Effect project – estimating the benefits of Nordic market surveillance cooperation on ecodesign and energy labelling

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Keywords

Ecodesign Directive (EuP/ErP), Energy Labelling Directive, market surveillance, efficiency, evaluation, product quality, effect, Nordic

Abstract

The ecodesign and energy labelling directives are predicted to reduce energy use in Europe with 5 % by 2020, which is a large share of the 2020 goal of 20 % decreased energy use. However, for this to be realised efficient market surveillance is needed to assure that all products put on the market comply with the requirements. This paper presents the Effect project which includes a calculation of the efficiency of the current market surveillance and thoughts on further development. The Effect project is part of the Nordic cooperation Nordsyn sponsored by the Nordic Council of Ministers for the period 2013–2015 with the aim to increase efficiency of market surveillance of ecodesign and energy labelling.

Efficient market surveillance with limited resources is a challenge as the ecodesign and energy labelling directives cover a diverse spread of products and today include 42 regulations. The aim of the Effect project was to assess the achieved benefits of market surveillance carried out 2011–2013 and to estimate potential energy loss due to non-compliant products on the Nordic market (Iceland, Finland, Norway, Sweden, and Denmark).

The results indicate:

- A prevented energy loss of €28 million for a market surveillance cost of around €2.1 million in the Nordic countries – i.e. a return on investment (ROI) of 13.
- An overall rate of 6.3 % energy non-compliance at a typical level of 35 kWh/year for the dominant non-compliant appliances, with a wide spread from 1.6 to 700 kWh/year in non-compliance.
- 168 GWh electricity savings can be achieved in the full lifespan from sales of one year if all Nordic countries share and act on all tests.
- The average total cost per appliance tested in lab was around €6,000, but this varies widely for products.
- Individual Nordic countries can save a lot on market surveillance expenses when results from other Nordic countries are shared and subsequently increase market surveillance efficiency.

Note that these results are based on a limited set of data and depend on assumptions made.

The paper presents a number of policy recommendations for improving market surveillance in EU through enhanced cooperation between Member States.

Background

In order to lessen the climate changes the European Union (EU) has set a goal to decrease the energy use with 20 % by 2020. To reach this goal several tools are needed. The EU Commission has calculated that the ecodesign and energy labelling directives together can decrease the energy use with 5 % by 2020. The expected electricity savings are about 465 TWh/year in 2020 within EU (Kemna, 2014). In comparison the total electricity use in France is about 494 TWh/year (IEA, 2010). So, in theory many (150) coal plants could be shut down as a result of ecodesign and energy labelling. In average an EU coal plant has an output of 600 MW (Ecoprog, 2012) and if it runs for 60 % of the time it will give about 3 TWh/year (600×24×365×0,6).

However, in order for the ecodesign and energy labelling regulations to give the large savings expected, effective market surveillance is needed. Alarmingly, the Commission review of the ecodesign directive in 2011–2012 estimated that 10–20 % of products covered by implementing measures are non-compliant (Review, 2012), and therefore not all planned savings are actually reached.

In addition to saving energy and so decrease climate change, the ecodesign and energy labelling requirements also decrease toxics in the environment, acidification, noise etc. and increase the performance of products.

HISTORY OF ECODESIGN AND ENERGY LABELLING

The first energy labelling directive came already 1992 and has pushed washing machines and refrigerators etc. to be much more energy efficient according to long time measurements (TemaNord 2007:605). The energy labelling directive was revised in 2010, the scope was enlarged to all energy related products and the label became international with symbols (Energy labelling directive, 2010). The EU-commission established the ecodesign directive in 2005, and it was revised in 2009 enlarging the scope from energy using products to energy related products (Ecodesign directive, 2009). These directives only set the frame, whereas the requirements are set in product specific EU-regulations, which are directly valid legislation in all EU Member States, and also applies to the EEA countries Norway, Iceland and Lichtenstein (Efta, 2015). The ecodesign regulations set limits for how much energy and other resources the product is allowed to use to be put on the EU/EEA market. Ecodesign requirement can also include noise limits or information requirements, for example that the packaging of a lamp must indicate how much mercury the lamp contains. Energy labelling regulations state how the product should be labelled, according to the A–G (or A+++ to D) scale. The energy labelling gives the consumers information on how much energy the product uses and other relevant information such as capacity, noise, emissions, dust pick-up etc. to give the consumers the possibility to make more informed choices.

Ecodesign and energy labelling work together in a push-pull manner. Ecodesign is supposed to remove the worst products while energy labelling pull development of better, more energy efficient products through consumers' requests for better products and through the producers' wish to provide better products than their competitors. Furthermore, there are other labels which identify the very best products on the market, like the eco-label (EU-flower), Energy Star, etc. Further there is green public procurement, technology procurement, demonstration, cleantech, and research which drive the development of even better products.

THE CHALLENGE FOR MARKET SURVEILLANCE

Today, there are 26 ecodesign and 16 energy labelling regulations, so in total 42 regulations. Each regulation can include requirements for several products so the amount of models to test is of course huge. Not only are more products coming into the system, the requirements are also getting more difficult to test and to perform market surveillance on. This is due to that new regulations cover business to business products, large and expensive products like transformers and machine tools, products that sometimes are produced in just one copy which is put into use without ever reaching the market, products that are built into systems with other products etc. In addition, there is more and more focus on setting requirements on resource efficiency aspects like lifetime, information on chemical substances and end-of-life handling. This is a new field for market surveillance and coverage of standards/measurement methods is not complete.

