



## Study

# Investigation of the economic benefits of standardization for Siemens switch technology

Study carried out on the basis of ISO methodology to determine the economic benefits of using standards

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Prepared within the Chair of Innovation Economics of the TU Berlin in a collaboration between ISO, DIN, the TU Berlin and Siemens AG.

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## Abstract

The aim of this study – carried out within the framework of a collaboration with ISO (International Organization for Standardization), DIN (German Institute for Standardization), the Chair of Innovation Economics at the Technical University Berlin, and Siemens AG - was to determine the economic benefits of using standards taking as a basis the recently developed ISO methodology. The analysis was conducted by taking as an example the research, development and market preparation of Siemens' switch technology, and the DIN EN 62271 series of standards pertaining to this technology.

As this was a pilot project concerning the utilization of the ISO methodology, the practicality and user-friendliness of this methodology were to be evaluated as well. Since not only the content but also the structure of a standard has consequences for its economic benefit, following a suggestion by Siemens an additional investigation was conducted in the form of an empirical survey dealing with the extent to which the structure of a standard is subjectively considered to be good or bad in terms of its usefulness in practice.

In the course of this study there were some difficulties in implementing the methodology, which were largely a result of the very general definitions of its individual steps which were not adjusted to the needs of different types of company. After the methodology was successfully implemented with a few adjustments to the procedure, suggestions for improvement could be made for both the basic concept and for the documents and tools provided.

Results of this study show that there are clear economic benefits from using standards. Even a very conservative consideration of the effects observed shows that there is an impact on the profit (EBIT) of about 1.1% within the company areas under consideration. A positive benefit for Siemens switch technology is thus clearly demonstrated. However, whether this impact can be said to generally apply to other companies will not be determined until the many studies carried out within the framework of this pilot project in companies other than Siemens and with other framework conditions have been evaluated.

A survey was also conducted of the impact of the structure of extensive standards on the perceived usefulness of such standards, since the user-friendliness of a standard also has a bearing on the benefits generated by its use. It was shown that the perceived practicality could be increased by making a few corrections to the structure of the standards in the DIN EN 62271 series, which tend to be regarded as being too large in scope.

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## 1. Introduction

In the present study, the methodology for quantifying the benefits of standardization developed by ISO and Roland Berger within the framework of an international pilot project is applied and tested in respect of its practical applicability. For this purpose, an evaluation of the monetary implications of the use of standards by industry was carried out following the ISO methodology, in collaboration with the switch technology and standardization divisions of Siemens AG. The main focus was on the DIN EN 62271 standards series, which are essential for the switch technology sector.

The necessity of such a methodology rests mainly on the observation that standardization in the industrial environment is often regarded as a concrete financial burden of uncertain benefit. This attitude is based on consideration of the matter from a cost accounting point of view. While there is a concrete cost centre for "standardization", there are no profit centres with the same designation on the opposite side of the balance sheet. Indeed, in contrast to the evident costs of standardization, it is often difficult to identify the resulting profit.

This could, among other things, be because standards are often used to prevent costs from incurring in the first place, for example by creating contractual and legal security. In addition, the advantage of using standards only becomes apparent through their application in a particular business function. Thus, the resulting advantage is often regarded as an achievement of the departments which implement the standards. Here the ISO methodology comes into play, as it tries to crystallize and aggregate the advantages gained in individual business functions through standardization, with the result that an accumulated virtual balance sheet entry "benefits of standardization" can be created once the methodology is applied.

The present study not only focuses on the application of the ISO methodology, but also on any difficulties which might occur, and on any changes and adjustments which need to be made to the implementation and evaluation of the methodology. This will especially help in improving it further, making it more user-friendly and less complicated for use in the industrial environment.

Since the economic benefits of standards not only depend on their content but also on their applicability, an empirical study of the perception of the usefulness of extensive industrial standards was suggested by Siemens as well.

The extent to which the structure of a standard in everyday use is perceived to have a negative or positive impact on its usefulness is also explored. Building on these observations, conclusions are made regarding potential improvements to the DIN EN 62271 series which is principally being considered here.

This study was carried out in collaboration with ISO, DIN and the Chair of Innovation Economics at the TU Berlin. The project was supported by Siemens AG as a partner from industry, particularly its switchgear manufacturing plant in Berlin.

## 2. Siemens, the company

### 2.1. History

The globally operating business known today as "Siemens AG" was founded in 1847 by Werner von Siemens and Johann Georg Halske as the "Telegraph Construction

Company of Siemens & Halske" in Berlin. Besides great successes in building up the European telegraph network, once Werner von Siemens discovered the dynamo-electric principle, heavy-current technology also became a fundamentally important sector of the company. In 1903 the energy divisions of Siemens and Halske merged with Schuckert & Co. to form Siemens-Schuckertwerke GmbH, which continued to set milestones with the electrification of Germany and Europe.

Siemens grew steadily, new markets were added, such as medical and household appliances, and the company succeeded in building up such a strong position in the market that not even the Second World War and the concomitant loss of practically all of its assets, as well as its rights to its name and patents, could drive it into bankruptcy.

With the repositioning of the company in 1966, various Siemens firms were unified organizationally and legally to form Siemens AG. Today, the globally active Siemens AG is divided into three sectors: "Industry", "Healthcare" and "Energy". Siemens "Energy" is a world market leader in the development and provision of the most modern and efficient energy plants for power generation, transmission and distribution.<sup>1</sup>

In 2010 Siemens AG had 405,000 employees (128,000 in Germany) and recorded a turnover of 75,978 million euros with a profit (after tax) of 4,068 million euros.<sup>2</sup>

## 2.2. Switch technology

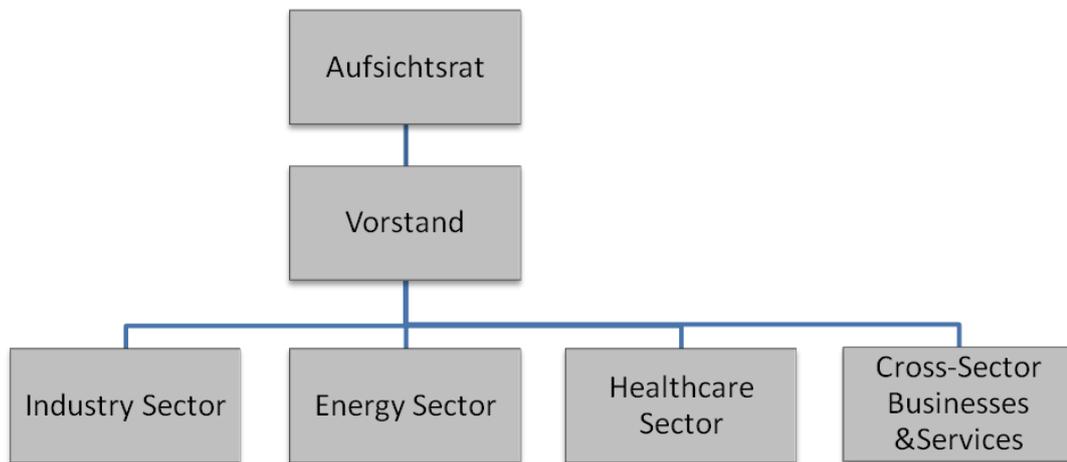
Siemens Energy offers a broad spectrum of switch technologies. High voltage switches are used predominantly in power transmission and mid-voltage switches are used in power distribution. The portfolio of Siemens switches includes outdoor and indoor switchgear, air- and gas-insulated switchgear, as well as circuit breakers, current disconnectors and earthing switches. All of Siemens' switchgear devices meet or exceed the relevant DIN EN standards and are known on the market for their high level of safety, reliability and longevity. Consequently, Siemens' switchgear is seen as being in the higher price bracket of the sector, which means that additional efforts and expense are necessary to convince customers of the advantages of the very high technical standard of the switches. This can be achieved, for example, through additional tests and proof of the devices' performance by demonstrating that the minimum values laid down in the DIN EN standards are exceeded.

Employees working in switch technology at the Berlin and Erlangen sites took part in this study.

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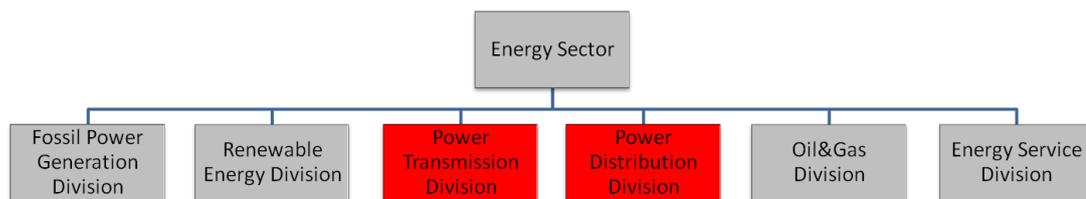
<sup>1</sup> Siemens AG (2010a)

<sup>2</sup> Siemens AG (2010b)



((Key: Aufsichtsrat = Supervisory Board, Vorstand = Managing Board))

■ Divisions involving switch technology



**Figure 1 – Switch technology in the organizational structure<sup>3</sup> of Siemens AG (author's representation)**

### 2.3. Standardization policy at Siemens

Siemens has very wide-ranging experience with standardization and has been making extensive use of it for a long time. Siemens regards standardization as very important for the company's success and has an entire department dedicated to this subject. At Siemens various standards are used in production, for price optimization and for compliance. Beyond that, great value is attached to participation in standards committees, which is seen as an important tool for ensuring a competitive, future-oriented product portfolio.

