Evaluating the Net Effect of the ISDE Subsidy Scheme in the Netherlands – Comparison of Evaluation Methods to Estimate Additionality

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The national government encourages Dutch households and businesses to use less natural gas and more sustainable heat. The Sustainable Energy Investment Subsidy (Dutch: Investeringssubsidie Duurzame Energie or ISDE), which has been in place since 2016, provides a subsidy for the purchase of solar boilers, heat pumps, biomass boilers and pellet stoves. The scheme is meant for both private individuals and business users. An important element in the evaluation of the ISDE was the 'additionality' of the scheme. This was evaluated by the Dutch organization for applied natural scientific research (TNO) in 2018 and by SEO Economic Research (SEO) in 2019. In this paper the evaluation methods are described, compared and critically reviewed in order to identify uncertainties and limitations of the methods and possible improvements. The methods lead to different results for the additionality of the ISDE scheme per type of device and this paper looks into the reasons for this. Additional evaluation studies' results depend on many factors elaborated on in this paper.

Keywords: evaluation, subsidy, additionality, survey, free-riders

INTRODUCTION

Background

The national government encourages Dutch households and businesses to use less natural gas and more sustainable heat, which reduces CO_2 emissions. The Sustainable Energy Investment Subsidy (Dutch: Investeringssubsidie Duurzame Energie or ISDE[1]), which has been in place since 2016, provides a subsidy for the purchase of solar boilers, heat pumps, biomass boilers and pellet stoves. The scheme is meant for both private individuals and business users[2]. The available subsidy for business users and private individuals is € 100 million in 2020 (RVO, 2020).

The ISDE is a subsidy that is paid out by the Netherlands Enterprise Agency (RVO.nl) after installation of the device. For biomass boilers, pellet stoves and heat pumps, the amount of subsidy is determined by the capacity: appliances with a larger capacity receive a higher subsidy. For solar water heaters, the amount of subsidy is determined on the basis of an estimate of the number of kilowatt-hours produced annually.

The government strives that the subsidy amount covers approximately twenty percent of the (average) investment cost. A higher percentage could give rise to problems related to European state support rules, while a lower percentage would limit the effectiveness of the subsidy too much (In 't Veld, 2019). The aim of the ISDE scheme was to attract as many parties as possible who want to invest in sustainable energy and to have them participate in the simplest possible way. To maximize the outreach of the scheme it was chosen to opt for existing technologies known to a large number of potential customers. Before ISDE, no national subsidy scheme was in place to stimulate individual (small scale) application of these exact technologies. Although other types of national policy instruments (e.g., loan programs, normative instruments) are in place, they do not always directly stimulate the same measures. Furthermore, occasionally, local programs (e.g., municipal subsidies or loan programs) stimulate the same measures.

Scope of the Paper

An important element in the evaluation of the scheme was the 'additionality' of the scheme. This was evaluated by TNO, The Dutch organization for applied natural scientific research (Dutch: Toegepast Natuurwetenschappelijk Onderzoek), in 2018 (Menkveld and Niessink, 2018) and by SEO (SEO Economic Research) in 2019 (In 't Veld et al., 2019). In both evaluation studies, the additionality share is calculated per type of ISDE device.

TNO and SEO used a different approach, each with uncertainties and limitations, yielding different results for additionality percentages. In this paper the evaluation methods of TNO and SEO are described, compared and critically reviewed. This review is also done using the documents available on the EPATEE site (Policy Evaluation Toolbox[3]). These include EPATEE topical case studies (for instance about the topic of additionality), which are documents explaining evaluation principles and methods with examples. Results from this paper can help provide insights into the uncertainties and limitations of evaluation methods and also possible ways to improve future evaluations of additionality in energy policy (related to savings and renewable energy in buildings).

As background, some descriptive statistics (in the next section) illustrate the Dutch heat installation market and describe the potential influence of ISDE. These statistics were grounds for the researchers involved in the monitoring and data analyses about the four types of ISDE devices (see references in next section) to expect and state that the ISDE has indeed had a large additional effect on the market. This statement is however premature as will be explained throughout this paper.

THE DUTCH HEAT MARKET AND THE ISDE

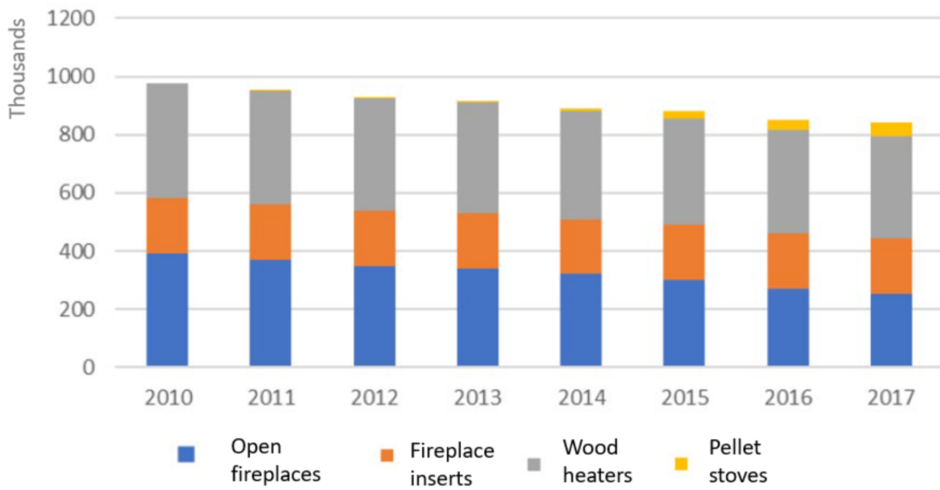
In the Netherlands the vast majority of buildings is heated with natural gas-fired boilers (rounded 90% in terms of petajoules (PJ) final use of heat) (Segers et al., 2019). ISDE devices comprise part of the remainder.

Pellet Stoves

The trend in the number of fireplaces and stoves in households is shown in Figure 1. According to data from Dutch Fireplace and Stove Industry (Dutch: Stichting NHK), the total number of wood-burning stoves and fireplaces is decreasing. This is mainly caused by the decrease in the number of open fireplaces.