So in short, market surveillance is a challenge. The market surveillance becomes more and more complicated and expensive. Cooperation between countries is a way to be able to keep up good market surveillance on a huge number of products.

ACTIONS TO IMPROVE MARKET SURVEILLANCE

It is clearly written in the regulation 765/2008 and also in the ecodesign and energy labelling directives that market surveillance is needed to make sure the products on the market really fulfil the requirements, and that the market surveillance is the responsibility of Member States (Regulation 765/2008; Ecodesign directive, 2009; Energy labelling directive, 2010). The EU commission has no intention to intervene, other than funding projects and ensuring infrastructure (Review, 2012; Evaluation, 2014). It is also clear that the EU commission hope for cooperation between Member States in order to achieve sufficient market surveillance (Regulation 765/2008).

The EU commission has enhanced the development of market surveillance as well as cooperation through the funding of several EU projects;

- Atlete I: joint testing of refrigerators (Atlete, 2015);
- Atlete II: joint testing of washing machines (Atlete, 2015);
- Ecopliant: several working packages focusing on the development of a database for Member States to share test results, how to best choose products for testing etc. (Ecopliant, 2015);
- Eepliant/Prosafe: new project 2015–2017 focusing on LED lamps, printers, space heaters and combination heaters (Prosafe, 2015).

And then there is Nordsyn funded by the Nordic Council of Ministers in order to improve Nordic market surveillance, see below.

Even though these projects clearly strengthen the market surveillance, it is obvious the market surveillance can be further improved. In the evaluation of the ecodesign and energy labelling directives in 2011–2012 and 2013–2014 (Review, 2012; Evaluation, 2014) it was argued that market surveillance should be improved, by for example more cooperation between market surveillance authorities (MSAs), a database for sharing of test results etc.

NORDSYN

Nordsyn is a three year program 2013–2015 sponsored by the Nordic Council of Ministers (Nordsyn, 2015). Participants are MSAs for ecodesign and energy labelling in the Nordic countries; Iceland, Finland, Norway, Sweden and Denmark. Sweden has taken on the role of project manager (Lovisa Blomqvist) with a steering group including representatives from all the Nordic countries' MSAs.

Nordsyn holds ten projects and even more sub-projects. Some projects focus on hands-on information material and guidelines for market surveillance. Other projects address working methods and cooperation, how to share market surveillance plans and test results etc. Yet other projects are deeper studies to get a better base to understand and develop of ecodesign and energy labelling market surveillance. One of these studies is the here presented Effect project (Effect project, 2015).

Nordsyn aims to improve the efficiency of market surveillance of ecodesign and energy labelling in order to; support the Nordic producers, consumers and MSAs in the implementation of the ecodesign and energy labelling directives; clarifying a Nordic view and practice to the EU cooperation; meeting the Nordic Prime Ministers' Green Growth Initiative; and to see how the market surveillance can meet future challenges with more regulations on increasingly difficult products and a more integrated, globalized and internet-based market.

The intention is that material and results from Nordsyn could also be useful for other EU countries.

Introduction and aim

This paper presents an analysis of the costs and benefits of performing market surveillance and the benefits of cooperation. This paper is based on the Effect project (Effect project, 2015); a Nordsyn study conducted during 2013 and 2014 using data from Nordic countries to estimate the costs and benefits of the current market surveillance of ecodesign and energy labelling.

The aim of the Effect project was to estimate the magnitude of potentially lost energy savings due to non-compliant products on the Nordic market (Iceland, Finland, Norway, Sweden and Denmark) and assess the achieved benefits and costs of market surveillance, and has been carried out using test data for the period 2011–2013.

The main aim of this paper is to spread the conclusions of the Effect project; i.e. that market surveillance is cost efficient, especially when MSAs cooperate. In the paper we also try to take the findings a little further and discuss how they can be used to improve sampling for tests and plan the market surveillance in a more efficient way. The intension is that these calculations can serve as good background for development of market surveillance and how market surveillance is handled in future ecodesign and energy labelling regulations.

The structure of this paper is to first give a summary of the Effect project; the methodology, the calculation results, possible calculation improvements etc. Then some thoughts are presented on how the results can be used and how to further improve market surveillance of ecodesign and energy labelling.

The effect project

CALCULATION METHOD

As mentioned in the background of this paper there is a Commission estimate that 10–20 % of the products covered by ecodesign and/or energy labelling regulations are non-compliant. With perfect market surveillance there should have been full compliance, so inefficient market surveillance has opened up for this 10–20 % non-compliance.

Using the Commission estimations, Sweden has previously made this very simple calculation of what lack of market surveillance can lead to: ecodesign and energy labelling are estimated to save a total of around 400 TWh/year in 2020 on EU level with the adopted regulations. With the Commission estimation that, say 10 % of the savings from ecodesign and energy labelling can be lost due to lack of market surveillance, energy savings around 2 TWh per year in 2020 will be lost for Sweden in 2020, if the market is not well controlled (400 TWh/year × 0.1 × 0.05, where 0.05 is the Swedish share of the EU electricity use).