Within the remit of this analysis, it was evident that the standardization concept is actually very widespread and, as a rule, it is rare for the benefits of standardization to be questioned. Where this does occur, this is mostly due to financial pressure coming from individual departments. Departments which fall into this category include Research and Development (R & D), since there is no direct means of demonstrating how investment in standardization results in benefits, and the monetary quantification of this benefit is

<sup>3</sup> Siemens AG (2010c)

considerably more difficult than is the case with purchasing, for example.

### **3. Introducing the ISO methodology**

#### **3.1. Setting the objective**

The ISO methodology is a procedure used to systematically analyze - taking Porter's value chain as a starting point - the individual value creation stages within a company, company area or even an entire industrial sector with respect to the financial implications of standardization. This method is intended for investigations into the impact of standardization on value creation within a business. The idea of such an investigation is not new. For example, as early as 1990 DIN published a technical report on "Ways of calculating the success of standards projects"<sup>4</sup>. Admittedly, the separate consideration of each value creation stage is a considerable improvement on the earlier approach because it makes the identification of the impacts of standardization more structured and more comprehensible.

Furthermore, the methodology is used to determine which factors within a company influence the benefits of standardization and how these benefits can be maximized. The method is based predominantly on surveys of technical experts and standardization experts inside the company. On the basis of these interviews, an attempt is made, using a detailed, step-by-step plan, to localize and substantiate each potential source of the benefits to be gained from standardization.

#### **3.2. The individual steps of the methodology<sup>5</sup>**

##### Analysis of the value chain

As a first and elementary step, the value chain of the particular company is considered and systematically analysed. The stages at which there is potential for influencing company success through standardization are identified. Indicators of such potential include the relevance of the particular value creation stage for the end product, the number of standards, and the share in the EBIT of the total production.

In addition, the selection of the value creation stages to be considered is influenced by further factors such as the expected availability of data and contacts within the company or the resources available for the analysis.

##### Identifying value drivers

Value drivers are core competences and other factors which give the company a direct competitive advantage and are thus essential for its success. The identification of value drivers is very important, as they can enhance the impact of standardization and are thus of enormous importance for the investigation. As was already the case with the search for relevant value creation stages, it is also possible to work with indicators such as the influence on the EBIT when trying to identify value drivers.

##### Identifying the impacts of standards

Standards can influence products and processes in many different ways, and thus have an effect on revenue streams.

At this step, a list of the potential impacts of standards is used to determine the areas of

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<sup>4</sup> DIN (1990)

<sup>5</sup> ISO, Roland Berger (2010)

the company which are actually influenced by standardization. Even if this is not a central part of the investigation, it should be kept in mind that the application of a standard can have both positive and negative effects on different areas. For instance, the introduction of a complex, standardized mounting device can make production more efficient, but at the same time it can have a negative effect on the working environment (noise, temperature) or the flexibility of the works.

#### Data evaluation and aggregation

In the last step, the actual evaluation of the impact of standardization on the company is carried out. Interviews are conducted with employees, taking the selected value creation stages and the established value drivers and impacts of standardization into consideration. The intent is to verify and quantify the established effects. The data obtained from the interviews are examined for consistency and are evaluated using the company's key indicators (turnover, EBIT, etc.)

By aggregating the individual effects determined in this way, the full financial implications of standardization on the business can be estimated.

## 4. Application of the ISO methodology

### 4.1. Analysis of the value chain

#### 4.1.1. Value chain of the industry

First, the position of the switch technology sector considered in this study within the overall industrial context is determined (Figure 2). As can be inferred from the name "Energy" given to this Siemens sector, switch technology is part of the larger energy technology sector, and within the electricity supply value chain, which involves essential components for the transport and distribution of electrical energy for uses ranging from high-voltage circuit breakers in transformer stations to low-voltage switchgear in a building.



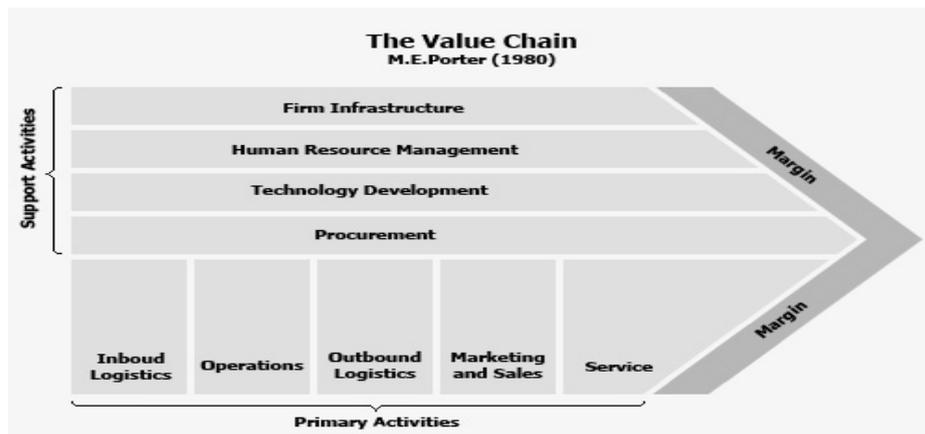
Figure 2 - Value chain for electricity<sup>6</sup>

#### 4.1.2. Value chain at Siemens

In Siemens' switch technology sector there is a conventional value chain, presented in the form introduced by Porter (see Figure 3)<sup>7</sup>.

<sup>6</sup> Winje D. (2009)

<sup>7</sup> Michael E. Porter (1989)



**Figure 3 – Value chain according to Porter<sup>8</sup>**

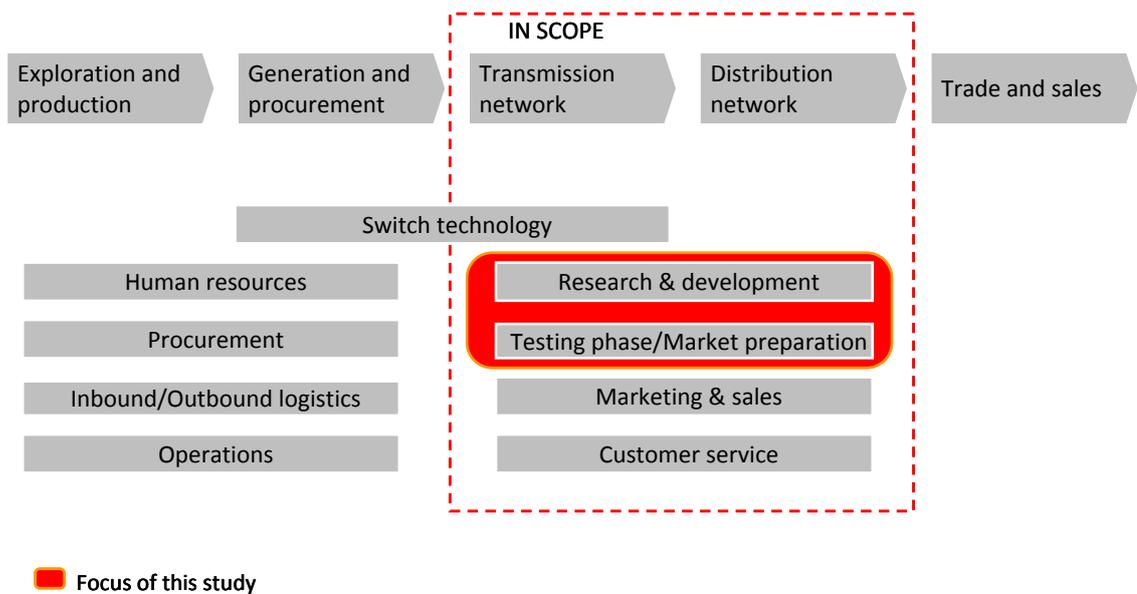
#### **4.1.3. The value creation areas considered here**

It is important to bear in mind that the switch devices and installations with which we are concerned may be complex, but they represent a technology which has basically been familiar for decades and one which brings with it little in the way of new logistic or operational demands. Changes that have been made over the past few years predominantly relate to the optimization of functions and improving the efficiency of the switches. This leads to the assumption that the stages of the value chain having the greatest impact on company success, and thus the most important value drivers, tend to be in the areas of research, development and communication and interaction with customers. The observation that Siemens has managed to retain its position in this market not by competing on price but by maintaining a high technical standard supports this assumption.

On the basis of this observation and taking into consideration the information and supervisors available for this study, the focus of the analysis will lie in the development and market preparation of the switch products (Figure 4). Apart from R&D, this includes the extensive testing phase including type testing as well as contact with customers. Serial production with its attendant areas of procurement and logistics will not be considered here.

