The role of independent product testing in energy efficiency policy

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Abstract

The paper discusses the role of independent product testing in energy efficiency policy. It also addresses the importance of having in-house testing capacity for authorities responsible for regulations, market surveillance and promotion activities.

The role of product testing – in lab as well as in field conditions in order to cover technical and behavioural aspects – is analysed regarding the following dimensions: 1) ensuring consumer protection; 2) stimulating research and innovation; 3) formulating minimum performance and labelling requirements; 4) performing market surveillance; 5) supporting measures for enhancing the application of requirements, including information and training using networks of users and energy advisors.

The analysis is based on the long experience of product testing in Sweden and the different ways of organising testing are discussed. Lastly, the paper discusses the advantages and drawbacks of having in-house testing capacity within the authority responsible for policy decision and/or market surveillance, including aspects such as cost efficiency, expertise in standardisation, and know how in performing and procuring tests.

Introduction

Tests on appliances have been performed by Swedish authorities since the 1940s. The main purpose was consumer protection, and the consumer agency had its own consumer journal where tests results were published. In the 1990s with the introduction of energy labelling, the attention on energy efficiency increased, although consumer aspects were still dominating. With the ecodesign directive in 2005, energy efficiency increased even more in importance and the testing activities related to energy were moved from the Consumer Agency to the Energy Agency in 2006. The Swedish Energy Agency was given the responsibility for representing Sweden in the ecodesign and energy labelling committee following instructions from the Government Office, and for drafting preliminary Swedish positions for interministerial consultation. The Swedish Energy Agency was also appointed as market surveillance authority for both the ecodesign and the energy labelling directives.

Testing evolved from being mainly used for consumer information and protection, to become a central tool in the decision making process for formulating requirements for ecodesign and energy labelling, as well as for market surveillance. This institutional evolution made Sweden the only Member State where the same authority has all main responsibilities for the implementation of the directives (decision process, market surveillance and supporting measures) and at the same time has an in-house laboratory.

To put testing in a context, it is important to consider the following policy instruments that have formed the energy efficiency policy for energy related products:

- Promotional information activities, such as campaigns, test results, directly or through multipliers such as networks of energy advisors.
- Energy labelling, voluntary and since 1992 mandatory under the Energy Labelling Directive[1].

1. 2010/30/EU, recast of 1992/75/EEC.

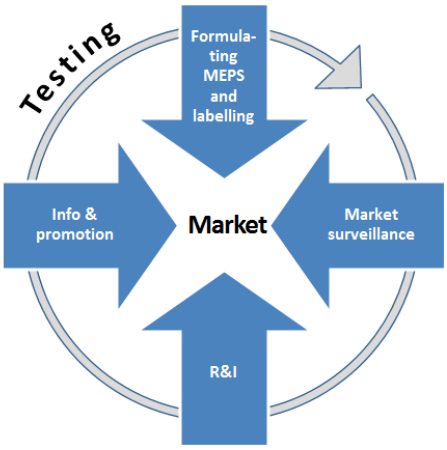

Figure 1. Independent testing as a pillar for policy instruments.

- Minimum Energy Performance Standard (MEPS), in particular under the Ecodesign Directive[2], in this paper also called "ecodesign requirements", which can also include functional and non-energy related environmental requirements.
- Research and innovation programs, including technology procurement.

Independent testing has been a pillar for the above mentioned policy instruments, by addressing technical as well as behavioural aspects. Testing range from traditional laboratory testing according to standards, to field measurements such as measurements campaigns in households or installed products. Field measurements are often completed by questionnaires in order to complement the measurements and better ensure the dynamics of energy use.

This paper analyses the role that independent testing can play in product energy efficiency policy in general, and uses the Swedish situation as a case study.

Why product testing?

The first question to answer is why independent testing is necessary. This can be, for example, when adequate test data is lacking but greatly needed, when required by law, when tests can stimulate research and innovation or when the tests themselves can be used as an information tool.

For the coming discussion it is simpler to group tests for formulating MEPS and labelling together and to have the market surveillance of the legislation as a separate group. Together with the two remaining policy instruments this can be illustrated as shown in Figure 1, also illustrating testing as a common pillar.

In the following four subsections the reasons, the "whys", of testing is discussed for the different policy needs.