The use of pellet-fired wood stoves, which can either be installed as primary heating installation, or used as an atmospheric element (amenity) in a home, has however seen significant growth in the Netherlands since 2016 (Koppejan and De Bree, 2018). This is partly due to the financial incentive under the ISDE scheme, according to Koppejan and de Bree (2018) (Koppejan and De Bree, 2018). This increase is visible in yellow in Figure 1. (The real starting point of the increase could also be in 2015). According to the Dutch association of the pellet stove industry (Nbpi), less than 3,500 pellet stoves were sold through 2015. In 2016 approximately 9,000 pellet stoves were sold, and around 13,000 were sold in both 2017 and 2018 (In 't Veld et al., 2019).

FIGURE 1
TOTAL NUMBER OF FIREPLACES AND STOVES IN HOUSEHOLDS (IN THOUSANDS)



Source: Koppejan and De Bree 2018 (original source: data from Dutch Fireplace and Stove Industry: Stichting NHK)

A study by the NHK indicates there are around 50,000 pellet stoves present in dwellings in 2018 (Hamstra, 2018). SEO also mentions 50,000 pellet stoves used in dwellings (In 't Veld et al., 2019). SEO indicates there were an estimated 34,000 pellet stoves installed with ISDE in the period 2016 up to and including 2018 (In 't Veld et al., 2019). This would mean that a significant share (around two-third) of pellet stoves were installed with use of ISDE subsidy (Koppejan and De Bree, 2018).

Biomass Boilers

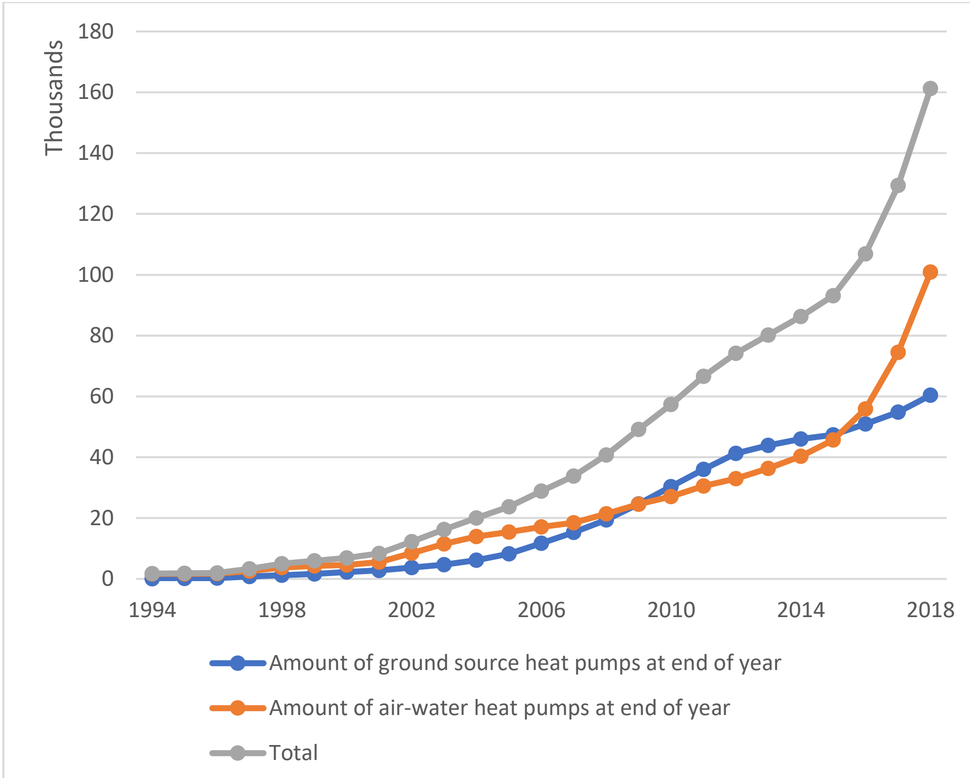
The number of biomass-boilers in the Netherlands and the heat produced is not precisely known, in particular due to uncertainties in the statistics for the biomass boilers with lower capacity (<500 kW) that are used for heating in households or (smaller) companies (Kampman and van der Niet, 2019). ISDE subsidies are available for these lower capacity biomass boilers. As a result, the number of smaller boilers has grown rapidly between 2016 and 2018 (Kampman and van der Niet, 2019). Koppejan and de Bree (2018) show that the growth in number of biomass boilers and heat production at companies continues until 2020, based on projections using a TNO model. However exact statistics on the degree of growth are not available. From 2003 the total number of petajoules (final energy) that companies produce with biomass has been increasing; production went from 10 PJ in 2015 to 15 PJ in 2017 (Kampman and van der Niet, 2019). In 2017, 3,600 biomass boilers were used by companies and an unofficial[4] reported estimate for 2018 is that around 5,300 installations were located in households (Kampman and van der Niet, 2019).

SEO indicates that there were an estimated 7,000 biomass boilers installed with ISDE in the 2016-2018 period (In 't Veld et al., 2019). Combining the figures would imply that a large share (around three-fourth) has been purchased with use of the ISDE subsidy. The majority of the smaller biomass boilers that receive an ISDE subsidy are placed in the business market (agriculture, services, industry) (Menkveld and Niessink, 2018).

Heat Pumps

Figure 2 shows the total number heat pumps producing heat (for space heating and/or hot tap water) in the residential and non-residential sector. Under the ISDE scheme belong two types, air-to-water and ground source heat pumps. Air-to-air heat pumps (often used for space heating and cooling) are excluded in the ISDE regulation. The number of air-water heat pumps shows an upward trend and doubled between 2015 and 2018, to a total of 100,000 units in 2018 (CBS, 2020a). The number of ground source heat pumps has also increased and is around 60,000 in 2018 (CBS, 2020a).