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<sup>8</sup> Michael E. Porter (1989)



**Figure 4 – The value creation areas considered here (author's representation)**

#### 4.2. Identification of value drivers

The search for value drivers proceeded on the basis of numerous conversations with employees and on the joint analysis of the state of the envisaged market, and the positioning of Siemens AG in this market. In the course of these conversations, it became clear that, apart from obvious factors such as the improvement in cost efficiency and the further development of a future-oriented product portfolio, many other intangible values also play a major role. For instance, maintaining a good reputation over many years and the image of a manufacturer demanding the highest quality are two such factors. The value drivers identified are listed below:

**Table 1 – Identified value drivers**

- Improving product efficiency
- Cost-effective further development of the product portfolio
- Products which cover a wide spectrum of customer needs but with emphasis on extremely demanding systems
- Future-oriented technology
- Above-average quality and reliability of switches and switchgear
- Tests and inspections which go beyond the requirements of the standard to substantiate an above-average quality
- Capitalizing on long years of experience and maintaining a good reputation

#### 4.3. Identification of the impacts of standardization

After the first few interviews with switch technology employees it became clear that it would not be possible to apply the methodology described earlier without modifications. This is mainly because switches and switchgear are products that cannot be sold if they do not fully and demonstrably meet the relevant standards for switch devices and are thus unthinkable. This results in an initial condition which is at odds with some of the assumptions of the methodology.

In an environment in which compliance with standards must be seen as being obligatory

for all market participants, and in which these standards have generally existed for decades, the search for the financial benefits gained from using standards is very difficult.

A situation thus arises in which it is neither possible to establish the benefits by comparing the state of affairs before the standards were introduced nor to make comparisons with competitors who do not make use of standards.

One approach for the investigation is feasible, however, which is to consider the revision of the relevant standards at regular intervals and to see whether added value has been created for Siemens through these revisions, and whether this added value benefits all companies in the sector to the same extent.

#### **4.3.1. Standards relevant to switch technology**

In selecting the standards relevant for this study, it quickly became clear that significant influences on the sector under consideration are encountered only in terms of the category of the product standard. Whereas no process standards could be found that are relevant to this study, the characteristics of functional safety standards (compliance) were certainly identified. However, these are usually in the form of tests and safety requirements within product standards.

The standard series which is generally used and essential to switch technology as a whole is DIN EN 62271 "High-voltage switchgear and controlgear". In this context, the following standards are of especially practical relevance for the sectors under review:

#### **Table 2 – Standards especially relevant for the study**

- DIN EN 62271-1 "Common specifications"
- DIN EN 62271-100 "Alternating current circuit-breakers"
- DIN EN 62271-200 "AC metal-enclosed switchgear and controlgear for rated voltages above 1kV and up to and including 52kV"
- DIN EN 62271-203 "Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV"

The adaptations and modifications to these standards made over the past few years were identified and investigated as regards their potential monetary impacts.

#### **4.3.2. Indicators for identifying the impact of the relevant standards**

With the help of indicators, the often very complicated and not always evident relationship between the changes made to the standards and the company's success is elucidated, particularly on the basis of the value drivers identified. In order to make this connection clear, it must be possible for the indicators to be influenced by a standard and they must have a direct impact on the company. A list of indicators which meet these criteria, and hence can be referred to in our subsequent investigation of the changes made to the standards, is given below:

### **Table 3 – Indicators of relevant changes to a standard**

- Changes to the procedure for developing switches and for their approval
- Changes to the technical requirements for switches and switchgear
- Changes to quality and service requirements
- Changes to recommended values and to values which must be adhered to

Special attention should be paid as to whether the following indicators apply:

- The change to the standard affects a criterion relevant to tendering
- Changes to the standard do not equally affect all market participants
- The cost to Siemens or other market participants for implementing the changes
- The extent of the actions needed as a result of the changes (e.g. on the basis of costs incurred/savings made, or matters which have a bearing on employees affected by the changes)

#### **4.3.3. Potential impact of changes to standards on company success**

For the following, consultations with expert personnel at Siemens regarding the standards listed in 4.3.1 above were carried out. For each standard a Siemens switch technology expert with special knowledge of that particular standard was consulted (for contact details, see Appendix I). Correlations between the value drivers and indicators given above were investigated. Potential changes to DIN EN 62271-100 and DIN EN 62271-203 that would benefit Siemens became especially evident, although only a few changes seemed likely to have a direct positive impact on the success of the business.

With many of the changes, an influence on the market as a whole could be expected, a fact which could affect the performance of the company in a complicated nexus of ways.

The changes to the standards are presented below, and each standard is connected with one or more indicators or value drivers. For the sake of clarity each change is assigned to one of three categories according to its impact. In each case there is a short explanation and the impact on Siemens and the market as a whole is described.

#### **Table 4 - Direct positive impacts of changes to standards**

Direct positive impacts:

(Savings or profits are the direct result of applying the changed standard)

1. DIN EN 62271-100, Subclause 6.111 - Capacitive current switching tests, combination of tests

In the past, the switching tests required for type testing switches for capacitive currents had to be carried out separately for different current and voltage parameters.

As a result of the change, a combination of these tests is now permitted. The outcome is that switches need to be tested to considerably fewer characteristic values. The test procedure is now simpler and the company can save time and money.

Indicator: Change to the procedure for developing switches and for their

approval

Value driver: Cost-effective further development of the product portfolio

2. DIN EN 62271-203 – Harmonization of the standard with US standard IEEE 37.122 (on-going)

European companies will find it much easier to gain and serve customers in the US market as a result of the harmonization of the two standards. Fewer customized versions of products will now have to be made and there will no longer be a need to carry out additional safety tests where the IEEE standard deviates from the DIN EN standard.

Indicators: - Change to the procedure for developing switches and for their approval

- Change to the technical requirements for switches and switchgear

Value drivers: - Cost-effective further development of the product portfolio

- Products which cover a wide spectrum of customer needs

3. DIN EN 62271-203, Subclause 8.1 - Recommended voltage levels

There are very many different voltage levels on the various markets and it is not efficient to have to make a switch especially for each voltage level. Hence, a limited range of recommended voltage levels is now given in the standard.

As a result, manufacturers can now cover a wide market with a smaller product portfolio. The management and maintenance of the product range will also be easier and cheaper. However, there is a risk that regional suppliers will be able to serve a local market better than those supplying products which have been adapted to a wider market.

Indicator: - Changes to recommended values and to values which must be adhered to

Value drivers: - Products which cover a wide spectrum of customer needs

### **Table 5 - Indirect positive impacts of changes to the standard**

Indirect positive impacts:

(Savings or profits result from competitors having problems implementing the changed standard)

1. DIN EN 62271-100, Subclause 4.101 - Examination of different DC time constants

Circuit breakers can only interrupt the current flow if the alternating current amplitude passes through zero. The timing of this is influenced by the direct current constant of the alternating current. The greater this is, the longer it takes for the switch to extinguish the light arc between the two contacts and this leads

to greater complications. In the past, a constant of 45 milliseconds was assumed for the switch test. But this time interval does not reflect the variety of values used in practice. Given that there will be individual customers with regional requirements, switch capability is now tested and certified for the four direct current constants (45, 60, 75, and 120 milliseconds).

This means a greater expenditure for the development and adaptation of switches. However, this can vary depending on the performance of the switches, their size and the know-how of a manufacturer, and can lead to a competitive advantage.

Indicators: - Changes to the technical requirements for switches and switchgear  
- Changes to recommended values and to values which must be adhered to  
- Changes to the standard / resulting increase in expenditure do not affect all market participants equally

Value drivers: - Products which cover a wide spectrum of customer needs but with emphasis on extremely demanding systems.

## 2. DIN EN 62271-100, Subclause 6.2.11 - Voltage test as a condition check

An additional voltage test is specified in which the capabilities of a switch to isolate open circuit sections must be tested if they cannot be proved to be effective by inspection.

This change can have various implications for a manufacturer, depending on the quality and performance of the switches produced. Either only one additional test is needed which the switch is to pass, or – in some cases, extensive - structural alterations to the product will be needed if it is to pass the test. This can give an advantage to some manufacturers.

Indicators: - Change to the procedure for developing switches and for their approval  
- Changes to the standard/resulting increase in expenditure do not affect all market participants equally

Value drivers: - Above-average quality and reliability of the switches and switchgear

## 3. DIN EN 62271-100, Subclause 6.101.1.1 – Characteristic performance curves of drive units

Depending on the kind of test a switch has to undergo, it can be advantageous to build in different kinds of drive units that switch. For example, while there is less wear on contacts where there is a fast drive and thus the switching times are shorter, the wear of the drive itself increases, so that is likely to withstand fewer switching cycles. When type testing, a performance curve for the drive unit is drawn up at the start of the test so that a suitable drive unit does not have to be selected for every test. The same drive unit must now be used in all subsequent tests. To ensure this, for every test a check is made to see if the performance curve of the unit installed in the switch system remains consistent, at least to

within small tolerances.

Manufacturers who have problems passing all the tests with just the one drive unit, and who had previously replaced the drive units as needed, are now at a disadvantage because of this change. On the other hand, manufacturers who always used the same drive unit for the entire test will not be affected by the change, and will have an indirect advantage over manufacturers as described above.