TESTING FOR FORMULATING MINIMUM PERFORMANCE AND LABELLING REQUIREMENTS

The formulation of the requirements constitutes the main challenge in the ecodesign and energy labelling decision process. For each product group, it means to define the scope, the categories, the function, the aspects to address, the metrics, the level of the requirements, and their verifiability. Testing has especially contributed in the following aspects:

- To test the appropriateness of the test method, including its accuracy, precision, repeatability (of successive measurements in the same conditions and lab) and reproducibility (in different labs), as well as its costs.
- As input for a new or a revised standard.
- To develop or assess the adequacy of a metrics, including potential trade-offs between requirements and the function of the product.
- To assess the adequacy of the level of the requirements. The level of the requirement, or its stringency, is probably the most sensitive part in the decision making process. This level is the object of negotiations between the parties involved (industry, consumer and environmental organisations, European Commission and finally the Committee of Member States representatives), and will require the adequate balance between energy and environmental performance, and the impact on industry and consumers. Market and industry data, complemented by a technical analysis from the preparatory studies, are in principle sufficient. However, the availability of data is very often a problem, at least in a format that allows comparability. Thus, testing plays a crucial role whenever i) standardised information is not available or ii) if there are suspicions about the quality of the information provided.
- To improve guidelines for the implementation of a product regulation. Testing has also been used for supporting the implementation of the regulations, in particular where tests are incomplete or are under development, and when transitional methods are used.
- To support market studies including the foreseeable development and market penetration of new technologies.

Table 1 presents a few examples of tests used in defining requirements, and in supporting the implementation and market surveillance. The test results have been used in the Swedish positions as a contribution to the EU decision process. However, it is not possible to provide evidence of the extent to which the test results have influenced the decisions taken.

Furthermore, performing the tests as above described, provides the experience needed for the implementation and market surveillance phases which are discussed next.

TESTING FOR MARKET SURVEILLANCE

A condition that the large savings promised by the ecodesign and energy labelling directives are achieved is that the products comply with the requirements in the regulations. It is the national market surveillance authorities' responsibility to verify that this is really the case. Compliance is also essential to guarantee fair competition and to protect consumers from faulty products.

Testing laboratories are usually sourced at national level in the EU Member States (Krivosik et al., 2013). However some countries declare making use of both national and foreign laboratories and Sweden is one such country. Market surveillance

2. 2009/125/EC, recast of 2005/32/EC.

Table 1. Examples of tests results performed or commissioned by SEA used as contributions to the EU decision process.

Product	Defining ecodesign requirements and energy labelling classes	Supporting Implementation and market surveillance
Lighting	Test report assesses the proposal to delaying the 2016 ban on general service halogen lamps. Compiles own tests and available test reports. (Bennich et al., 2014).	Screening used help to target segments with a higher rate of non-compliance.
Room air conditioners	Level of the requirements: Seasonal Coefficient of Performance (SCOP) and noise.	Investigating unclarities in the test method, namely regarding the settings to use for the test.
Heat pumps	Appropriateness of the test method, level of the requirements.	Contribution to the Implementing guide, test of transitional methods.
Exhaust air heat pumps	Level of the requirement. Adequacy of test method.	
Solid fuel Boilers	Level of requirements – emissions and energy efficiency.	
Electric water heaters	Test accuracy in the test method. Level of the requirements.	Contribution to the Implementing guide, test of transitional methods.
Variable Speed Drives	Level of the requirements. Adequacy of the IE-classes in the proposed standard FprEN 50598-2. (DTI and STEM, 2015)	
Range hoods	Parameter (total extracted air volume), metrics, and level of the requirements. Contribution for the revision to a new standard on odour removal.	

Table 2. Market surveillance tests carried out by the Swedish Energy Agency in 2014.

	No of regulations	No of products
In-house	6	51
External national labs	2	24
External foreign labs	2	12
Total	**10**	**87**

tests in Sweden are performed in-house at the SEA, in external nationally sourced labs and in external foreign labs. The market surveillance tests carried out in 2014 are compiled in Table 2[3] as an example.

As the complexity of the products regulated increases, for example when products are not available "off the shelf" such as non-residential ventilation units or power transformers, market surveillance requires new approaches beside traditional laboratory product tests, although these are performed whenever possible. These alternative approaches include control of technical and other documentation, *in-situ* measurements of installed products and screening tests.