FIGURE 2
TOTAL NUMBER OF HEAT PUMPS PRODUCING HEAT (EITHER FOR SPACE HEATING AND/OR HOT TAP WATER) IN BOTH RESIDENTIAL AND NON-RESIDENTIAL BUILDINGS



Source: (CBS, 2020a)

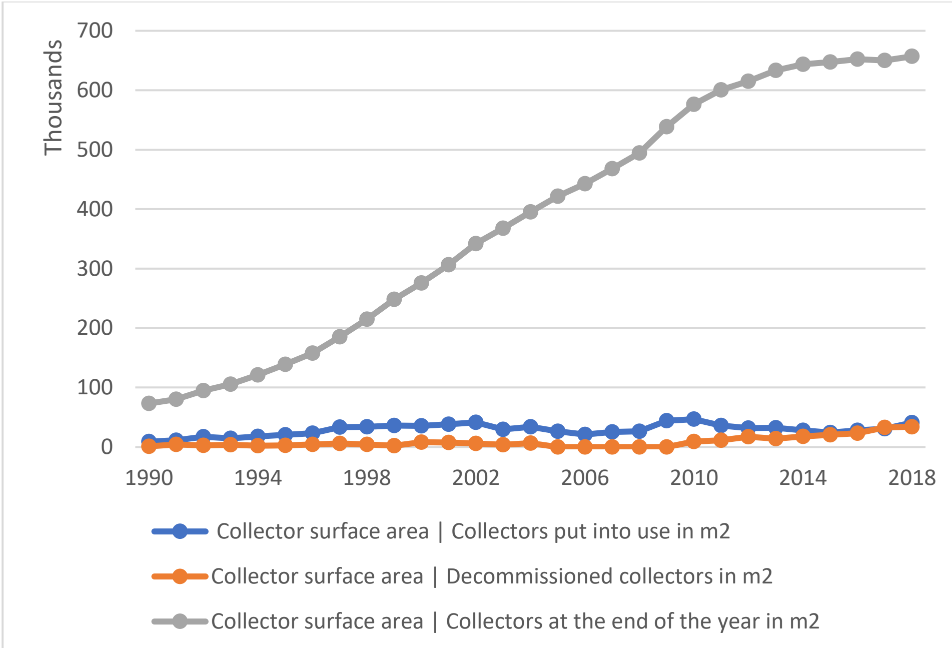
SEO indicates that there were an estimated 62,000 heat pumps installed with ISDE in 2016 up and including 2018 (In ‘t Veld et al., 2019). This would mean that a significant share (around 90%) is installed with the use of the ISDE subsidy. According to Menkveld and Niessink (2018) about half of the ISDE applications[5] for heat pumps are intended for new construction.

Solar Boilers

The development of the collector surface area in m^2 (i.e., units producing heat) of solar boilers is shown in Figure 3. The operational collector area at the end of the year is shown in grey. The total collector area has been rising since 1990. However, in recent years, growth has been leveling off. The total surface area of solar water heaters since 2014 is around 650,000 m^2 (In ‘t Veld et al., 2019). According to Menkveld and Niessink (2018), the market for solar water heaters is currently largely a replacement market.

According to CBS, 100,000 m^2 of solar collector area was installed in 2016 up to and including 2018 and in the same period 90,000 m^2 of solar collector area was taken out of operation (CBS, 2020b). This confirms there is almost no net increase. SEO indicates there were an estimated 11,000 solar collector units installed with the use of ISDE in the 2016-2018 period (In ‘t Veld et al., 2019). While the total number of collectors (units) is not precisely known, a rough assumption of 5 m^2 per solar collector gives an estimate of 20,000 units of solar collectors installed in 2016-2018. This estimate indicates that a significant share (more than half) of units were installed using ISDE in this period.

FIGURE 3
TOTAL SURFACE AREA (M2) OF SOLAR COLLECTORS PRODUCING HEAT IN BOTH RESIDENTIAL AND NON-RESIDENTIAL BUILDINGS



Source: (CBS, 2020b)

Conclusively, we have seen in this section that for all four technologies a significant share of installations has made use of the ISDE.

Summary of the Key Figures of the ISDE

Table 1 summarizes key figures from the ISDE evaluation over 2016 up to and including 2018 (In 't Veld et al., 2019). The numbers are largely based on integral data from RVO.nl that registers subsidies and devices. For the calculation of heat production, the CO_2 reduction and emissions, SEO has made the calculations and necessary assumptions as explained in (In 't Veld et al., 2019). The emission of air pollutants is known for 60 to 75 percent of the devices, based on test data supplied by suppliers themselves.

TABLE 1
SUMMARY TABLE SEO EVALUATION OF THE ISDE SUBSIDY FROM 2016 THROUGH 2018

	Biomass boilers	Pellet stoves	Heat pumps	Solar boilers	Total
Total subsidy	€43 million	€19 million	€137 million	€17 million	€215 million
Number of appliances	7,000	34,000	62,000	11,000	114,000
Heat generation per year (final energy)	2.6 PJ	0.84 PJ	1.7 PJ	0.09 PJ	5.3 PJ
Maximum CO_2 reduction per year	165 kton	53 kton	73 kton	5.7 kton	0.3 Mton

CO_2 abatement costs	18 €/tonneCO_2	26 €/tonneCO_2	127 €/tonneCO_2	220 €/tonneCO_2	50 €/tonneCO_2
Side effects	Air quality (noise, smell)	Air quality (noise, smell)	F-gases Noise	None	Air quality F-gases Noise
Emission PM10 per year	28 tonne	11 tonne	-	-	40 tonne
Emission NOx per year	245 tonne	91 tonne	-	-	336 tonne
Emission CO per year	190 tonne	107 tonne	-	-	296 tonne

Source: (In 't Veld et al., 2019). NB: Heat generation per year is calculated based on total number of ISDE appliances installed in 2016 through 2018 (see number of appliances) and the calculation method for heat generated is the same as used in (Menkveld and Niessink, 2018).

SEO states that appliances purchased with ISDE from 2016 through 2018 produce 5.3 PJ renewable heat per year[6] and that this gives a maximum saving of 0.3 Megatonnes of CO_2 per year compared to a situation in which this heat would be generated using natural gas-fired boilers. According to SEO this is a maximum since a certain share of appliances would also have been purchased without subsidy (i.e., maximum here refers to gross effect). This CO_2 saving is a relatively small share (1%) of total CO_2 emissions of the built environment in the Netherlands of 24 Megatonnes in 2018 (Schoots and Hammingh, 2019). It is also a maximum because it assumes a natural gas-fired boiler is replaced but sometimes an existing sustainable heating appliance is replaced. This 5.3 PJ is a relatively small share (3%) of the total renewable energy generation in the Netherlands of 156 PJ in 2018 and is also modest (8%) relative to the 68 PJ of renewable heat generation in the Netherlands in 2018 (CBS, 2020c).