Indicators: - Changes to the procedure for developing switches and for their approval  
- Changes to the standard/resulting increase in expenditure do not affect all market participants equally

Value drivers: - Highest quality and reliability of the switches and switchgear  
- Capitalizing on long years of experience and maintaining a good reputation

4. DIN EN 62271-100, Subclause 6.111 – Capacitive current switches, reclassification

Switches are classified in two quality categories depending on their performance and safety. Class C2 has the strictest requirements, while the criteria for Class C1 are less strict. In the past, the category being applied for had to be stated before the test. If the product failed the test, it had to go through the entire testing procedure again for the lower category. With the change to the standard, the requirements for Class 2 were raised but the boundary conditions for the test were simplified. This means that whether or not the criteria for C1 have been fulfilled it determined in C2 testing. If a switch does not achieve C2 classification, it can still be classified as Class C1 without having to go through further testing.

Since very many customers (especially of high-voltage products) will accept only Class C2 products, the new more demanding criteria can be an advantage for manufacturers whose switches are more robust and which will achieve C2 classification without any problem. Likewise, the change can be a relief for manufacturers of less robust switches, for they can now obtain C1 classification if they fail the C2 test.

Indicators: - Changes to the procedure for developing switches and for their approval  
- Changes to the technical requirements for switches and switchgear  
- Changes to the standard/resulting increase in expenditure do not affect all market participants equally

Value drivers: - Highest quality and reliability of the switches and switchgear  
- Capitalizing on long years of experience and maintaining a good reputation

## 5. DIN EN 62271-203, Annex F – Service Continuity

This annex shows more precisely and by means of examples what demands are made on service continuity, that is the stability of operations.

This factor not only depends on the quality of the switch, but is directly linked with the service offered by the manufacturer.

Since two important factors come together here, namely the reliability of the switch and the scope and performance of the service, different manufacturers can position themselves differently. If one manufacturer meets market demands with an optimal combination of the two, or if he can profile himself by offering a higher quality level than the others, this can give him an advantage in the market.

Indicators: - Changes to recommended values and to values which must be adhered to  
- The change to the standard affects a criterion which is relevant to tendering

Value drivers: - Highest quality and reliability of the switches and switchgear  
- Capitalizing on long years of experience and maintaining a good reputation  
- Tests and inspections to substantiate an above-average quality level

## 6. DIN EN 62271-203, Subclause 12 – Environmental aspects

SF<sub>6</sub> gas, which is used in switches, is a greenhouse gas the contribution to the greenhouse gas effect of which is 22,000 times greater than that of CO<sub>2</sub>. It is therefore very important to ensure and check that the switches are air-tight. For that reason it is now required that all gas losses occurring during installation or servicing are documented. Likewise, any new filling or refilling of a switch with gas must also be documented.

This change means that much depends on the air-tightness of switches made by individual manufacturers. If the gas loss is minimal then this could bring an advantage over other manufacturers who make switches which are less air-tight.

Indicators: - Changes to recommended values and to values which must be adhered to  
- The change to the standard affects a criterion which is relevant to tendering  
- Changes to the standard/resulting increase in expenditure do not affect all market participants equally

Value drivers: - Highest quality and reliability of the switches and switchgear  
- Future-oriented technology  
- Additional tests and inspections to substantiate an above-average quality level

## Table 6 - Impacts which cannot be attributed to a particular change

Impacts which cannot be attributed to a particular change:

- 1 Anticipation and consideration of potential future changes to standards in the development and design of switching products

At this point it should be emphasized again that any changes whatsoever within the standard under consideration (DIN EN 62271) must be implemented and applied in full without delay.

This highlights all the more the importance of continually observing and, where appropriate, influencing the standardization process. Changes to standards and the impacts they have on the required performance of products, materials, safety requirements, and test procedures do not come as a surprise. They have a slow lead time and if imminent changes are recognized early enough, current developments and designs can be reviewed so they can be adjusted to meet future needs.

If such a development is not spotted in time or is not given due consideration, extremely high adjustment costs could incur over the short-term and a temporary sales stop could result. Therefore, manufacturers who continuously invest in observing, evaluating and taking account of standardization activities, will be at a considerable advantage over manufacturers who only implement a standard when it has become mandatory to do so.

- Indicators:
- The extent of the actions needed as a result of the changes made to the standard (e.g. on the basis of costs incurred/savings made)
  - Changes to the procedure for developing switches and their approval
  - Changes to the technical requirements for switches and switchgear
  - The change to the standard affects a criterion which is relevant to tendering

- Value drivers:
- Cost-effective further development of the product portfolio
  - Future-oriented technology

### 2. Participation in standards committees

Although the focus of the present investigation is on the application of standards, it is important to emphasize that participating in the standards development process is of great importance. Companies that actively participate in standardization can profit from doing so in many different ways, for example, they can influence a standard so that it suits that company's current and future products.

But aside from influencing the standard, there are other considerable advantages to be gained through open discussions on the topic being standardized with other experts or even with competitors.

Thus, there is less risk of falling short of the market with a product innovation or of missing out on changes on the market.

Indicators: - Potential changes to all values, requirements etc. in standards

- Changes to the standard/resulting increase in expenditure do not equally affect all market participants

Value drivers: - Future-oriented technology

- Cost-effective further development of the product portfolio
- Capitalizing on long years of experience and maintaining a good reputation

#### **4.4. Evaluation and aggregation**

The impacts elaborated and introduced in 4.3.3. above were evaluated quantitatively. First, each impact was considered separately and the monetary benefits gained from it were quantified with the help of the relevant experts.

For some impacts this was not possible, as the relevant statistics were not available, or the expense and time required to obtain them (especially the involvement of Siemens employees) were not in proportion with any advantages gained.

In such cases, qualified estimates were made and bundled together with any impacts having similar value drivers/indicator-combinations in order to obtain a broader basis of indices for a reliable estimate.

With many impacts or impact groups, the data available are not sufficient to attribute a specific value to the established outcomes. Often, it would have been possible to concentrate on a single value by constructing mean values, but that would not have been useful since there would be a false impression of accuracy that the present study does not claim because it is based mainly on qualified estimates made by experts. Therefore, where there is no certainty about the values, calculations of outcome maxima and minima are given. Thus the total result aimed for is an interval within which the true value can be found with high confidence.

For a few impacts which are currently in the implementation phase, no reliable estimate could be made despite consultation with several experts. In these cases, only the expected potential of the change to the standard was discussed.

#### **4.4.1. Key figures quoted for the purpose of evaluation**

The company's key figures which were used to assess the individual impacts are presented here. The figures represent realistic estimates, but are not the exact figures, because these are not fully accessible due to company policy.

#### **Table 7 – Key figures for switch technology in Siemens**

- Table removed for the purposes of data protection -

#### **4.4.2. Evaluation of the direct positive impacts**

1. DIN EN 62271-100, Subclause 6.111 – Capacitive current switching tests, combination of tests

The cost of developing a switch can be estimated to be somewhere between 15 and 20 million euros. The resulting savings amount to about 0.5% of the development costs, that is roughly 150,000 to 200,000 euros.

2. DIN EN 62271-203 – Harmonization of the standard with US IEEE 37-122

The harmonization process is currently in process, but it is possible to draw some early conclusions. Foremost, as expected, Siemens' sales and, with them, the market share of Siemens control panels in the USA have increased markedly. It can be assumed that, despite periodic variations in their market share and taking into account other market influences, a good 50 % of this improvement can be attributed to the harmonization process.

The term "harmonization process" has been used because the increase in market share not only has to do with the greater ease of selling switches produced and tested according to the DIN EN standard. Many customers first became aware of Siemens products thanks to Siemens' participation in the harmonization process, and many customer contacts were made as a by-product of participation in standardization working groups.

The market in the USA for control panels represents about 5 % of the world market and this market share was improved by about 50 %, of which about 20 % can be attributed to the harmonization process. Given an annual profit of 54 million euros in this sector, a market share increase of about 20 % in a 5 % market segment means an added profit of about 540,000 euros, or about 1 %.

3. DIN EN 62271-203, Subclause 8.1 – Recommended voltage levels

The reduction of voltage levels is also a measure which is currently being put into practice. As already mentioned, this impact can potentially help reduce the product range and hence simplify the management and maintenance of the products. But negative impacts could still arise. For instance, local manufacturers could, as a reaction to this reduction in product choice, design products better suited to the individual requirements of their customers and thus have an advantage when tendering for contracts. Because there were very few data available about this change and because the possible outcomes are ambiguous, this impact could not be reliably assessed.

#### **4.4.3. Evaluation of the indirect positive impacts**

1. DIN EN 62271-100, Subclause 4.101 – Examination of different DC time constants

There are only a few switches on the market which can be used straight-off with high DC time constants. On the other hand, there is only a comparatively small

demand for such special switches. Because of this, only 12 out of 8,000 switch sales were directly attributable to this capability. Although this corresponds to only about 0.15% of total sales, these products are designed for very high voltage and current levels, and thus are at the upper end of the price scale. It can also be assumed that a customer who purchases such a robust switch from Siemens is likely to order further switching components for his network, whose performance level may not be as high. Altogether it can be assumed that this impact has an influence on profit of about 0.5 to 1 %. Thus the benefit gained through this change to the standard change is between 65,000 and 130,000 euros.

2. DIN EN 62271-100, Subclause 6.2.11 –Voltage test as general test of condition
3. DIN EN 62271-100, Subclause 6.101.1.1 – Characteristic performance curves of drive units
4. DIN EN 62271-100, Subclause 6.111 – Capacitive current switches, reclassification

These three impacts will be considered together, since the resulting benefits in all three cases arise from the fact that the competitors, primarily the "low-cost" manufacturers from China and India, who either cannot meet the stricter requirements specified in the changed standard at all or can do so only with an increased expenditure.