The market surveillance activities are coordinated in Sweden within the Market Surveillance Council, which comprises 18 market surveillance authorities from different areas. This coordination includes the publication of the yearly Market Surveillance Plan which is available at the Market Surveillance Councils webpage[4].

INFORMATION, TRAINING AND OTHER PROMOTION ACTIVITIES

These measures can be classified in two types: i) measures directly supporting the implementation of legislated policy instruments such as ecodesign and labelling and ii) other promotion activities which sometimes target consumers and other groups more directly.

Below two examples are discussed in this context, again using Sweden as a case study. In the first example, tests are directly aimed to the public as an information tool, and in the second example testing facilities are used in education and training.

3. No. of products: Some product groups require multiple tests items, for example, lighting requires a minimum of 20 samples.

4. The Market Surveillance Council, www.marknadskontroll.se/en/.

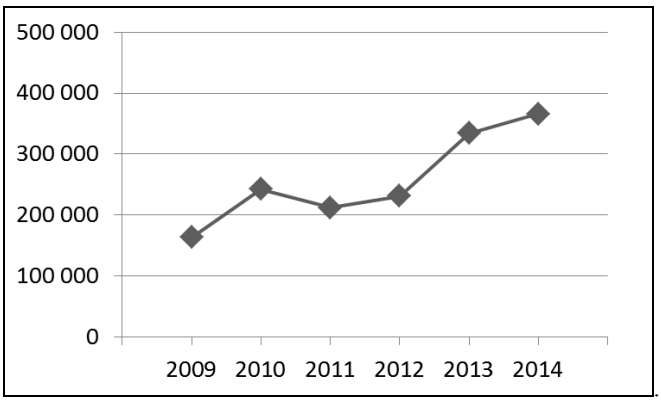

Figure 2. Visits to the SEA's test web pages.

Tests published on the web and as press releases

In general, the public is very interested in tests. An example is the large public interest in tests in consumer magazines and specialised journals. The focus of such tests varies greatly as well as the manner in which they are carried out, and span from simple subjective opinions to expensive tests at an accredited laboratory.

The Swedish energy agency's Testlab has a long record in publishing such tests with focus on the energy efficiency of products. As discussed above, prior to 2006 the Testlab was a part of the Swedish Consumer Agency and had its own consumer magazine.

The SEA tests are always accompanied by information regarding the product type. These tests have multiple aims such as (1) to show the energy efficiency of the products, (2) to increase the awareness of the importance of energy efficiency, including behaviour influence, (3) to provide Swedish municipal energy advisors with facts and informative material, and (4) to inform about new ecodesign and labelling requirements. Thus, such tests can be said to be used as vehicles to convey information to the public. In the classification set out above, activities 1–3 fall in category ii) "other promotion activities which sometimes target consumers and other groups more directly" whereas item 4 more directly links to i) supporting the implementation of legislation.

The tests are published on the SEA website and in Figure 2 the number of annual visits is shown[5]. The test pages have the highest visiting rate on the agency's web and the tests are also multiplied by the press. In 2014 the Swedish energy agency appeared 212 times in Swedish press related to the words ecodesign, energy labelling, tests or Testlab, and 21 press releases[6] where published. In a majority of these press releases test results and information on ecodesign and energy labelling are intermixed. As stated above, the tests are also used by the municipal energy advisors in their counselling and 81 % state that they refer to the test results in their work.[7]

5. Other energy agencies, such as the Danish Energy Agency also publishes tests on the web, see, for example, http://sparenergi.dk/.

6. Swedish Energy agency annual report 2014.

7. Swedish Energy Agency annual report 2014.

TRAINING AND EDUCATION WHERE THE TESTING FACILITIES ARE USED

Knowledge on energy efficiency and the impact of behaviour requires training efforts. Many products are highly complex and also the legislation is highly complex. Thus a range of different training efforts are required. From the experience acquired since the inclusion of the test laboratory in the SEA in 2006, the e authors would like to argue that the effectiveness of such training can be enhanced if it contains hands-on technical content such as witnessing tests or demonstrations. The lab resources at the Swedish Energy Agency are also used for training purposes and the throughput for one year is shown in Table 3. Being able to see how measurements are actually carried out may strengthen the confidence in the system and reduce barriers to the often complex legislation.