However this calculation is a little too simple. The estimate for lost savings was as a first approximation set to a simple non-compliance rate (10 %) multiplied by the estimated savings (400 TWh for EU). Both of these figures are highly uncertain. And the idea of just multiplying the two introduces a new error, since the non-compliance (NC) rate says something about how many, but nothing about how much, the non-compliant products represent.

So in the Effect project a refined calculation approach is developed to estimate how big a deviation (in annual consumption) the non-compliant appliances introduce, compared to a standard purchase (which has to be defined). Multiplied by the non-compliance rate for the particular product group, and the annual sales volume in the target year (say 2013), the annual energy savings loss per product group was obtained. Multiplying by the product specific lifespan, the total lifespan loss is calculated. Summing up over all product groups and all Nordic countries, a Nordic estimate for lost savings is calculated. In symbols:

$$E = \sum_{j=1}^{Countries} \sum_{i=1}^{Products} \left(CNC_{ij} - CC_{ij}\right) * R_{ij} * S_{ij} * L_i$$

E	Estimated lost energy savings
CNC_{ij}	Average annual consumption of non-compliant appliances, product group i, country j
CC_{ij}	Average annual consumption of standard purchase (compliant appliances), product group i, country j
R_{ij}	Average non-compliance rate, product group i, country j
S_{ij}	Sales in target year, product group i, country j
L_i	Lifespan, product group i
i	1..cirka 40 product groups regulated
j	Nordic countries (Sweden, Denmark, Norway, Finland, Iceland)

Below is a description of how the different elements in the formula for this study were found.

Non-compliance rate

In order to be able to calculate the non-compliance rate for every product group, data from performed tests was used. However, the sampling method is crucial for what the tests really say about the non-compliance rate.

Sampling is used to say something about a whole population, based on a subset of data. A problem area was detected; the surveillance was often not based on random sampling. In many situations, it is chosen to perform non-random/judgmental/handpicked/targeted sampling. This is often the case for market surveillance, where products suspected to be non-compliant with the regulations are selected. This is because a general picture of the market situation in terms of a non-compliance rate is not the primary goal, but instead a specific wish and obligation to monitor, and eventually get rid of the illegal products through contact to the producers of the non-compliant products that occur.

Can a handpicked sample say something about the whole market situation, with regard to compliance rates? The simple answer is no. But in practice, this is the knowledge about the market that is at hand. Assumptions must then be introduced, in order to extract any information about the market from the targeted sampling. Also, in some cases the hand-picked samples are supplemented by a small random sample from the remainder of the market. How can this be included? In the following paragraphs, the cases are described and used calculation methods specified.

Pure random samples

In this case, the statistical theory can provide us directly with a predictor, since we have a sample that follows the binomial distribution (compliant or not). Hence, the estimate for a non-compliance rate (P) for the whole market (N) is: P = p/s, where p = number of non-compliant elements in the sample; s = sample size; and the total number of non-compliant elements are N×P.

Only handpicked

When you have a handpicked sample, the sample cannot be said to follow a probability distribution. We have to introduce an assumption and we choose: the handpicking is effective and based on specific knowledge, leading to the assumption that all picked elements are non-compliant as default. The non-compliance rate (P) for the whole market (N) is then: P = p/N, where p = number of non-compliant elements in the sample.

Mixed random and handpicked samples

In the mixed situation, the calculation formula becomes a bit more complicated. If we build on the previous assumptions and terminology, the situation is now that we still have a presumably effective handpicking of s_1 elements of which p_1 are non-compliant, and then a supplementary random sample of s_2 of which p_2 are non-compliant. So the handpicking is effective, but may leave some out to be caught in the extra sample. The overall rate of non-compliance for the whole market of N elements, are then still $P=p_1/N$ but now with a contribution from the random part (Q):

$$P = p_1/N + Q$$

The situation of the random sampling is now based on $N-s_1$ elements. For those, the predictor for the rate of non-compliance must be $Q = p_2/s_2$. But the random sample only accounts for the share $(N-s_1)/N$ of the market. In order to add up the two factors, the following formula was used:

$$P = p_1/N + (N-s_1)/N \times p_2/s_2, \text{ or } P = (p_1 + (N-s_1) \times p_2/s_2)/N$$

Energy consequences of non-compliance

Non-compliance with MEPS

For the calculation we need to know, for each product group, how large the average deviation is of the non-compliant products. We call this the "penalty". Again we use the same data set.

In the case of non-compliance according to a minimum limit there are two reasonable scenarios for the alternative product; either it would be a "standard purchase", i.e. a sales weighted average purchase *or* a product that just meets the minimum energy performance standard (MEPS) limit. The latter is used here with the argument that the non-compliant product probably was cheap, and the consumer would have bought another cheap product, just compliant, if the non-compliant product was removed from the market. This would typically mean a lesser penalty and therefore risks underestimation in the present calculation. The penalty is:

$$E_P = E_{NC} - E_{limit}$$

Non-compliance with labelling

In case of incorrect labelling, the penalty is evidently the difference from the actual measured energy consumption and down to the limit for the declared (but false) class. In case the measured consumption is not available in the surveillance data, experience suggests that the correct energy class is the lower neighbour energy class, i.e. D instead of C, B instead of A etc. The energy penalty (E_p) would thus be, as a first approach, the difference between energy midpoints of the two relevant classes. In order to ensure a conservative estimate for the NC effect, it is suggested to use half of the difference, since the actual consumption in principle could be anywhere in the range between the two class limit. So it is decided to use this formula in the present calculations:

$$E_P = (E_{NC} - E_{Class\ Xlimit})/2$$

Sales and lifespans

We use sales to calculate the annual effects of the non-compliance. Sales from Denmark (ELMODEL-bolig, 2015) are used and transferred to the other Nordic countries using a scaling from GDP in each country.