At this point a major problem arises in that very many products which do not satisfy the new criteria nevertheless still manage to get on to the market with documentation which does not reflect the actual technical properties of the devices. This problem is exacerbated by the fact that there are many customers for these products who are prepared to accept a lower safety and performance level in order to make a short-term profit out of the markedly lower prices of such products. Therefore, a distinction must be made between the impact on an ideal market, and the fact that, at the moment, as good as no benefit at all can be reaped from these impacts.

According to estimates by branch experts based on data gained through experience and test results for competitors' products, the new requirements of impacts no. 2 and 3 cannot be met by about 15 to 20% of the products currently on the market. With impact no. 4 this is still about 10%.

However, these percentages cannot be added together as such, because they often represent the same products of competitors which cannot meet several requirements.

It would not make sense to work out the degree of overlap amongst products which do not meet the individual requirements. For while the value of the theoretical benefit would increase, such an estimate would most definitely make the calculation less robust.

For this reason it is assumed, where the requirements of impacts 2, 3 and 4 are not fulfilled, that we are dealing with the same products. Consequently it is assumed that 15 % of the products currently on the market do not satisfy at least one criterion of the updated standard and therefore would have to be removed from the market, at least for the time being.

Assuming that Siemens' circuit breakers account for about 25 % of the market, and that the 15 % of the switches to be removed from the market is distributed evenly over the remaining 85 % of the market, then the increase in sales for Siemens would be as follows:

New relative market share:

$$\text{old market share/new market size} = 25/85 = \text{approximately } 29.4\%$$

Increase in sales:

$$\text{new market share} * \text{sectored market} = 29.4\% * 15\% = 4.4\%$$

If these figures are now interpreted in terms of the actual turnover in circuit breakers, then it would mean a turnover increase of 11.4 million euros and an increase in profit of 572,000 euros.

In light of this number, it becomes quickly apparent that there is great potential here and that it would make sense to carry out further investigations on how to better communicate the advantages of Siemens products on the basis of compliance with the standard.

#### 5. DIN EN 62271-203, Annex F – Service Continuity

All customers expect a reliable switch as well as good customer service. However, it has been shown that some customers consider this as being essential and would therefore be prepared to accept a surcharge in return for this security. According to many estimates, the proportion of such customers is about 20 % of the total and the surcharge would be about 1 %.

Accordingly, this would have an effect of 0.2 % on profits, which amounts to 108,000 euros.

Since this calculation is based very much on estimates, it is to be thought of as a maximal outcome, while, on the other hand, the minimal outcome would be no economic benefit at all.

#### 6. DIN EN 62271-203, Clause 12 –Environment aspects

The new regulations regarding the use of SF<sub>6</sub> gas are just now being put into effect and therefore no clear effects could be observed. Furthermore, there is a fear that this change can lead to the growth of a "grey market" (as we can see already with other impacts) in which products may be traded even though they do not fulfil the requirements. Looking at the situation from today's point of view, this impact cannot be reliably assessed and there is a chance that no real benefit of any relevant magnitude may come about in the future.

##### **4.4.4. Impacts which cannot be attributed to a particular change**

#### 1. Anticipation and consideration of potential future changes to standards in the development and design of switch products

It is not possible to define a constant, periodically recurring benefit because if standardization is responsibly carried out, the benefit will be that no unusual events occur and no extraordinary payment streams arise.

Yet even if standardization is carefully carried out, a series of unfortunate circumstances can lead to important developments in standards which are not

recognized in time and appropriately implemented. A case of this kind did in fact occur in the switchgear sector when, in the framework of changes to DIN EN 62271-200, new guidelines for the internal arc fault test were prescribed. Since the switchgear was manufactured to a high safety level, it easily passed the test after a few relatively small modifications. However, suddenly the entire product range had to be tested all over again. This involved great expenditure in time and money in the region of 3.5 million euros.

This financial outlay could have been avoided almost entirely if the impending change could have been spotted in good time, for then much of the gear could have been tested in a routine testing regime in accordance with the new test standard.

Thus it can be assumed that in this case the benefits of standardization would have contributed a profit of up to 3.5 million euros.

For this calculation, it is assumed that the additional expenditure in the case of an incorrect standardization policy could be incurred during the revision of a standard. Approaching standardization with foresight will ensure that these costs will not be incurred. Assuming the relevant standards are revised roughly every ten years, then the possible annual cost reduction will lie somewhere between 0 and 350,000 euros.

## 2. Participation in standards committees

Assigning a value to participating in standardization requires a further study of at least the same magnitude as the present one, and even then, clearer values would presumably not be obtained. Thus no attempt is made to quantify this point, although it has a very high status at Siemens and has a considerable effect on identifying future trends and developments which are just starting to become apparent.

By taking an active part in standardization, there is much less likelihood of not noticing an important change to the standard. In contrast to the losses described above, which arose because a change was identified too late, there are various positive courses of action when there is very early contact with the draft standards developed in the course of the standardization process. Siemens can, for example, try to influence the development of the standard or adapt future products to future requirements at an early stage of their development. Finally, apart from the impacts mentioned above in respect of the product conforming to the standard, the company will also profit from an improvement in the skills of colleagues taking part in the standardization process. Depending on the tasks that need to be completed in such a committee, participation can be regarded as training in teamwork, leadership, or simply as a way of getting used to working in the English language.

Of course, taking part in standardization is also costly, since employees will be removed from their regular work and fees for taking part in the work of standards committees and travel expenses will be incurred. Taken as a whole, however, the benefits far outweigh the costs.

#### **4.4.5. Summary and aggregation of the results**

The impacts on the company's profits which thus far have been presented individually are summarized here in a table (Table 8). The results will be summed at the end of the table and set in the context of the total profit of the switch technology sectors under consideration. This gives the total impact on the EBIT of the changes to the relevant standards over the past few years .

#### **Table 8 – Aggregation of the impacts of standardization**

- Table removed for the purposes of data protection -

## 5. Evaluation of the results of the ISO methodology

Despite some challenges and the necessity of making some adjustments (for further details see Chapter 7 below), it was possible to apply the ISO methodology in the areas of research and development, testing and market preparation of Siemens switch technology. The results of applying the ISO methodology are presented below, with a general section and a section specifically devoted to Siemens..

### 5.1. General evaluation of the results

During the study it was often not easy to gain access to the necessary values, with the result that most values are based on expert estimations. This was also the reason why the result is given in terms of intervals. However, at no time was the work conducted with unfounded or only very vague data, so that it is justifiable to claim that the data used for the methodology were reliable and well-founded. Nevertheless the result cannot be expressed in the form of a direct numerical value as a tangible benefit. Rather, it is a matter of first of all observing that there is an impact at all and establishing, by means of a rough estimate, whether this impact will lead to a constant value.

In carrying out the ISO methodology, an impact of the use of standards on the profit of the Siemens sectors under consideration was found to be roughly 1.1 % up to 2.8 %.

To further evaluate these results, the following specific boundary conditions of the study need to be taken into consideration:

- We are not dealing with the benefits of applying new standards, but only with the benefits of minor changes to an established standard. The benefits gained from a new standard can be considerably greater, especially in areas which have not been standardized.
- In order to make a plausible evaluation of the benefits from the observed impacts of the changes to the standards, in cases of doubt the lowest values were always estimated.
- Three chronologically and thematically independent new editions of existing standards from the switch technology sector were considered.
- Since the objective of the study was to demonstrate the benefits of applying standards in the switch technology sector of Siemens AG, attention was directed towards the positive impacts of standardization in this explicit case. The impacts used for the study, especially the indirect ones, could certainly also have negative implications for other companies.
- There was no detailed investigation as to whether the changes to the standards considered might have given rise to negative impacts as well. Because of Siemens AG's active participation in the standardization process, it can be assumed that such negative consequences were kept to a minimum and do not reach the level of the benefit gained by the new editions of the standards.

After consideration of the boundary conditions it is possible to conclude that the observed positive impact is definitely well-founded and plausible. The conservative estimate of 1.1 % highlights a feature of this positive impact that cannot be explained only in terms of disturbing influences and random variations in the market.

The precise numerical value of the result arises from the unique way in which the question is posed, with a focus on particular areas of switch technology and current economic aspects, and cannot thus be applied directly to other companies. However, the observation of a clear positive benefit of standardization in an unambiguous economically viable quantity is a result which most certainly can be so translated.

Naturally, despite this determination, it cannot be universally concluded that any company will gain an economic benefit from applying standards. However, if further studies carried out using the ISO methodology bring similar results, a general characterization could prove to be true.

Yet even this single result is an important indicate that companies should consider their dealings with standardization and investigate the potential economic advantages of standards and standardization. The existence of potentials alone is not sufficient to actually realize economic benefits, as has been seen in our consideration of Siemens switch technology.

## **5.2. Evaluation of the results of the methodology from the perspective of Siemens AG**

Siemens AG already has a very distinct standards culture and standardization as a whole is taken very seriously. Siemens is very active both in the use of standards and in participation in standards projects, and this clearly pays. In all sectors considered, products were very well prepared for changes currently taking place so that, when the standards were finally updated, no unexpected tasks or costs arose. Often it was even possible to profit from the revision of the standard, a point which has been elaborated by means of some examples and calculations in the present study.