TESTING FOR RESEARCH AND INNOVATION PROGRAMS

Independent testing can also play a role in research and innovation policies. One policy instrument that has used testing widely is technology procurement, which is a policy instrument intended to accelerate the development of new energy efficient technology. It involves a tendering procedure in order to stimulate the competition between manufacturers using an aggregated buyers group that will in most cases guarantee the winner an initial order. Around 60 technology procurement projects have been carried out since the 1980s by the Swedish Energy Agency and its forerunners[8], ranging from refrigerators, heat pumps, windows and water taps, to building energy management systems. Testing is used in order to determine the winning product, which is in most cases awarded with a guaranteed initial order.

The importance of testing and verification is considered particularly important in innovation procurement policy instruments such as technology procurement, and "[…] independent agency testing and evaluation of technologies that match the buyer group's need was a key driver for many companies to participate in the procurement programmes" (COWI, 2009).

An extended use of testing by an authority responsible for research and innovation as the Swedish Energy Agency can be of great use, well beyond technology procurement initiatives. These tests can include both laboratory as well as *in-situ tests*. This is already the case for the in-house lighting lab that can test the performance of products for companies receiving research and innovation funding, or loans in the case of start-up companies.

The Agency, in coordination with its research programmes, performs also field measurement for heat pumps, where many other aspects than the product, like installation, sizing, control and user behaviour are determinant for the energy performance of the installations.

How to organise testing?

We believe that the majority of testing activities carried out by Member State authorities and that are directly related to ecodesign and energy labelling is for market surveillance. Furthermore, as more products are regulated, market surveillance testing should, and hopefully will, increase if the promised savings are to be achieved.

8. A database of technology procurements carried is available at www.energimyndigheten.se/Foretag/Teknikupphandling1.

Table 3. Throughput training and visits in SEA's laboratory. Figures for 2014.

	No of events	No of persons
Training Municipal Energy advisors	4	70
Training Life Academy	4	120
Legislation focus seminars	2	65
Advanced lighting course	1	12
Group visits	18	120
Total	**29**	**387**

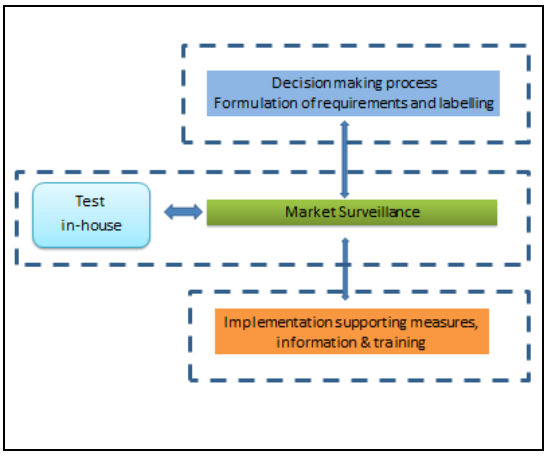

Figure 3. In-house testing.

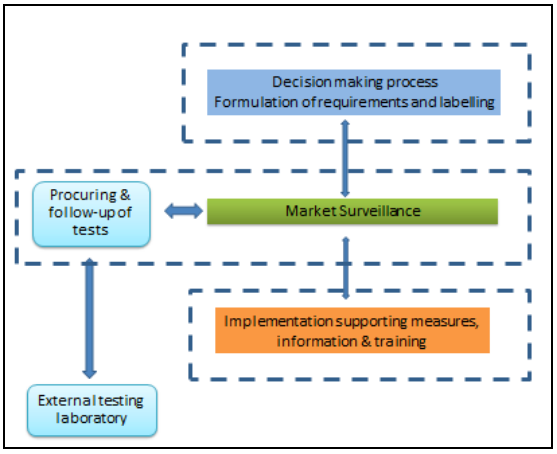

Figure 4. Contracting external testing.

This chapter describes how product testing for ecodesign and labelling by Member States authorities can in principle be organised. Three basic types are identified:

- In-house testing, described in Figure 3. Few Member States authorities have significant in-house testing capacity. These include Sweden, as well as for some limited products and parameters Finland, Germany, Spain and the United Kingdom (National Market Surveillance Authority NMO), (Krivosik, et al., 2013), (Krivosik and Attali, 2014), (Pahal et al.2013).
- Contracting testing externally, represented in Figure 4. This is the most common type of organisation, and is used by most of the Member States performing tests.
- Contracting the procurement of testing and testing externally, represented in Figure 5, being used in Denmark for example.