The effect of a non-compliance purchase has not only an impact in the year of the purchase, but as long as the appliance is in use. In our case, a simple multiplication with expected lifespans (ELMODEL-bolig, 2015) is used to calculate the full lifespan effect.

Cost and benefit calculations

In order to convert the calculated non-compliance effects in terms of lost energy savings into economic effects, some assumptions are made. For the end-user, the extra cost ($C_{end\text{-}user}$) of purchasing a non-compliant appliance will be the energy price ($P_{end\text{-}user}$) multiplied by the identified energy penalty (E_p):

$$C_{end\text{-}user} = E_P \times P_{end\text{-}user}$$

where the price may vary between sectors, countries and with time. An annual average was used for each country (Eurostat 1).

If it is assumed that the market surveillance efforts – in time – lead to full compliance, the costs for the society are only the costs of the market surveillance, which was calculated.

CALCULATION RESULTS

In order to make sure that the needed data for these calculations could be collected, it was decided to conduct a pilot project before the main Effect project was carried out. The aim of the pilot was to establish a first proof of concept regarding a calculation method for the estimating the effects of non-compliance in the Nordic region, and to get an overview of available data sources and their most important attributes (country, scope, ecodesign/labelling/both, product group, sample size, year, selection method, known expenses). The pilot showed that in total almost 2,500 appliances have been tested in the Nordic region since 2009 (Effect project, 2015). It was decided that enough data was available to carry out the calculation, even though more and better data would have improved the validity. It was however decided to limit the calculation to only use laboratory tests and only from 2011 and on. This resulted in the data pool presented in Table 1.

Non-compliance rate

Next step was to look at the volume of non-compliance, see Table 2. Overall not so many non-compliant appliances are found, except for combined fridge-freezers where 60 of 87 were non-compliant (see the rightmost column in Table 1 and 2).

Note that in the calculation in this project, only non-compliance in terms of energy is included and limited to violation of ecodesign energy use limit or incorrect energy-labelling. Other kinds of non-compliance can also lead to energy loss (too high standby energy use, too long time until automatic shutdown etc), but were not included in this calculation. And then there is other kinds of non-compliance that is not direct energy related, for example lack in technical documentation, but that is not considered in this study as we focus on energy use.

Applying the formulas presented above to handle a combination of random, semi-random and hand-picked samples, specified, we calculated the non-compliance percent rates, shown in column B in Table 3. We obtained an overall rate of 6.3 % non-compliance. Again, this is for the received lab tests only. An interesting note is that only standby is non-compliant due to the ecodesign limit, all the other non-compliances noted concern the energy label.

Energy consequences of non-compliance

Next step is to get and estimate how severe the violations are. Based on the received technical data and the formulas presented above, we calculate the estimated energy cost of non-compliance per sample, see column C in Table 3. The calculation background for the values can be found in the Effect report (Effect project, 2015). Non-compliance was calculated to a typical level of 35 kWh/year for the dominant non-compliant appliances, with a wide spread from 1.6 to 700 kWh/year. Big variations are seen, not least due to the single electric fan. This was not a particularly big fan, so still this result seems fair – many of these industrial fans consumes 20 times the deviation per year. The most important figure is the 35.9 kWh/year difference found for fridge-freezers, since the NC ratio for this product group is much higher than for the other product groups.

Then we calculate the annual effects as described above. The sales are estimated using Danish model data (ELMODEL-bolig, 2015) combined with scaling from GDP in each country. These were DK 1; NO 1.3; SE 1.8; FI 0.8; IS 0.05. Also we have a few more certain sales figures for Sweden (Swedish Energy Agency, 2015). This calculation gave us that about 160 million appliances within the studied product groups are sold every year, in the Nordic countries together (Effect project, 2015). The NC effects for these 160 million appliances are shown in Table 3 as

Table 1. Lab samples received. E=ecodesign, L=labelling, R=random, SR=semi-random, HP=hand-picked.