DESCRIPTION OF EVALUATION METHODS

Method Used by TNO

At the end of 2018, TNO published an update of the estimated effects of the ISDE. Based on the available data of subsidy applications per year and assumptions on energy related parameters[7] they calculated the expected petajoules renewable energy production and petajoules savings of the scheme for the four devices. Furthermore, TNO estimated the additionality shares of the scheme for the four devices. The period on which the additionality is based differs per device in the TNO analysis: for biomass and pellet stoves the additionality was estimated based on survey results for applicants in the years 2016 through 2018, for heat pumps the additionality was estimated for 2016 through 2020 and for and solar boilers it was based on data for 2016 and 2017.

TNO estimated the additionality share for biomass boilers and pellet stoves using the outcome of a market survey among ISDE applicants in which the respondents were asked for reasons why they applied. Using this information, the additionality share was estimated through the identification of 'free-riders.' The method used to calculate petajoules can be categorized as 'stock modelling.' The additional petajoules follows from combination of survey results, statistics on ISDE applications, and deemed renewable heat production. A more general background on different calculation methods for net effects in policy evaluation can be found in (Boonekamp and Van den Oosterkamp, 2019).

The **free-rider definition** used in this paper is as follows: participants who would also have taken the same measures (in full or partly) in the absence of the policy instrument (Breitschopf et al., 2018; Collins and Curtis, 2018; Voswinkel et al., 2018). Considering the ISDE is for appliances it is, especially in case of households, only about full free-riders (i.e., there is only one heating appliance). A partial free-rider would be possible if multiple heating installations are present and only a part of them is replaced, for instance in a large non-residential building. This can occur in ISDE but is not explored further in evaluations[8] by TNO and SEO, since this situation mostly doesn't apply.

TNO used results from a survey carried out by Kantar among ISDE applicants in 2018 (see Heldoorn and Kaal, 2018). In the survey, respondents are asked about the situation before the installation was purchased. The results for biomass boilers are shown in Table 2 and for pellet stoves in Table 3. In order to estimate the additionality in terms of petajoules renewable heat, it should be considered 1) which part of the applicants did not yet possess a wood-fired boiler and 2) which part of the applicants would have purchased no device without ISDE. The additionality share for biomass boilers is calculated in table 2 as 133/214=62%, for which the reasoning is explained below. The additionally share for pellet stoves is calculated in table 3 in a similar manner which gives 337/1728=19.5%.

The group that would have purchased a device without a subsidy is free-riding and not considered additional. The group that had another reason for purchase ("None of these") is not considered in the calculation; this category is set to zero. In situations where a boiler or stove replaces an existing boiler or stove, this does not lead to a net increase in renewable heat production and is therefore not counted as additional. The "don't know" answers are also not counted as additional. The remainder is additional. In this way TNO comes to the conclusion with regard to biomass boilers that 133 out of 214 applications or 62% of the applications leads to extra renewable heat production, the other applications concern the replacement of an existing biomass boiler or concern applicants who would have bought a biomass boiler without a subsidy. For pellet stoves, TNO concludes that 19% leads to extra renewable energy production, the other applications concern the replacement of an existing wood-burning stove or concern applicants who would also have purchased a pellet stove without a subsidy.

TABLE 2
CALCULATION OF SHARE OF BIOMASS BOILER APPLICATIONS THAT LEADS TO EXTRA RENEWABLE ENERGY

	I did not intend to buy a biomass boiler, partly because of this subsidy I bought a biomass boiler	Without a subsidy I would not have bought a biomass boiler, but a gas-fired boiler	Without a subsidy I would not have bought a biomass boiler, but I would have left the old heating system	I was already planning to buy a biomass boiler; I had done this without a subsidy	none of these	Total
N Total	71	39	61	48	12	231
N do not know	2	0	1	2	1	6
N total excluding don't know	69	39	60	46	0[1]	**214**
N already had a biomass boiler	12	7	16	15	0	50
N had also bought a biomass boiler	0	0	0	31	0	31

without a subsidy						
N that leads to extra renewable	57	32	44	0	0	**133**
Percentage additional						**62%**

Source: based on survey (Heldoorn and Kaal, 2018)

1) "None of these" answers are not considered in the calculation (set to zero).

TABLE 3
CALCULATING THE PROPORTION OF PELLET STOVE APPLICATIONS THAT LEADS TO EXTRA RENEWABLE ENERGY

	I intended to buy a wood-burning stove, but as a result of the ISDE subsidy I have bought a pellet stove	I planned to buy a stove other than a wood stove, but I bought a pellet stove as a result of the ISDE subsidy	I was already planning to buy a pellet stove and had done so without an ISDE subsidy	Total
N total	237	591	900	**1728**
N pellet stove replaces a wood stove	47	248	198	494
N had bought a wood-burning stove anyway	190	6	702	898
N that leads to extra renewable	0	337	0	**337**
Percentage additional				**19.5%**

Source: based on survey (Heldoorn and Kaal, 2018)

The additionality for heat pumps and solar boilers is estimated using another method (i.e., not based on a survey). The additional petajoules follow from a combination of stock analysis/modelling, statistics on ISDE applications, and deemed savings/renewable energy production. The additionally share of ISDE was estimated by making assumptions about different subgroups within the subsidy recipients. Two subgroups were distinguished, namely 1) application of these installations in new buildings and 2) during renovations.

About half of the heat pump requests (in 2016 and 2017) are intended for new construction (Menkveld and Niessink, 2018). For new construction projects, an applicant with an Energy Performance Coefficient (EPC) calculation must prove that the new construction project already meets the legal requirements for the EPC without the heat pump for which a subsidy is requested. An applicant is not eligible for ISDE if it requires a sustainable heating installation to meet the legal EPC requirement. The ISDE can still be awarded though. It was reasoned by Menkveld and Niessink that requests for heat pumps in new buildings are therefore additional[9]. A side question is whether there is sufficient control on this to prevent fraud.