But there were also areas in which a potential available benefit could not in practice be made use of economically. Specifically, there were potentials which resulted from stricter test requirements and were based on the fact that competitors cannot easily fulfil the new requirements (indirect positive impacts 2 to 4 in 4.3.3). Although it can be proven that some of the competitors' products cannot pass the sometimes essential, safety-relevant tests, they are still offered on the market and no success has been had in communicating this state of affairs to potential customers.

Here it really does seem that there are some customers who consciously favour products because of their lower prices and which are clearly of lesser quality and durability. Nevertheless it may be assumed that some of these customers would decide against such products if they had had access to better information about them and thus could become potential Siemens customers. It is therefore important that a further analysis be carried out to investigate how information about quality can be communicated to the market in an acceptable way so that the potential described above can, at least in part, be realized.

Furthermore, it will be important to communicate the conclusions of the present study regarding the positive impacts of using standards and taking part in standardization. That way it will be certain that the proactive involvement in standardization, which has led to positive results, will continue in the future as well.

## **6. Experience using the ISO methodology and suggestions for modifications**

In the following, experiences gained in the course of becoming familiar with and applying the ISO methodology and the associated tools will be addressed. In particular, a close look will be taken at difficulties which occurred and the necessary adaptations that followed as a result. Where possible, suggestions will be made about potential measures for modifying the methodology in order to make it even more comprehensible and easier to use in the future.

### **6.1. Getting to know the ISO methodology**

The ISO methodology is described in great detail in many different documents and it is illustrated with good, but sometimes too simplified, examples of its use in practice. The large number of documents which have the same content unnecessarily hampers the process of becoming familiar with the methodology. Likewise, confusion can arise when, in discussing individual topics of the methodology, each participant in the conversation is referring to a different document and to passages which vary among the documents. That aside, the process of becoming familiar with the methodology gets under way very rapidly and one quickly gets an understanding of the consistently systematic procedures. Since, the methodology is only available in English at present, translating specific terminologies into German (as might be necessary in consultations with experts, for instance) may lead to complications. But this problem is more likely to occur in a small-to-medium size company and was not an issue at Siemens.

### **6.2. Application of the ISO methodology**

It quickly becomes apparent when applying the ISO methodology that it is best suited to a traditional manufacturing company which has been firmly established on the market for some time and which replenishes or updates its standards portfolio at regular intervals. If, however, the company being investigated for this analysis departs from these assumptions, difficulties are encountered relatively quickly when carrying out the prescribed steps of the process.

The intention here is therefore to consider standards which were introduced within the past five years in order to quantify the resulting added value by comparing the company's current key figures with those before the introduction of the standards. However, this approach could not be applied in the environment of switch technology because the relevant standards have existed for decades and have always been applied. An actual case of using standards could not be compared with a fictional case in which no standards are used as the standards in question are mandatory and must be applied in order to bring the product into circulation. Thus, a situation in which no standards are applied was so alien to all the experts consulted that no useful information could be gained from such questions.

In a similar way, comparisons with competitors are not feasible if all companies are obliged to apply the standard. Thus, the only possible approach to determining the benefits of standardization was to compare the current standard with the previous version or with succeeding versions which are already in preparation.

A further complication with the assessment resulted from the realization that legally ideal conditions do not prevail in the market under consideration. If we compare two manufacturers of switch products, where a standard lays down stricter requirements we

would expect the manufacturer whose products meet these stricter requirements to have an advantage over a manufacturer whose products do not satisfy the requirements. However, many products from "low cost" manufacturers are offered for sale with all the necessary paperwork despite inadequate performance and are willingly bought. In such cases, the benefits resulting from the change to the standard are not reflected in the company's key figures and therefore had to be estimated theoretically.

When carrying out the assessment, it was sometimes a great challenge getting hold of the company's key figures (such as turnover and costs), which were needed for evaluating the benefits of standardization. These numbers certainly exist, but the company treats them confidentially and is unwilling to make them available for external purposes. This was especially the case because the focus of the analysis was on research and development, and such figures, if made public, can provide competitor companies with important information regarding current investments.

Likewise, the endeavours of the methodology to give detailed numerical values to the results based on the accuracy of the information received from the company, cannot be supported. Such a numerical value would infer a sense of accuracy which the present study does not claim to have, based as it is on the qualified estimates of experts.

### **6.3. The tools of the ISO methodology**

In the toolbox of the methodology there are many documents which, in theory, provide graphics, schemata and questionnaires for every phase of the analysis. Likewise, advice regarding the identification and quantification of the potential impacts of standardization, and tables for the purposes of evaluation are also provided.

The tools are also only available in English, and are strictly oriented towards an ideal course of procedure. As soon as the procedure deviates from the prescribed methodology (for example, for the reasons already stated above under 6.2.), many of the tools could no longer be used in the given form, and it was often easier to devise a special tool designed particularly for the problem at hand than to modify the pre-existing tool.

In many cases the reason for this was that although the documents provided clearly give the impression the investigation should be conducted as broadly as possible (in an entire company or even an entire sector of industry), this would be at the expense of a more precise, in-depth study of the benefits of standardization in specific areas. Many of the approaches for analysis and evaluation suggested in the tools were too superficial for our purposes, precisely because the present study primarily focuses on product research and development and their preparation-for-market.

### **6.4. Suggestions for modifications**

- The ISO methodology and tools should be available in the local language of the company in question, especially for the use of small and medium-sized companies.
  
- Various different versions of the initial version of the methodology and its associated tools should be available, which should depend on elementary criteria of the companies under consideration. Possible criteria would be:

- Whether a company, only a department of that company, or the entire sector is being considered.
  - Whether the relevant standards are applied voluntarily or whether they are mandatory.
  - Whether the subject is a private, state-run or partly-privatized business.
  - What constitutes the company's or department's principal means of creating value: manufacturing, services or idea engineering.
- It should be possible to sub-divide the identified impacts of standardization into theoretical impacts and realizable impacts, if needed.
  - The evaluation should, depending on the figures obtained from the company, aim at obtaining either a specific value or a specific interval as its result.
  - In case a company is not allowed to provide information about costs, profits, etc., it would be useful to have an alternative (e.g. an algorithm) which would enable the study to dispense with the need to use absolute numerical values without distorting the relative order of magnitude of the results. Such an option is very important, because in the case of the earlier DIN study of the economic benefits of standardization, only 9 % of all companies involved were prepared to give information regarding their costs.<sup>9</sup>

## **7. Impacts of the structure of extensive standards on their subjectively perceived usefulness**

To fully realize the economic benefits resulting from applying a standard, it is important that the standard user can quickly gain an overview of that standard, understand it and apply it with ease. Therefore one of standardization's important objectives is to provide complete, precise, compact and easily understandable information on the subjects being standardized.

Thus, especially with very complex and extensive topics, a conflict between the targeted completeness and comprehensibility can arise. A standard can become incomprehensible over time as useful or even necessary information is continually added to it. Here the risk of such a development is particularly great in the case of standards which refer directly to a large group of topics or products. But such a conflict can occur even in the case of standards which provide detailed information on all phases of the life cycle of the object being standardized.

This is the case with DIN EN 62271-100, for example. It contains detailed information for all life phases of a circuit breaker, beginning with technical and constructional requirements, and ranging from testing guidelines to assembly, maintenance and effects on the environment. In all, the standard has a total length of about 350 pages (in just one language).

Of course one cannot simply begin to arbitrarily shorten such a standard, but there are possible approaches for making such extensive standards more user-friendly. These include the sensible structuring of contents, a consistent division of the standard into normative and informative content, focusing on elementary information that is central to the standard, and placing additional information in annexes. Sometimes it must also be

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<sup>9</sup> DIN (2000)

considered whether a the scope of the standard can be narrowed if the amount of information which it contains cannot be sensibly structured.

The extent to which structural factors of a standard influence the perception whether or not it is useful in practice was determined by means of a questionnaire dealing with the question of the economic benefits of standardization in the case of DIN EN 62271.

In the questionnaire, users of standards in the DIN EN 62271 series and other very extensive standards were asked to evaluate the depth, breadth, length and structure of the standards they are currently using. The responses of 12 users of the DIN EN 62271 standard series and 24 users of other extensive standards were evaluated.

In the following the results of this survey are presented and an attempt is then made to come up with possible structural changes to the DIN EN 62271 standards series which could improve its usefulness and hence the economic benefits of applying these standards.

## **7.1. Results of the survey**

Below, the evaluated results of the survey are presented. The complete evaluation of the survey and the associated graphics are given in Appendix 9.3.

### **7.1.1. Depth of the standard**

Most of those surveyed regard the range of topics treated in the standard which they are using as exhaustive. The predominant opinion is that the standard goes into detail wherever it is necessary and only rarely contains information which goes beyond the necessary depth of detail. A trend can be seen however in the opinion of users of the DIN EN 62271 series, who feel that their standard is too extensive for practical use, while some users of other extensive standards have complained about the lack of important information (Figures 5 and 6).

### **7.1.2. Breadth of the standard**

Almost all those asked are working with a standard that only deals with a particular object/topic or group of similar objects/topics. Here the breadth of the standard is perceived by nearly all those surveyed as being exactly right for practical use (Figures 7 and 8).