Actual available Lab samples			Country	DK	DK	DK	FI	FI	FI	IS	IS	IS	NO	NO	NO	SE	SE	SE	All			All
Product	**E**	**L**	**Method**	**R**	**SR**	**HP**	**R**	**SR**	**HP**	**R**	**SR**	**HP**	**R**	**SR**	**HP**	**R**	**SR**	**HP**	**R**	**SR**	**HP**	**All**
TV	X	X		0	0	10	0	0	0	0	0	0	0	0	0	5		9	5	0	19	24
Standby	X			0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	25
EPS (external power supplies)	X			0	17	8	0	0	0	0	0	0	0	0	0	0	0	9	0	17	17	34
Lighting (light sources)	X	X		0	0	18	0	0	0	0	0	0	0	11	0	40	0	0	40	11	18	69
Air-conditioners and comfort fans	X	X		0	0	18	0	0	0	0	0	0	0	0	0	4	0	0	4	0	18	22
Electric motors	X			0	0	55	0	0	0	0	0	0	0	0	0	20	0	0	20	0	55	75
Fans 125-500 kW	X			0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6
Circulators	X			0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	8
Refrigerator/freezers domestic	X	X		0	0	47	0	0	0	0	0	0	0	0	10	30	0	0	30	0	57	87
Washing machines	X	X		0	0	10	0	0	0	0	0	0	0	0	0	7	0	0	7	0	10	17
Dishwashers domestic	X	X		0	0	7	0	0	0	0	0	0	0	0	0	4	0	0	4	0	7	11
Driers, domestic	X	X		0	0	10	0	0	0	0	0	0	0	0	0	7	0	0	7	0	10	17
Combined driers/ washing machines		X		0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4	0	0	4
SUM				**0**	**17**	**222**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**11**	**10**	**121**	**0**	**18**	**121**	**28**	**250**	**399**

Table 2. Number of non-compliant products in each test. E=ecodesign, L=labelling, R=random, SR=semi-random, HP=hand-picked.

Non-Compliance (E) count			Country	DK	DK	DK	FI	FI	FI	IS	IS	IS	NO	NO	NO	SE	SE	SE	All			All
Product	**E**	**L**	**Method**	**R**	**SR**	**HP**	**R**	**SR**	**HP**	**R**	**SR**	**HP**	**R**	**SR**	**HP**	**R**	**SR**	**HP**	**R**	**SR**	**HP**	**All**
TV	X	X		0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Standby	X			0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5
EPS	X			0	4	3	0	0	0	0	0	0	0	0	0	0	0	2	0	4	5	9
Lighting (light sources)	X	X		0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	2	1	3
Air-conditioners and comfort fans	X	X		0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4
Electric motors	X			0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7
Fans 125–500 kW	X			0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Circulators	X			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Refrigerator/freezers domestic	X	X		0	0	**34**	0	0	0	0	0	0	0	0	**8**	**18**	0	0	18	0	42	60
Washing machines	X	X		0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	2
Dishwashers domestic	X	X		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Driers, domestic	X	X		0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	1	0	2	3
Combined driers/ washing machines		X		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1
SUM				**0**	**4**	**57**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**8**	**22**	**0**	**3**	**22**	**6**	**68**	**96**

annual effects (column D). Around 18 extra GWh/year is used, with the largest contribution from combined fridge-freezers of 13 GWh/year.

Using lifespans we can calculate the lifetime effects for one year of sales, see column E in Table 3. The appliance lifespans were taken from the Danish ELMODEL-bolig (ELMODEL-bolig, 2015).

Cost and benefit calculations

To calculate the effect in higher electricity bills/costs for the consumers we applied a kWh price of €0.26 for Denmark; €0.14 for Finland; €0.17 for Sweden (Eurostat 1). For Iceland we used 0.10 and for Norway 0.13 (Fjordbak Larsen, 2015). The results are shown in column F in Table 3. So approximately 168 GWh or €29 million can be estimated as extra consumption due to NC, from one year of sales, summing up all years the appliances in average exist.

To calculate the benefit/cost we need the costs of the market surveillance activities. The exact costs of each market surveillance activity is not so easy to get hold off, but with a few estimates an average for all costs per tested model of around €5,440 was attained (Effect project, 2015). This figure can be used as an estimate for all the conducted tests. These costs adhere from 3 years of testing activities, and do not include documentation control costs. The costs are divided by 3 to be comparable to one year of sales. So, when looking at the difference between costs and "benefits", a good upside is seen. E.g. for refrigerators in Sweden the benefit is 8.24–0.16/3 = €8.18 million (Effect project, 2015). An overview is shown in Table 4.

A good deal of the benefits comes from the fact that market surveillance done in some countries affects the whole market. Thus, Finland has for example saved around €3.7 million on having the Swedish and Danish tests exposing NC in the assumingly common Nordic market.

Optimal market surveillance can in total save about €28 million after a full appliance lifespan, from one year of sales alone.

Sensitivity analysis

In order to see which product groups would be most important to test in future, a simple sensitivity calculation was done, see Table 5. If the NC rates changes with 1 %, the resulting benefits would be higher. The difference between the two situations suggests which product groups would contribute most. Two measures are calculated; relative change compared to own product groups ("Ratio"), and relative change compared to all product groups ("Share").

The Ratio column indicates what relative change in savings would be accomplished with a 1 % increase in NC-rate, compared to already accomplished for this appliance group i.e. relative to its own group. Washing machines, Lighting, and TVs give the largest change, according to this. Looking at the Share column, we see the relative change compared to all groups where Standby, Lighting, and Electric motors would contribute most to future savings, provided that NC-rates increase by 1 %.

UPSCALING TO ALL EU COUNTRIES – NOT INCLUDED IN EFFECT PROJECT

It is possible to upscale the numbers from the Effect project to EU-level, if you find a scaling factor. Eurostat data show an electricity use in households and service sector (without use in industry and transport) of 203,217 GWh in the Nordic countries and 1,726,270 GWh in EU-28 in 2012 (Eurostat 2). This gives us a scaling factor of 8.5.