For existing buildings, the only other national supporting action for heat pumps in this period was the use of heat pumps in existing buildings at zero energy building (ZEB) renovations by housing associations. The heat pumps that are placed in the context of ZEB renovations are considered by Menkveld and Niessink (2018) to be non-additional, since the renewable energy and energy saving of these are allocated to another policy instrument (program). The National Energy Outlook 2017 projects that 35,000 air heat pumps are installed as part of ZEB renovations in the period 2016 to 2020. This yields 0.7 PJ renewable heat. In the same period, an estimated 2.1 PJ renewable heat in total is generated with heat pumps. Therefore, it was concluded 67% leads to extra renewable heat generation and savings on top of the zero on the meter renovations.

For solar boilers in existing buildings, Menkveld and Niessink (2018) compared the installed collector surface area (m^2) within the ISDE scheme in 2016 and 2017 with the installed surface area in previous years (years without ISDE in place) using data from CBS sustainable energy statistics. This shows that the surface area of ISDE applications in 2016 and 2017 was lower than the surface area of new systems put in operation in previous years. It was found by Menkveld and Niessink 2018 that there is primarily a replacement market and it was concluded that these systems would also have been installed without an ISDE subsidy. The contribution of ISDE is therefore not considered additional in existing buildings. As an example: In 2016, according to CBS, nearly 25,000 m^2 of solar boilers were put into use. Of this, 12,000 m^2 were installed with use of ISDE. On the basis of a 20-year lifespan, CBS also estimates that 16,000 m^2 of covered solar heating systems will be taken out of operation in 2016. The market for covered solar heat systems is therefore largely a replacement market[10].

In 2016, 17% of ISDE applications for solar boilers concern new-construction, in 2017 this is 14%. An applicant is not eligible for ISDE if it requires a sustainable installation to meet the legal EPC requirement. It was reasoned by Menkveld and Niessink that requests for solar boilers in new buildings are therefore additional (i.e., since these measures do not belong to the package of measures to meet the EPC requirements). In the National Energy Outlook 2017 projections, solar boilers are installed in new buildings, but not as a way to comply with the EPC requirement. Menkveld and Niessink 2018 used the share of applications in new buildings of 17% in 2016 and 14% in 2017 (and 14% for further years) as additionality percentages for solar boilers.

Method Used by SEO

In 2019, the Ministry of Economic Affairs and Climate (EZK) commissioned SEO to evaluate the ISDE. SEO investigated the effectiveness and expedience of the scheme in the period from 2016 through 2018. An important element in this evaluation was the additionality of the scheme. The additionality of the scheme is based on a SEO survey with vignette questions carried out in 2019 combined with a logistic regression and simulation model.

SEO surveyed 3,500 ISDE applicants. The response rate was 29% (N=1,109). The respondents all answered at least one vignette question. The survey consisted of six vignette questions (hypothetical situations) in which a choice was given between two options: the appliance with ISDE subsidy and the reference boiler (on natural gas) without a subsidy. There were 100 different versions of such choices, so that the variation between the parameters and respondents was large enough to estimate the sensitivity of financial factors, according to SEO. An example of such a question is given in Figure 4.

In general, respondents in hypothetical situations opted for the ISDE device a little more often than for the condensing boiler. This is no surprise as, as in fact, the respondents in reality purchased an ISDE device. Around 3% of respondents chose six times for the ISDE appliance (there were six vignette questions). In practice, this group will buy the device anyway and the subsidy does not incentivize them to do so. For example, they would do so for sustainability reasons.

FIGURE 4
EXAMPLE OF A VIGNETTE-QUESTION AS USED IN THE SEO SURVEY

Would you opt for an high efficiency condensing boiler or a biomass boiler in the following situation?

Option 1	Option 2
High efficiency condensing boiler	Biomass boiler
1.700 m^3 natural gas per year	3.900 kilogram wood pellets per year
Investment (purchase, installation and assembly): 3.000 euro	Investment (purchase, installation and assembly): 5.500 euro
No subsidy	Subsidy: 500 euro
Total annual user costs: 1350 euro per year	Total annual user costs: 1300 euro per year

Source: (In 't Veld et al., 2019)

As a next step the researchers put the vignette results into a regression model meant to explain price sensitivity. The logit model[11] examines the influence of the purchase costs, the subsidy amount and the usage costs - the three financial variables in the vignettes - on the choices of the respondents. The regression formula is as follows:

$$f\ (yI\text{SDE}) = \beta 0 + \beta 1 * \text{add. invest} + \beta 2 * \text{subsidy} + \beta 3 * \text{annual savings} + \varepsilon \qquad (1)$$

with yISDE the binary choice for the ISDE device (1=yes, 0=no), $f\ (\dots)$ is a logistic function, $\beta 0$ a constant, $\beta 1$, $\beta 2$ and $\beta 3$ the model parameters to be estimated, and ε an error term[12]. The explanatory variables are defined as follows:

- add. invest = purchase amount ISDE device - purchase amount condensing boiler,
- subsidy = subsidy amount ISDE (no subsidy possible for a condensing boiler),
- annual savings = operating costs condensing boiler - operating costs ISDE device (per year),

The most relevant parameter here is $\beta 2$: the estimated subsidy effect.

Table 4 shows the results of the logit regression analysis on the answers given on parameter $\beta 2$. The estimated parameters $\beta 1$ and $\beta 3$ (not shown here) do not appear to deviate significantly from zero for any of the devices, which is an indication of limited price sensitivity. The estimated subsidy effect, $\beta 2$, also appears to be close to zero. A higher positive value means a positive effect on "purchase likelihood." The subsidy effect is strongest for biomass boilers and heat pumps, and only those two effects are significant at a 10 percent level (p-values of 0.051 in both cases indicated with *).