There is almost always a division into a normative section and an informative section, but in some cases this is not consistent (Figure 9). A significant difference in the responses of the two different groups of standards users under consideration regarding standard breadth could not be determined.

### **7.1.3. Length of the standard**

Most users consider the standard they are using to be too long. Although there are some reservations about whether shortening the standard is feasible, many users think this should be attempted. Correspondingly, the greater number of users feel the standard contains too much additional information, although some were in favour of more additional explanations.

The users of standards other than the DIN EN 62271 series, however, mainly regard the length of the standard they are using as exactly right. Among the few users who would like to see the length of the standard adjusted, the number who want shorter standards is greater than those asking for additional explanations (Figures 10 and 12).

Almost all those questioned reported that, for the standard they are using, there are plans to include additional information in annexes to ensure the standard remains

concise despite its length. A noticeably large number of users of the DIN EN 62271 series reported, however, that this is not being carried out consistently (Figure 11).

#### **7.1.4. Structure of the standard**

Both the users of standards of the DIN EN 62271 series and users of other standards mainly reported that the standard being used contains all important items of information in one document that is structured in clauses. Almost all those surveyed feel that this structuring is good, although there were some who wished for minor adjustments to the structure (Figure 13). One possible adjustment would be to bundle information that is important for particular user groups and to present it contiguously in the document.

Only relatively few users of a standard in the DIN EN 62271 series reported that such a collection of information was reflected in the structure, but many reported that they would consider such a step sensible. Most users of other extensive standards, on the other hand, reported that such a provision was already being used extensively (Figure 14).

## **7.2. Potentials for improving the usefulness of the DIN EN 62271 standards series**

The users of standards from the DIN EN 62271 series are predominantly satisfied with the standards used. Nevertheless, the opinion was often voiced that the standard which they are using contains too much additional information and is therefore too long. However, some fear that shortening the standard may not be feasible. Thus the question arises as to how the standard can be improved for the user without shortening it.

Within the framework of the survey it was shown that it is often intended to divide the standards into a normative section and an informative section and to place information in annexes, but that this is often not done consistently. If this procedure were to be done in a consistent manner, it would help keep the main body of the standard shorter, and the standard would be more concise.

Moreover, there are not enough fragments of standards in which important information relevant for particular user groups is gathered in the DIN EN 62271 series, or at least such are not identified by the users. Since many of those questioned have reported that they think it would make sense to bundle information in this way, it would be important in future to encourage the creation of such fragments and - where this has been done already - to draw the users' attention to them.

It is apparent, then, that it would be possible to make the standards in the DIN EN 62271 series more concise and manageable without actually shortening the contents of the standard. Since the above-mentioned corrections to the structure could certainly provide positive impulses for the benefits brought about by the standard in question, it is recommended that the reorganization of content be considered during the next update of the standards.

## 8. Conclusion

It is largely recognized that standardization is an important economic factor. However, in the past this has been due to many isolated effects, theoretical principles and individual experience. Using the ISO methodology, the present study has demonstrated the clear positive economic benefit to be gained from the application of standards. Admittedly, the figure quantifying the minimum benefit from standardization, approximately 1.1% of the EBIT, is not a value with universal validity that can be applied to all other companies, but this clear outcome underscores the importance and credibility of the effect that is generally acknowledged.

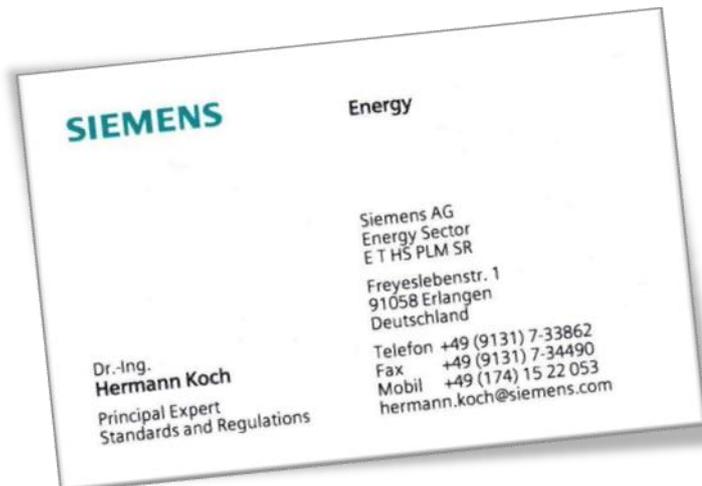
While implementing the ISO methodology in the present pilot study, a few difficulties occurred which were mainly due to the fact that the methodology is formulated in relatively strict and inflexible terms. It was, however, always possible to circumvent these difficulties by reflecting on the basic idea of the methodology and using a little creative effort. On this basis, modifications to the ISO methodology were suggested in order to make it simpler, more flexible and easier to understand in the future.

In the additional survey carried out regarding the effects of the structure of extensive standards on the subjective perception of their usefulness, we were able to conclude that the standards of the DIN EN 62271 series are considered to be too long, even when they are compared with other extensive standards. It was also noted, however, that a number of changes would give the standards a clearer structure, thus enhancing their usefulness.

## 9. Appendices

### 9.1. Appendix I - Experts consulted for the study

Below are the names of those experts who were particularly intensively involved in the interviews and analyses for this study. I owe them my thanks, for they have supported this study with great enthusiasm and given me much of their valuable time.



## 9.2. Appendix II – Questionnaire compiled by the author for investigating the usefulness of standards

### Depth of the standard:

1. How precisely and with how many details, variants and variations and how much useful additional information are the topics for standardization dealt with in the considered standard?
  - Very short, hard to take in without prior knowledge **Error! Objects cannot be created from editing field codes.**
  - Short and succinct **Error! Objects cannot be created from editing field codes.**
  - Somewhat short but going into greater detail where necessary **Error! Objects cannot be created from editing field codes.**
  - Reasonably detailed **Error! Objects cannot be created from editing field codes.**
  - Very detailed and with a great deal of useful additional information **Error! Objects cannot be created from editing field codes.**

2. Is the information adequate, insufficient or too extensive for practical use?

- Much too extensive
- Too extensive
- Exactly right
- Just about adequate
- Insufficient **Error! Objects cannot be created from editing field codes.**

### Breadth of the standard:

3. Does the considered standard deal with a particular object, a type or group of thematically similar objects in depth, or does the standard deal with fundamentally different objects that are merely placed in a common context?
  - The standard addresses a particular object or topic
  - The standard addresses a concrete group of objects or topics which are interconnected
  - The standard addresses a group of thematically similar objects or topics

- The standard addresses fundamentally different objects or topics which are, however, placed in a common context
- The standard addresses independent objects or topics

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4. Is the breadth of the standard appropriate for its practical use or would you prefer it to have a narrower or wider focus on the subject requiring to be standardized?

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- Focus far too wide. Urgently needs to be narrowed
- Focus too wide
- Exactly right
- Too focused

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- Focus too narrow. Should have a wider range

5. Has the standard been divided into a normative part and an informative part?

- Yes, this has been done consistently
- Yes, but this has NOT been done consistently
- Yes, but this is not necessary
- No, but it should be
- No, and neither is it necessary

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Length of the standard:

6. Is the range of topics requiring to be standardized presented as concisely as is necessary to deal with the subject in adequate depth, or does the standard contain the right amount of or too much additional information?

- Far too much extra information
- Too much extra information
- Exactly right
- More information or explanations would be desirable
- Important supplementary information is missing

7. Is useful additional information placed in annexes in order to keep the essential main part of the standard as concise as possible?

- Yes, this has been done consistently
- Yes, but this has NOT been done consistently
- Yes, but it is not necessary
- No, but it should be
- No, but neither is this necessary

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8. Is the length of the standard commensurate with the size and scope (depth/breadth) of the topic and is it still practicable to work with a standard of this length?

- The standard is much too long and unreasonable to work with. It must be shortened
- The standard is very long and difficult to work with. It ought to be shortened
- The standard is long. It could do with being shortened
- The standard is long, but cannot be shortened
- The standard is of appropriate length

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Structure of the standard:

9. Is the structure of the standard or its division into sections appropriate for practical use?

Examples of possible structures/divisions:

- A) Standard XYZ is divided into clauses; e.g.: 1. – 8.4.12
- B) Standard XYZ is divided into parts; e.g.: XYZ-1, XYZ-2 ...
- C) Standard XYZ is a meta-standard and refers to separate standards providing more detailed information

- Yes, the structuring is very good
- Yes, the structuring is good
- The structuring is okay, but could be improved
- No, the structuring is not ideal but there is no better solution
- No, the structuring is not reasonable and should be revised

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9.1 Does the standard use one of the structures from the example above?