The calculated savings of the Effect project (€30 million) then correspond to 255 million Euros to be saved within EU. This is how much you can save within EU for one year of sales if all countries do as much market surveillance as the Nordic countries and share it and act on it. Also presuming the activities are well coordinated so that the same product is not tested

Table 3. Summarizing table showing the total number of non-compliant products for each product group (A), the non-compliance rate (B), the non-compliance per sample in energy (C), the calculated annual effects in lost energy (D), the calculated energy effects in lifetime (E) and the calculated economic costs of the non-compliance (F).

	A. Non-Compliance (count)	B. Non-compliance (%)		C. Non-compliance (kWh/y) per sample		D. Annual effects (GWh)	E. Effects (GWh) full lifespan	F. Effects (mio. €) full lifespan
	Random + Handpicked + Mixed	All	Est. market size	Avg	Comments			
TV	1	0.5	1,000	9.0		0.14	1.01	0.17
Standby	5	0.5	1,000	5.9	assumed 4 hours/day standby	1.06	4.23	0.72
EPS	9	1.8	500	1.6	assumed 2,000 hours/year running	1.71	6.84	1.17
Lighting (light sources)	3	0.3	1,000	2.7	assumed 1,000 hours/year burning	0.46	2.31	0.40
Air-conditioners and comfort fans	4	8.0	50	40.0	1 observation	0.57	6.84	1.17
Electric motors	7	0.7	1,000	117.8	assumed 2,000 hours/year running	0.41	6.12	1.05
Fans 125–500 kW	1	2.0	50	694.0	1 observation	0.34	5.15	0.88
Circulators	0	0.0	50	0.0	no NC	0.00	0.00	0.00
Refrigerator/freezers domestic	60	60.8	1,000	35.9	Label difference div 2	13.29	132.85	22.78
Washing machines	2	0.3	750	10.8	Label difference div 2	0.03	0.29	0.05
Dishwashers domestic	0	0.0	1,000	0.0	no NC	0.00	0.00	0.00
Driers, domestic	3	0.9	350	24.5	Label difference div 2	0.10	0.97	0.17
Combined driers/ washing machines	1	6.7	15	90.0	Label difference div 2	0.18	1.78	0.31
SUM/AVG	96	6.3		79.4		18.28	168.4	28.9

Table 4. Total benefits in million € (saved electricity minus costs for tests).

Total benefits (million €)	DK	FI	IS	NO	SE	Sum
Product						
TV	0.04	0.02	0.00	0.04	0.04	0.14
Standby	0.11	0.06	0.00	0.10	0.40	0.68
EPS	0.32	0.15	0.01	0.23	0.42	1.13
Lighting (light sources)	0.09	0.05	0.00	0.06	0.07	0.27
Air-conditioners and comfort fans	0.33	0.15	0.01	0.23	0.39	1.10
Electric motors	0.22	0.14	0.01	0.20	0.34	0.91
Fans 125–500 kW	0.26	0.11	0.01	0.17	0.32	0.87
Circulators	-0.01	0.00	0.00	0.00	0.00	-0.01
Refrigerator/freezers domestic	6.94	2.94	0.14	4.43	8.18	22.63
Washing machines	0.00	0.01	0.00	0.01	0.00	0.02
Dishwashers domestic	-0.01	0.00	0.00	0.00	-0.01	-0.02
Driers, domestic	0.03	0.02	0.00	0.03	0.05	0.13
Combined driers /washing machines	0.09	0.04	0.00	0.06	0.10	0.30
SUM	8.4	3.7	0.2	5.6	10.3	28.1

Table 5. Sensitivity test of obtained economic results.

Total benefits (mio. €)	Sum	+1 % NC	Ratio	Share
Product				
TV	0.14	0.49	3.48	0.05
Standby	0.68	2.12	3.13	0.22
EPS	1.13	1.78	1.58	0.10
Lighting (light sources)	0.27	1.59	5.82	0.20
Air-conditioners and comfort fans	1.10	1.25	1.13	0.02
Electric motors	0.91	2.41	2.64	0.23
Fans 125–500 kW	0.87	1.31	1.51	0.07
Circulators	-0.01	-0.01	1.00	0.00
Refrigerator/freezers domestic	22.63	23.00	1.02	0.06
Washing machines	0.02	0.20	11.15	0.03
Dishwashers domestic	-0.02	-0.02	1.00	0.00
Driers, domestic	0.13	0.33	2.43	0.03
Combined driers/washing machines	0.30	0.34	1.15	0.01
SUM	**28.1**	**34.8**	1.24	1.00

multiple times by different countries and also assuming the markets are similar. These are the savings of market surveillance of the 13 products included in the Effect project calculations. If market surveillance on more products is added, more energy and money will possibly be saved.

CONCLUSION AND DISCUSSION OF THE EFFECT PROJECT

From the results chapter, it can be concluded that:

- The cost per appliance tested in lab is around €5,440.
- Circa €28 million can be saved in the Nordic countries through collaborative market surveillance, through an investment of around €2.1 million, equal to a ROI of 13. Upscaled to EU this corresponds to €255 million.
- The overall energy non-compliance rate was 6.3 % at a typical level of 35 kWh/year for the dominant non-compliant appliances, but with a wide spread from 1.6 to 700 kWh/year in non-compliance
- The individual Nordic country can save significant market surveillance expenses when results from other Nordic countries are shared.
- 168 GWh electricity can be saved in the full lifespan.