TABLE 4
RESULTS OF THE LOGIT REGRESSION ANALYSIS OF THE ANSWERS GIVEN ON PARAMETER $\beta 2$ (S.E. = STANDARD ERROR)

	Biomass boilers	Pellet stoves	Heat pumps	Solar boilers
Value parameter $\beta 2$	0.12 * (s.e. 0.06)	0.04 (s.e. 0.05)	0.10* (s.e. 0.05)	-0.03 (s.e. 0.06)

Source: (In 't Veld et al., 2019)

The next step is to calculate the additionality percentage per ISDE device. For this SEO used a model in which many different reference cases were simulated, thereby using the above regression formula to determine the probability to invest. In the simulation the actual situation with ISDE is compared to a situation without ISDE in place. This makes clear what the model says about the effect of amount of the subsidy on purchase decision. Table 5 shows the resulting additionality percentages. The highest additionality result is 22% for biomass boilers and the lowest is 0% (no additionality) for solar boilers. This to SEO indicated that other effects (such as sustainability) were more important in the decision making to purchase than the financial incentive given by the ISDE.

RESULTS AND DISCUSSION

The resulting additionality (indicated as percentages) per method and per type of ISDE appliance are summarized in table 5. SEO finds, based on the vignette-questions combined with logit regression and simulation model, the lowest additionality percentages for the four types of appliances, and concludes that the additionality is probably limited for heat pumps, biomass boilers and pellet stoves, and limited for solar boilers. Based on the KANTAR survey, a higher additionality percentage for biomass boilers and pellet stoves is found by SEO (compared to the vignette-based method). TNO finds a different additionality percentage based on the same data from the KANTAR survey, for which reasons are explained later in this section. For heat pumps and solar boilers, TNO finds a higher additionality share than SEO, which is also considered later in this section.

Considering the (remarkably) large differences in additionalities found for biomass boilers and pellet stoves between methods, this is (probably to a large extent) related to the evaluation methods used. Survey methods have several limitations (see paragraph Limitations of surveys). One important limitation is that it is prone to biases (in questions and answers). In the SEO and KANTAR surveys it is about preferences stated on paper, while the respondents chose in practice (given the actual price incentives) for the ISDE device. This can lead to biases in answers.

Possible biases (in survey answers) are the social desirability bias and hindsight bias (see Voswinkel et al., 2018). Respondents are prone to giving socially desirable answers and/or think in hindsight that the subsidy did not play a large role in their decision making about their purchase. The social desirability bias could play a role in both the SEO and KANTAR survey. The hindsight bias can only play a role in the KANTAR survey since direct questions were asked about the actual situation, a situation in which the device was already purchased (i.e., no hypothetical question such as in the SEO survey).

These biases could have caused an overestimation of the number of free-riders, which in turn results in a low additionality. A low additionality means that the appliances have been purchased, but that these purchases not caused by the amount of subsidy awarded by the ISDE scheme. It could be due to non-financial reasons such as increased awareness (such as sustainability awareness), or simply because of end-of-lifetime replacement. Or because consumers attach a psychological value to the fact that the government grants subsidies, thereby not considering the subsidy amount. The evaluators did not investigate whether the subsidy scheme has led to more public awareness of the devices. The evaluators also did not examine to what extent other (non-financial) factors influenced the purchase decision.

As is evidenced by the fact that different evaluation methods come to very different results for the additionality, it becomes apparent that the true additionality of the ISDE scheme is hard to assess. Additionality evaluation studies' results depend on many factors. Important factors that determine the outcome are type of data collection, access to data of ISDE (and non-ISDE) participants, calculation methodology, the baseline (reference case) and inclusion and exclusion of effects (see Voswinkel et al., 2018). The design of a survey seems important for the outcome, but also many other factors determine the result. The design of the KANTAR survey with direct questions is of course different in nature from the one used by SEO with hypothetical situations. Elimination of bias (e.g., the social desirability bias) in both surveys completely seems impossible, however it deserves attention to investigate the possibilities to optimize survey questions as much as possible to reduce bias. It is possible to add additional questions aimed to identify free-riders. For instance, by including additional questions about 1) what other factors (such as sustainability or personal preferences) influenced the purchase and 2) what other policies played a role in the purchase and, if not already included, 3) what type of heating installation is present (in order to take into account replacement effects).

TABLE 5
RESULTING ADDITIONALITY PERCENTAGE OF THE ISDE SCHEME PER METHOD AND PER TECHNOLOGY

	Biomass boilers	Pellet stoves	Heat pumps	Solar boilers
SEO vignette question survey combined with logistic regression and simulation model (SEO survey carried out 28 May 2019 – 12 June 2019)	22%	3%	9%	0%
SEO reported value based on results KANTAR survey (survey carried out 26 April - 14 May 2018)	78%	48%	-	-
TNO reported value based on results KANTAR survey (survey carried out 26 April - 14 May 2018)	62%	19%	-	-
TNO attribution to ISDE instrument based on types of ISDE requests combined with statistical/stock modelling analysis method	-	-	67%	14%

Source: (In 't Veld et al., 2019; Menkveld and Niessink, 2018)

Important to note is that Menkveld and Niessink (2018) estimate, based on the data from Heldoorn and Kaal (2018), that the additionality is lower than the percentage as estimated by SEO (based on the same data). Important to note is that SEO defines additionality in the same way for all four appliances, namely revolving around the question whether a purchase decision is additional, i.e., caused by the financial stimulus of ISDE. On the other hand, TNO defines it as energy savings or renewable heat production which would not occur without ISDE. In this definition TNO also considers replacement effects. The difference is that Menkveld and Niessink (2018) do not count the replacement of old biomass installations with new ones as an additional effect for renewable energy. After all, these installations already produced sustainable heat and are only being replaced, so there is no net-increase in sustainable heat production. This shows the importance of defining what is meant by additionality. The definitions have the same baseline (a reference case without ISDE in place) but a different scope of analysis; the first requires data about investment intensions, whereas the second one also requires data about installations that are replaced. Such a difference in scope has to be known to the reader to interpret results correctly. Evaluation results can vary largely depending on the scope, evaluation method and calculation methodology (thereby not even considering numerous assumptions in the calculation methodologies).