These are basic types of organising testing which are often used in combination, as described in Figure 7.

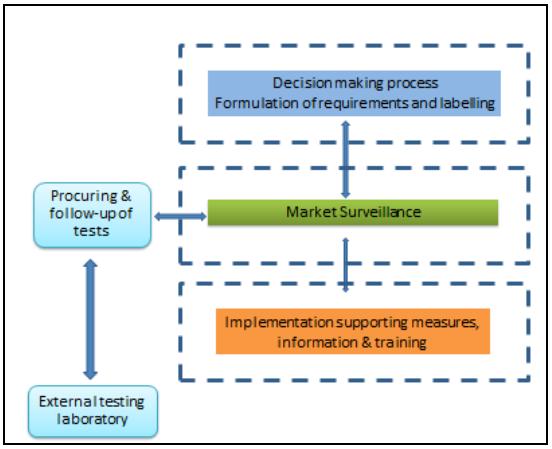

Figure 5. Contracting the procurement of testing and testing externally.

Case study: In-house lab capacity and experience of product testing in Sweden

The case of Sweden is presented in Figure 6. The three main functions for both ecodesign and energy labelling are under the same agency, namely the formulation of the requirements (with final instruction from the Government Office), ii) market surveillance and iii) measures supporting the implementation through information and training. Denmark is one of the few Member States with a similar organisation. However, the responsibility for the three main functions mentioned above with the potent, combined with the in-house testing capacity, makes Sweden a unique case in the EU.

The Swedish Energy Agency has an in-house laboratory, with facilities for testing lighting products and most of white goods and electronic equipment. Tests of more complex products are

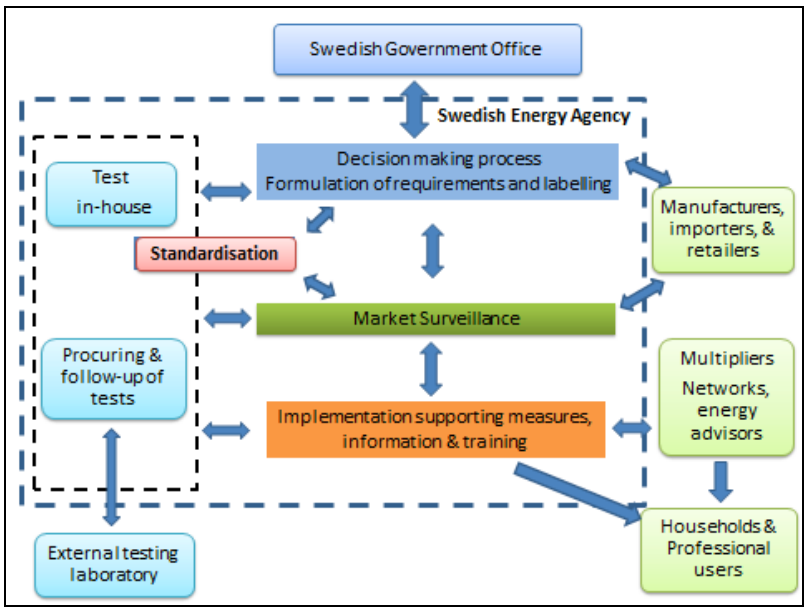

Figure 6. Swedish case, using a combination of in-house Testlab and external laboratories.

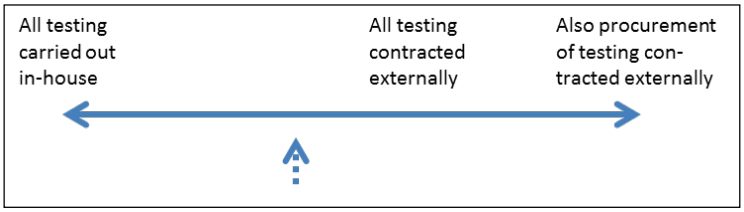

Figure 7. Combination of the three basic types of organisation of testing activities. The arrow indicates the situation at the Swedish Energy Agency.

contracted to external labs. Particular attention has been given to heat pumps as part of an integrated strategy dating from the early 1990s stretching from research and innovation, economic and administrative policy instruments, to information and training. As a result more than half of detached houses in Sweden have a heat pump, and almost a quarter have a ground source heat pump. Sweden was in 2013 the third largest market for heat pumps in the EU after France and Italy (Swedish Energy Agency, 2015). Other complex products tested are residential ventilation units, solid fuel boilers and room heaters, range hoods and PV-systems among others.

