary aim was to go some way towards investigating the effect of current official interventions. Our study does not offer evidence about the workings of current enforcement approaches. However, our findings suggest that official interventions, in the form of inspections and injunctions, are important factors instigating homeowners to change OSS. While informal means of enforcement, such as information and communication during inspections, may be sufficient for some homeowners to change their OSS, injunctions seems to be needed to encourage larger shares of homeowners change their OSS. Previous research have shown that information aiming at instigating voluntary action while keeping deterrent means in the background may be effective and instigate both compliance and positive attitude changes. We suggest that further studies assessing individuals' responses to enforcement approaches differing

with respect to, e.g., the immediateness of issuing injunctions and sanctions, could offer valuable knowledge for current management practice.

Departing from the motive structure presented in the paper we can also see implications for current policy-making and management practice. Given that homeowners are motivated by positive changes in benefits, economic incentives should in principle work. Since homeowners are ready to act when they see that outcomes are fair, it seems necessary to increase inspection rates, since this would make more homeowners change OSS in turn influencing other homeowners readiness to change their OSS. Furthermore, the results suggest that communication focusing on the environmental consequences of homeowners current OSS and changed consequences with a new OSS might be a possible way to motivate homeowners.

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Appendix A

Table A.1 Results of the PCA of factors and information sources important for the change of OSS, among homeowners who had changed OSS. Items not contributing to the formation of principal components are not shown.

	Component					
	Normally passive OSS actors	Convenient and safe	Authority advice, demands and information	Advice, contractors	Costs and benefits	Advice and information from close acquaintances
Advice, contractor				.836		
Advice, colleagues, relatives etc						.766
Demand from the authorities			.765			
Advice from the authorities			.683			
Convenient today		.831				
Environmental impact		.782				
Avoiding inconvenience, e.g. smell		.602				
Long-term safety		.760				
Risk of infectious diseases		.647				
Least re-construction					.883	
Cost was reasonable					.755	
Information sources						
Inspectors			.726			
Contractors (installers)				.842		
OSS consultant						.572
Relative, colleagues etc						.793
OSS manufacturers	.596					
OSS sellers/suppliers	.692					
SEPA (incl. webpage)	.742					
Avloppsguiden (incl. webpage)	.732					
Popular media in general (newspapers, webpages)	.728					
Environmental NGOs	.511					

Extraction method: Principal Component Analysis.
Rotation method: Oblimin with Kaiser Normalization.
Rotation converged in 10 iterations.
Total variance explained 64.9%.
SEPA: Swedish Environmental Protection Agency

Table A.2 Results of cross-tabulation of inspection campaign, injunction and the action to change OSS.

Inspection campaign				Have changed OSS			Total
				No	Yes, >15 yrs. ago	Yes, <15 yrs. ago	
No	Injunction	No	Count	605	83	179	867
			% within Injunction	**70%**	10%	**21%**	1,0
		Yes, >15 yrs. ago	Count	0	1	1	2
			% within Injunction	0%	50%	50%	1,0
		Yes, <15 yrs. ago	Count	5	1	17	23
			% within Injunction	**22%**	4%	**74%**	1,0
	Total	Count		610	85	197	892
		% within Injunction		**68%**	10%	**22%**	1.0
Yes, >15 yrs. ago	Injunction	No	Count	24	14	9	47
			% within Injunction	51%	30%	19%	1,0
		Yes, >15 yrs. ago	Count	1	5	0	6
			% within Injunction	17%	83%	0%	1,0
		Yes, <15 yrs. ago	Count	1	0	2	3
			% within Injunction	33%	0%	67%	1,0
	Total	Count		26	19	11	56
		% within Injunction		46%	34%	20%	1.0
Yes, <15 yrs. ago	Injunction	No	Count	160	41	95	296
			% within Injunction	**54%**	14%	**32%**	1,0
		Yes, >15 yrs. ago	Count	2	0	1	3
			% within Injunction	67%	0%	33%	1,0
		Yes, <15 yrs. ago	Count	33	10	72	115
			% within Injunction	**29%**	9%	**63%**	1,0
	Total	Count		195	51	168	414
		% within Injunction		**47%**	12%	**41%**	1.0
Total	Injunction	No	Count	789	138	283	1210
			% within Injunction	**65%**	11%	**23%**	1,0
		Yes, >15 yrs. ago	Count	3	6	2	11
			% within Injunction	27%	55%	18%	1,0
		Yes, <15 yrs. ago	Count	39	11	91	141
			% within Injunction	**28%**	8%	**65%**	1,0
	Total	Count		831	155	376	1362
		% within Injunction		**61%**	11%	**28%**	1.0

Table A.3 Result of the PCA of items related to motivational factors. Only the items contributing to principal components are included.

	1. Environmental concern	2. To benefit	3. To avoid inconvenience	4. Political trust	5. Qualified fairness	6. Efficacy if the OSS is changed	7. Trust, actors at the action level	8. Efficacy with current OSS	9. Disbelief in effectiveness of regulation	10. Ability to change the OSS
I should care for the environment	.774									
I get bad conscience if I don't act environmentally friendly	.740									
I feel a moral obligation to solve the environmental problems	.772									
It is very important for me to have an OSS with low environmental impact	.709									
People should strive for environmental-friendly lifestyles	.909									
People should protect the environment	.820									
People should strive for OSS with low environmental impact	.668									
Alternative OSS are cheaper to operate and maintain		.888								
Technologies are improved		.832								
The use of the OSS increases		.597								
Price is reasonable		.821								
If my OSS don’t meet the regulations			-.765							
If my OSS affect the environment			-.817							
If there is risk of infectious disease to the environment			-.874							
If my OSS smells, leaks or is in general inconvenient			-.803							
Trust in people in general				-.595						
Trust in public institutions in general				-.755						
Trust in inspectors, OSS-related matters				-.830						
Trust in municipality, OSS-related matters				-.842						
A low use of the OSS should give less stringent requirements					.569					
Economic situation should influence requirements					.710					
More persons in the households should imply tougher requirements					.796					
Remaining living time in the house should influence requirements					.679					
A change OSS decreases emissions and mitigates eutrophication						.910				
A change OSS decreases the risk of infectious diseases						.889				
Trust in contractors, OSS-related							.506			
Trust in relatives, neighbors, colleagues and similar persons, OSS-related							.718			
Trust in OSS manufacturers, OSS-related							.770			
Trust in OSS sellers/distributors, OSS-related							.759			
Trust in estate-agents, OSS-related							.579			
My OSS is approved								.914		
My OSS have sufficient treatment of wastewater								.898		
All homeowners should have the same degree of treatment									.519	
Society must place tougher demands to mitigate environmental impacts									.512	
Inspectors “turn the blind eye” when determining requirements									.516	
Most homeowners have OSS with insufficient treatment									.747	
If the risk of getting caught were higher more homeowners would change OSS									.605	
The fact that it is costly makes me hesitate to change OSS										.533
It is impossible for me to change my OSS										-.769
If I want to I can change my OSS										.772

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.

Rotation converged in 10 iterations.

Total variance explained 66.2%.