The TNO approach for heat pumps and solar boilers (i.e., without doing a survey) is a strong simplification that has limitations as 1) it is hard to set a baseline (what would happen without ISDE in place?) and 2) there is no consideration for motives to purchase. Attribution to a financial stimulus of a specific policy instrument is hard as it still cannot be ruled out that the heating installation is installed because of non-financial reasons (such as sustainability or personal preferences) or because of local policy instruments (or spill-over effects from other policies). Investigating non-financial motives for purchase and whether the ISDE (or any another instrument) has led to more public awareness of the devices is paramount in order to estimate additionality (both can be investigated using a survey, which also has its limitations as mentioned).

Spill-Over Effects

When evaluating net energy savings (or production), spill-over effects lead to savings in other areas or in the future due to the informative character of the policy, word-of-mouth effects, market transformation effects or other effects beyond the scope of the policy (Voswinkel et al., 2018). This is not considered in the evaluations of SEO and TNO. However, it is important to take this into account in order to not underestimate the effects of a policy. Applied to ISDE, a possible spill-over could mean that more and/or other types of measures (e.g., energy efficiency measures) measures are taken than would be otherwise. A possible reason for this is that the ISDE subsidy creates more awareness about the importance of sustainability. It should be realized though that, on the contrary, a higher environmental awareness caused by other policy measures could have caused more installations of ISDE devices as well.

Limitations of Survey Methods to Estimate Additionality

The boxes below show the pros and cons of the survey approach, which is based on the topical case study about net-effects (additionality) from the EPATEE Toolbox (Voswinkel et al., 2018). In addition to multiple biases in survey answers, also the participants' tendency to rationalise past choices, the participants' inability to know what they would have done and the fact that given responses to questions cannot be validated are cons of a survey approach. Pros are it is relatively inexpensive and, importantly, does not require a control group of people who did not participate in the scheme (see also paragraph No Control Group). Furthermore, one must be aware that the survey answers need to be representative for the population. This might sometimes be hard to guarantee if a certain technology is spread over many sectors in the economy (such as biomass installations).

Type of method and related conditions (Voswinkel et al., 2018)	Pros (+) and cons (-)
Survey approach participants are asked how they would have acted without the policy • Deemed or scaled savings possible • When no access to non-participant group (or not possible to define a control or comparison group) • When budget and time restrictions	+ Does not require non-participant control group + Flexibility to adjust questions to policy + Relatively low costs − Prone to biases (in questions and answers) − Participants' inability to know what they would have done − Tendency to rationalize past choices − Responses cannot be validated

No Control Group

SEO states that solid conclusions about additionally of the scheme are not possible to draw, mostly because of lack of a proper control group. It is not easy to find a group of (potential) users of these devices who do not make use the ISDE or are not familiar with the scheme (In 't Veld et al., 2019). In this case it is indeed difficult to access a control group, which is why a survey approach was used. In the statistics section of this paper, it was concluded that the majority of installations made use of ISDE, however there are still devices of the ISDE types installed without ISDE. This means there could 'possibly' be a relatively small control group. This is only the case if these people are not familiar to the ISDE scheme. It could be the case they had specific reasons not to apply for ISDE. It is practically difficult to contact non-ISDE applicants who bought a device and let them participate in the evaluation since there is no clear reason for them to participate. Nonetheless, in a (hypothetical) situation where it is possible to have a control group, this would be a preferred way to reduce bias. This gives the possibility to use a quasi-experimental design for evaluation (see Voswinkel et al., 2018). It is called ‘quasi’ because the groups do already exist, and are not assigned randomly, as in a Randomized Control Trial. In order to evaluate the ISDE using quasi-experimental design, the group who is subjected to the ISDE and a control group (who is not) are both analyzed on their purchases of the devices. If an analysis points out that the ISDE group buys more devices than the control group, then the ISDE has a net effect.

Type of Stimulated Measures

According to Broc et al. (2018) certain programs can be assumed to have either no or strong free-rider effects. For instance, subsidies on boilers less than 15 years old should have limited free-ridership because the lifetime of the appliance is 25 years. In other words, most free-riders would only purchase a new one at the end of lifetime. Following this line of reasoning could indicate that the net effect of the ISDE might be relatively higher for technologies with a small replacement market. Therefore, including a survey question about the age of the replaced heating installation (or hypothetical one) and comparing this to the expected lifetime might be a way to identify end-of-life replacement, which helps to identify end-of-lifetime-free-riders. To account correctly it must be known how large of a replacement market there is. TNO looked at replacement effects of solar boilers and concluded there is a large replacement market, also in years before the ISDE, so therefore the additional effect is expected to be small. For heat pumps the replacement market is small as the number of appliances has been growing rapidly last years. For biomass installations exact replacement figures are not available, but there has been a strong growth of pellet stoves and biomass boilers over last years, which points to a low share attributed to replacement.

Price Sensitivity and Free-Riders

SEO varied the amount of subsidy awarded in the vignette questions. Asking the questions this way SEO claims to have accounted enough for the price effects on the decisions made by the respondents. SEO finds no significant effect of price-related parameters of ISDE subsidy on the decision made. This suggests that there is almost no price-sensitivity. Interestingly this finding is different from other case studies in the literature about price sensitivity. For example, for building retrofits (e.g., insulation) Groesche et al. (2013) finds that as the size of the subsidy increases, households switch to more expensive retrofit options, with the consequence that the share of program funds allocated to free-riders decreases even as the overall cost of the program increases. With a subsidy covering 10% of the retrofit costs, some 90% of program expenses are awarded to free-riders; increasing the subsidy to 50% reduces the free-rider share to 65 %, although in total less measures are funded by the program. Within the context of the ISDE, an explanation for the limited additionality lies in the fact that the scheme aims at approximately subsidize twenty percent of the investment costs. The scheme is just not intended to be able to remove the entire unprofitable part of investment of the technologies. Possibly twenty percent is not high enough to excite many new investors. This implies a high share of free-riders. Note that in this case the low price-sensitivity found could be caused by the social desirability bias (see paragraph Limitations of survey methods).