Comparison with earlier estimates

As starting point a very simple calculation of what lack of market surveillance can lead to was shown. In Sweden alone, it showed that around 2 TWh per year will be lost for Sweden in 2020, if the market is not well controlled (400 × 0.1 × 0.05, where 0.05 is the Swedish share of the electricity use in EU). The results from the calculations within the Effect project shows that 62 GWh can be saved in Sweden with current market control (sub number of column E in Table 3, full description in the Effect project report). This may give a better estimate, even though the numbers are not exactly comparable. The Commission estimation that 10–20 % of the covered products are non-compliant, could in some sense be compared with the 6.3 % non-compliance rate found in the here presented calculations. But as mentioned above, our calculations only include energy non-compliance, so maybe one could say 6.3 % correspond to the part of the 10–20 % that is energy non-compliance.

In Atlete II it was found that 0 % of the non-compliance found in washing machines was energy non-compliance (Atlete, 2015). In Atlete I the share of energy non-compliance was larger. If 20 % of the NC is energy non-compliance, this would mean that 6.3 % energy non-compliance would correspond to a total non-compliance of 32 %. This is possibly a better value to compare with the Commission estimate of 10–20 % non-compliance. If lower portion energy non-compliance, the total non-compliance would be even higher.

The effect project give a low estimate

As mentioned above the presented calculations is a conservative estimate due to; the way the hand-picked samples are handled, how the energy penalty is calculated, only inclusion of energy loss from not meeting the limits, only including the loss in the product groups we had available tests for. Also, as this calculation was done using data from the Nordic countries, it could be an underestimate as there might be countries with less market surveillance where the non-compliance is higher, pushing up the non-compliance for the whole EU. Only the product group with provided lab tests have obtained an estimate for the market surveillance effects, and contributes to the total. In reality all product groups with active energy performance legislation are affected by the ongoing market surveillance, since the producers are aware of the risk of being tested. Again this adds to the fact that the estimated effects are conservative.

Possible calculation improvements

Methodically, the approach assumes that the extra consumption from NC is a good estimator for the effects of market surveillance. In fact, the NC's are what we see with the current level of market surveillance. More optimal effect estimations would be to look at differences between the current market surveillance and a region/country where no market surveillance is taking place. On the other hand, if all NC models are removed instantly from the market in all Nordic countries when discovered, the estimated potential savings from market surveillance are actually achieved.

The results are based on quite limited data. Both the potential saving effect and the costs estimated could be stronger if more test and cost evidence were provided, especially data containing all lab costs. There are a number of assumptions and improvement potentials worth mentioning since they affect the outcome significantly:

The treatment of the hand-picked samples

In the present calculation, the hand-picked samples are used so that the number of NCs found is counted as all NCs on the whole market, which is for sure an underestimation (actually the minimum NC rates are estimated this way), since not all NCs may be tested due to practical limits and therefore the NC rate may be higher. Supplementary random sampling should be added in order to avoid this underestimation. Until then, the results must be considered conservative. Random samples are of course favourable in this kind of calculations, but in reality we see more and more hand-picked samples, so how to best use these may be an area for further exploration. One way to improve the way to use hand-picked samples could be to do a small research project on this issue. A contact to the Technical University of Denmark has been made, and they recognize the problems and are willing to participate in such a project (DTU, 2015).

The energy "penalty" calculation

For ecodesign, the lost energy (penalty) was calculated comparing with a product just meeting the limit, giving a lower penalty than if comparing with an average product. For labelling, only half the distance to the limit for the correct label is used to calculate the penalty. The argument is that the tested appliance could be placed anywhere between the two limits, and therefore in average will be in the middle, i.e. half the distance. In practice the producers can control the consumption quite accurately, so this assumption may not reflect reality. But using only half the distance places the estimates as conservative. An improved, more exact calculation of the penalty could be reached if the distance between the actual measured energy efficiency and the limit of the class was used.

To further improve the calculation it could possibly be extended to include other losses of energy from e.g. lights, standby-use, TVs not shutting off after 4 hours as they should etc. These are not included in the present calculation which emphasizes the conservativeness of the estimates.

Data availability

The calculations would surely be strengthened and improved if more/better data on test results (from the Nordic countries or other EU countries), costs of market surveillance, lifespans, sales, and electricity prices were used. Also documentation control results could be used.

In the presented study, it is assumed that lifespans for each product group are equal to estimates used in the Danish stock model ELMODEL-bolig, and that sale figures from Denmark can be transferred to the other Nordic countries using a scaling from GDP in each country. More accurate data would improve the validity of the calculation.

Presented as annual savings

In the present calculation the results were presented as *annual* costs and savings in order to be easy to understand and to use. One could however look further into how to best present the findings. Sales for one year were used, but the penalty contribution of a full life time. The cost for market surveillance per year was used (the cost for the used tests from three years was divided by three). Still the *information* (NC-rate, penalty etc.) from the three years of market surveillance was used. But only information from the lab test results that we found was used, more is possibly out there.