Commissioning tests to external laboratories requires expertise for being able to plan, procure, interpret legislation, follow-up and verify the test results. The experience from in-house testing has been crucial to acquire the necessary knowledge for carrying out these activities.

In principle, the EU Member States fall in the range between the two theoretical extremes of having all testing carried out in-house and, on the other hand, also having the procurement of testing contracted externally as shown in Figure 7.

In-house labs generally have a lower throughput of test than standalone labs because the staff becomes more occupied with other tasks than testing. Also, the occupancy rate of the lab may be lower. This translates into a higher infrastructure and personal cost than a dedicated lab where the throughput is maximized.

One of the main advantages of in-house testing is the know-how of tests and products generated within the organisation. This know-how is particularly important to be able to formulate requirements and ensure their enforcement, and to participate in standardisation processes.

Regarding market surveillance tests, the ability to screen a large number of samples may help to target products with a higher rate of non-compliance, on which full tests are carried out. Such sampling is faster than if the tests are procured externally and especially products with a high replacement degree on the market benefit from a fast turnover. So called "reactive market surveillance" testing is also faster where a product is reported non-compliant and the lab very quickly can verify the suspected non-compliance. Some authors also argue that cost savings are attained when performing a mix of in-house and external testing (Heindrikx, 2014).

Also, the expertise in standardisation, even on a limited number of products, provides very relevant knowledge to be able to participate in standardisation work. This knowledge is difficult to acquire when tests are exclusively contracted externally. This includes the interpretation of existing standards, providing comments to mandates or draft standards, as well as the possibility to participate in technical committees. Government involvement is usually weak and thus some involvement is necessary to monitor the process and identify cases which can limit the effectiveness of the legislation.

One example of the use of this knowledge and testing capacity is the IEA-4E on Solid State Lighting[9], led by the Swedish Energy Agency and which aims at providing national Governments the tools required to increase confidence in solid state lighting. The project objectives include harmonising performance testing worldwide as well as developing standards and accreditation infrastructures.

As discussed in the section above technical facilities can also be used to enhance training efforts.

Conclusions

Testing plays a crucial role in energy efficiency policies for energy related products in i) the decision making process for new ecodesign and energy labelling requirements, ii) enhancing the impact of policies through information and other supporting measures, iii) market surveillance and enforcement.

In the formulation of requirements, testing is necessary when standardised information is not available or when there are suspicions about the quality of the information available. In these situations, testing provides unique information to assess the metrics and the stringency of the requirements. Furthermore, expertise about test standards allows assessing the appropriateness of the test methods in terms of verifiability of the requirements for future enforcement.

Testing can also play a role in supporting the implementation of the regulations, as a way of "preventing market surveillance". Awareness creation and a dialogue with market actors, including technical guidelines, are very effective tools to enhance the implementation of the regulations. This is particularly important when test methods are incomplete or are under development, and when transitional methods are used. Information targeting households and other end-users create awareness in particular for energy labelling. End-users can be reached through energy advisors and other multipliers, which appreciate test results.

As the complexity of the products regulated increase, and these are often not available "off the shelf", new approaches are required besides traditional laboratory testing. Measurements *in-situ*, system approaches, screening tests, as well as control of technical documentation and inspections will increase as market surveillance activities.

The paper discussed also how product testing can be organised in the Member States. This includes i) in-house testing, ii) contracting testing externally, and iii) contracting the procurement of testing and testing externally. In most cases it is a combination of ii) and iii) while in-house testing is less common. The case of Sweden was discussed and in particular the importance of in-house testing capacity.

The increased need for testing, both in quantity and in complexity, requires that authorities develop the expertise in the field. We believe that in-house testing generates this know-how, which is needed for formulating the requirements, ensuring their implementation and their enforcement, as well as for being able to participate in the standardisation processes.

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