A possible explanation for the rise in ISDE devices is that financial considerations are not the main reason for purchasing an ISDE device. Other motives could play a more important role than the amount of subsidy. Other motives could be amongst others:

- Sustainability or environmental friendliness
- Replacement of an old appliance at the end of its lifetime (also see paragraph ‘Type of stimulated measures’)
- Personal preferences
- Social reasons (e.g., “my neighbours also own one”)

Relation to Descriptive Statistics

Looking back to the statistics presented in the statistics section of this paper, one would certainly observe a strong increase in installed appliances since 2016, the year the ISDE was initiated. Also, a large share of appliances has been installed making use of the scheme. However, this does not tell about the reasons that applicants of the ISDE have purchased their device. The issue with looking at statistics that it only gives an indication (correlation) and not a causal relationship (e.g., ISDE leads to the purchase of more heat pumps). It can seem counterintuitive that ISDE has a small additional effect, but it is certainly possible given there are several non-financial motives for installing an appliance.

CONCLUSION

This paper shows that the evaluations carried out by TNO and SEO come to very different results for the additionality shares of the four ISDE devices. The true additionality of the ISDE scheme is hard to evaluate because it depends on many factors. Important factors that determine the evaluation outcome are type of data collection, access to ISDE (and non-ISDE) participants, calculation methodology, the baseline (reference case) and inclusion and exclusion of effects. This case example supports a known idea in the evaluation-community, namely that there is no ‘silver bullet’ to tackle a net effect evaluation. Each of the applied methods examined in this study have uncertainties and limitations. In this case an important limitation in the evaluations is that there is no (accessible) control group, which is why was opted for a survey-based method among ISDE participants in which questions were asked about what would have happened without ISDE (TNO only for biomass boilers and pellet stoves). A survey method is a logical choice in order to obtain information about the baseline (reference case without ISDE), however the method has limitations.

Several biases in surveys, such as social desirability bias and hindsight bias, or tendency to rationalize past choices, could result in an overestimation of free-riders, in turn indicating a low additionality. Other factors, such as sustainability then seem more important in the purchase decision (This could also explain why a limited price sensitivity was found by SEO.) Quantifying free-riders remains a challenge. It deserves attention to investigate the possibilities to optimize survey questions as much as possible towards this goal. A possible way is to include additional questions about 1) what other factors (such as sustainability or personal preferences) and 2) what other policies played a role in the purchase. Adding a question about (involving) the age of the replaced heating installation and comparing this to the expected lifetime could help to identify end-of-life replacements, which is non-additional. The lifetime argument from Broc et al. (2018) suggests that subsidy given to appliances (such as boilers) less than 15 years old could limit free-ridership if the lifetime of the appliance is 25 years, because a free-rider would only buy a new one at the end of its lifetime. TNO looked at replacement effects of solar boilers and concluded there is mostly a replacement market, also in years before the ISDE, so the additional effect of ISDE is expected to be small. For heat pumps, the number of appliances has grown rapidly last years, therefore the replacement market is small. For biomass installations exact replacement figures are not available, but there has been a strong growth of pellet stoves and biomass boilers over last years, which points to a low share attributed to replacement.

A way to reduce the overestimation of free-riders is by using non-survey-based evaluation methods using a control group, for instance a quasi-experimental design (or a randomized control trial). It should be noted though that such a design is not always practically achievable as it may be hard to access a control group. This is likely the case for ISDE since most people are familiar with the ISDE scheme and the group of non-ISDE participants is relatively small.

Directly comparing additionality percentages as found by TNO and SEO directly is misleading as there is already a difference in the definition (scope) of additionality. SEO defines additionality in the same way for all four appliances, namely revolving around the question whether a purchase decision is additional, i.e. caused by the financial stimulus of ISDE. On the other hand, TNO defines it as energy savings or renewable heat production which would not occur without ISDE. In this definition, TNO also considers if replacement of older installations by ISDE devices has led to more renewable energy or energy savings.

Evaluating whether non-financial motives or another policy instrument played a deciding role in the installed appliances is paramount in order to estimate additionality, which is a complex task for which there is no universal solution.

ENDNOTES

1. More information about ISDE is available through the site of the Dutch Enterprise Agency (RVO.nl).
2. There is also a subsidy for large renewable projects in place in the Netherlands, called the SDE+. This is an exploitation subsidy, not an investment subsidy. There is no overlap with supported measures by the SDE+ subsidy scheme, as the maximum capacity of the ISDE devices (e.g., biomass boilers) is precisely chosen in such a way that these schemes are complementary.
3. https://www.epatee-toolbox.eu/evaluation-principles-and-methods/
4. Based on total capacity of 350 MW for biomass boilers installed through 2018 and a household-sector share of 38% based on (Menkveld and Niessink, 2018). (Kampman and van der Niet, 2019) assume an average capacity of 25 kW (a rough assumption), and then estimate of the number of biomass boilers in homes at 5,300.
5. The applications for biomass boilers, pellet stoves and solar boilers concern mostly existing construction, with a share of new construction of 9 to 17 percent (Menkveld and Niessink, 2018).
6. Average production per year, averaged over lifetime of appliance.
7. Assumptions are made according to the method from the 2015 renewable energy protocol by Statistics Netherlands – CBS because this is the standard method that is also used for Statistics Netherlands statistics. The assumptions relate to default values for full load hours per appliance, wood consumption of pellet stoves, efficiencies, heating values of energy carriers, etc.
8. In the evaluations, the calculation of additionality shares does not make a distinction between full or partly free-riding. As a recommendation it would be advisable to do so. A possible way to estimate partial free-riding is by adding a survey question about the number of ISDE appliances bought per ISDE applicant and how many they would have bought without subsidy.
9. The effect does not attribute to the EPC requirements (a normative instrument). Therefore, it was attributed to ISDE. At hindsight the argument is oversimplified, since other non-financial factors could have played a role in the decision making to purchase the device (see also Results and Discussion). The same is true for the additionality calculation for solar boilers.
10. It could also be argued that without ISDE the market would have seen a decrease in the m^2 of solar collectors. Here it is however assumed that replacement would happen even without ISDE.
11. Different models were tested by SEO; all had little explanatory power, but this one was the easiest approach with results easiest to interpret (In ‘t Veld, 2019).
12. A possible topic for further research is to examine whether the used logit model is underspecified. Experience in attribution research suggests there are many program factors (and non-program factors) that influence investment decisions. By using only three factors, all other factors, particularly those that may have high explanatory power, like a desire to be sustainable, are combined into one error term, potentially resulting in the low statistical significance for the three included factors.

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