Suggestions for improving market surveillance

It is obvious that the market surveillance has development potential. With the Effect project calculations in mind, this chapter presents some further thoughts on how to enhance cooperation, how to better choose products for tests and future market surveillance.

The presented Effect project clearly shows cooperation is efficient and gives a basis for discussing how to best choose products/models for test/document control. We will also present some thoughts on how to ease cooperation between countries, improve regulations and future development of market surveillance.

HOW TO BETTER CHOOSE PRODUCTS TO TEST

As noted the ecodesign and energy labelling directives today include 42 different regulations and cover a diverse spread of products. The products are very different with respect to how much energy they use, how many there are on the market and in use and how much they contribute to lost energy if non-compliant.

There are different ways to use the outcome of the presented calculations in order to better steer the market surveillance and prioritize the right products:

1. One could argue that the products giving the largest yearly loss per product should be subjected to more tests; fans, electric motors, washing machines/driers (see column C in Table 3).
2. Or the products giving the largest total yearly loss today, using sales; refrigerators/freezers, EPS, standby (see column D in Table 3)
3. Another way is to look at the products where it would give the largest extra saving (€) if more non-compliant products were found; then electric motors, standby and lighting are the best choices (see sensitivity analysis column "share" Table 5).

4. Yet another way is to make additional tests where the largest share of non-compliance was found; refrigerators/freezers, air-conditioners/comfort fans, washing machines/driers (see column B in Table 3).
5. Or test more where most non-compliant items was found; refrigerators/freezers, EPS (external power supplies), electric motors (see column A in Table 3).
6. The product groups with no lab tests for the moment should be prioritized.

Which one of the above to use could vary. At the moment the Swedish MSA use the arguments of point 4 and 6 above to choose products for market surveillance inspections. However even more commonly new regulation/requirements coming into force or information on suspected non-compliance are reasons to choose product groups to test in Sweden. The way to choose products for market surveillance activities might need to be further developed in the future and this study gives a good background to do that.

After choosing a product, MSAs need to choose brands and models of that product to be checked. In order to be efficient the MSAs should try to choose brands and models that are suspected to be non-compliant or that have a big impact if non-compliant (large market share or high energy use). The data pool used for the Effect project, as well as other test results, could possibly be used to further analyse what brands and models might be expected to be non-compliant.

HOW TO EASE COOPERATION

The Effect project clearly shows that market surveillance is cost efficient, especially if countries cooperate and share results with each other. Upscaling the results of the Effect project to EU level gives us the saving potential of €255 million, which could be even higher if more products are covered. The results presented may be even more relevant in the future when more complicated products are up for market surveillance, i.e. cooperation will be even more important if/when we have more products to cover and these include business to business products, large and expensive products, products produced in just one copy, products put into use without reaching the market, products that are built into systems with other products. A reasonable level of market surveillance is necessary to keep up the credibility of the regulations and to provide a fair playing field for the producers.

Very important to note is that the calculated savings could only be reached if every cooperating country really act on the non-compliances found, even if those were found by another MSA. However there are many difficulties and "barriers" to overcome. For example the markets are not exactly the same, languages differ and timing is difficult.

Lessons learned from Nordsyn

Nordsyn, the Nordic cooperation on market surveillance of ecodesign and energy labelling, has found a number of ways to ease cooperation between countries:

- Share market surveillance plans in the beginning of each year, and if possible adapt these to each other. This is to minimize overlaps.
- Share results of market surveillance activities like tests, document controls etc.
- Make sure test reports and reports from document controls are in English, at least a summary.
- When performing market surveillance of a product, always ask for a list of equivalent products and share this information together with the inspection results.
- In order to feel comfortable using test results from each other it is important the tests are correctly done. Therefore it may be more important to use accredited labs. The presence and use of robust standards for all parameters is essential.
- When appropriate, try to choose products that are present at as many as possible of the markets of the cooperating countries.
- If the cooperation is developed it would be possibly to share the responsibility so that different MS take on to focus on different products categories or different kind of tests, which would possibly improve the efficiency even more.

IMPROVEMENT OF REGULATIONS

Something that could be studied in more detail within the collected data is whether NC in other aspects than energy use i.e. information requirements differs between product groups, and if this tells us something about how reasonable these requirements are and what is needed to improve the compliance rate. Also the way market surveillance is regulated could be improved, and the data pool could possibly give clues to which regulations need clarifications. So in this sense the data pool of the Effect project could also be used to develop the regulations.

FUTURE MARKET SURVEILLANCE

In order to further improve the efficiency of the market surveillance more automated systems could be developed. A so called "web-crawler" could be used to search specified internet sites for information in real time and to look at pages where we know that the energy use of products is shown, and see if they meet the current minimum requirements. A web-crawler could also be used to look for the information that is obligatory on internet due to the online labelling regulation which came into force 1st January 2015 (Online labelling, 2014). This will be of growing interest as the online shopping is increasing. Automated market surveillance may become more important in the future as gradually more and further complex products are regulated.

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Acknowledgments

The Authors would like to thank the Nordic Council of Ministers for the funding of Nordsyn and the Effect project. Also we would like to thank the Nordsyn steering group i.e. the Nordic MSAs for engaged input to the Effect project.