- A    B    C
- No, it has a different structure

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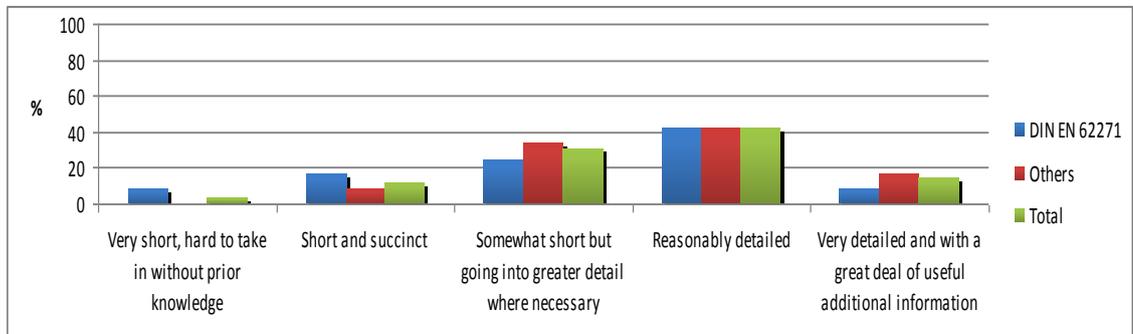
10. Is information that is interconnected or only of interest to particular user groups presented in a coherent manner in the standard?

- Yes, such coherent standard fragments are used frequently
- Yes, but such standard fragments are rarely used on their own
- Theoretically yes, but its potential benefit is not properly communicated
- No, but it would make sense
- No, but neither is it necessary

### 9.3. Results of the survey on the structure of extensive standards

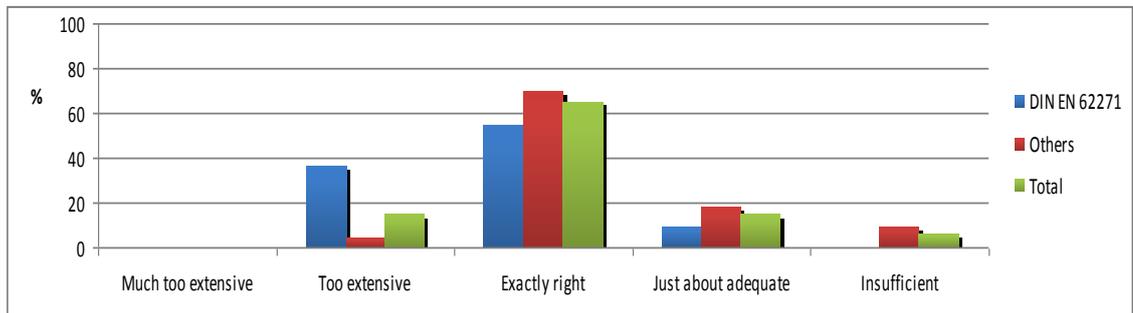
#### Depth of the standard

Question 1 - How precisely and with how many details, variants and variations and how much useful additional information are the topics for standardization dealt with in the considered standard?



**Figure 5 - Distribution of responses in the survey on the structure of standards - Question 1**

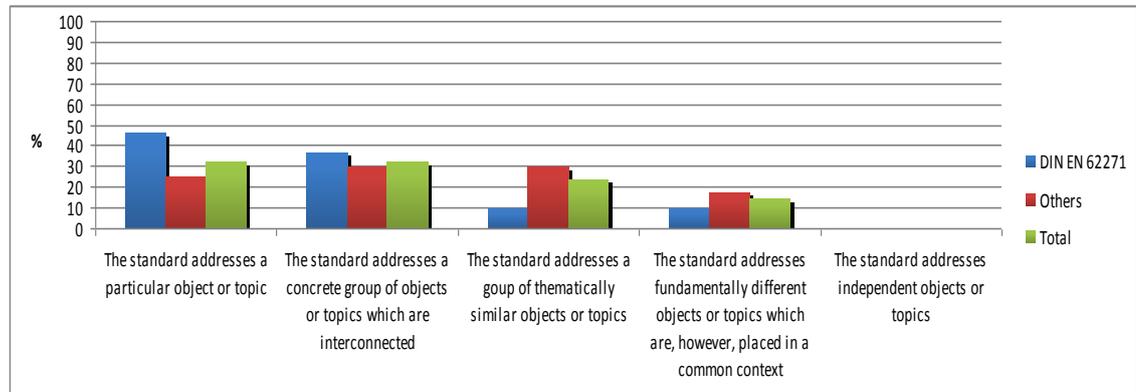
Question 2 - Is the information adequate, insufficient or too extensive for practical use?



**Figure 6 - Distribution of responses in the survey on the structure of standards - Question 2**

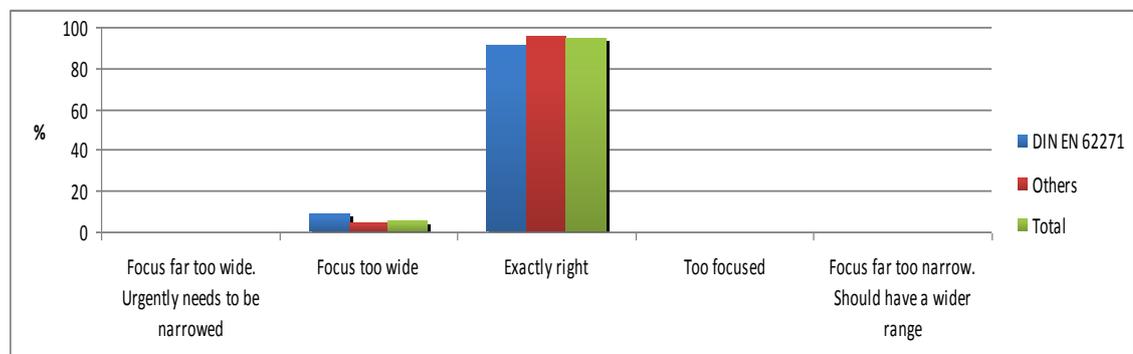
## Breadth of the standard

Question 3 - Does the considered standard deal with a particular object, a type or group of thematically similar objects in depth, or does the standard deal with fundamentally different objects that are merely placed in a common context?



**Figure 7 - Distribution of responses in the survey on the structure of standards - Question 3**

Question 4 - Is the breadth of the standard appropriate for its practical use or would you prefer it to have a narrower or wider focus on the subject requiring to be standardized?



**Figure 8 - Distribution of responses in the survey on the structure of standards - Question 4**

Question 5 - Has the standard been divided into a normative part and an informative part?

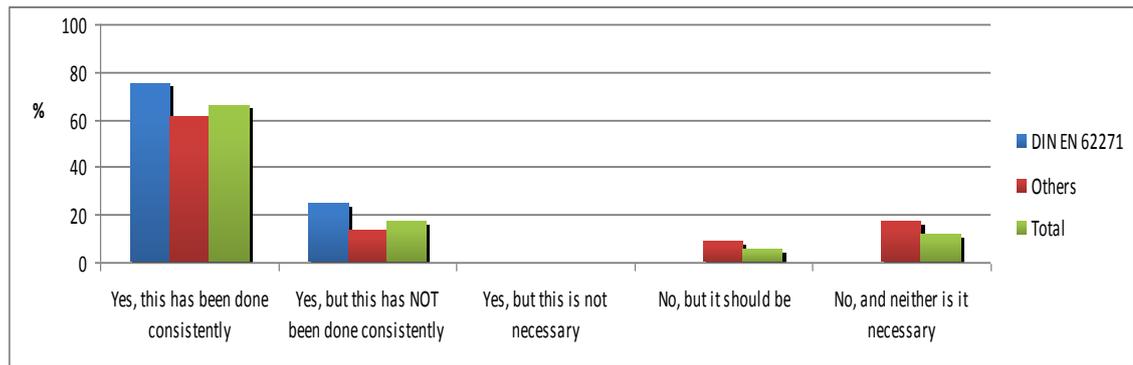


Figure 9 - Distribution of responses in the survey on the structure of standards - Question 5

### Length of the standard

Question 6 - Is the range of topics requiring to be standardized presented as concisely as is necessary to deal with the subject in adequate depth, or does the standard contain the right amount of or too much additional information?

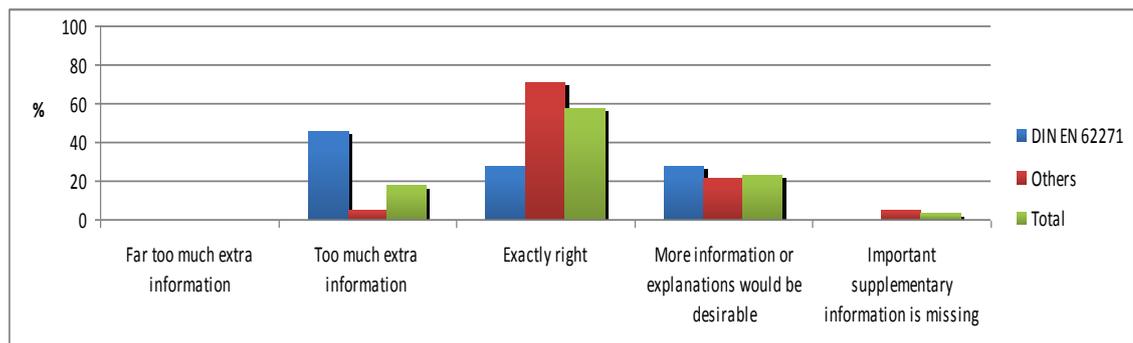


Figure 10 - Distribution of responses in the survey on the structure of standards - Question 6

Question 7 - Is useful additional information placed in annexes in order to keep the essential main part of the standard as concise as possible?

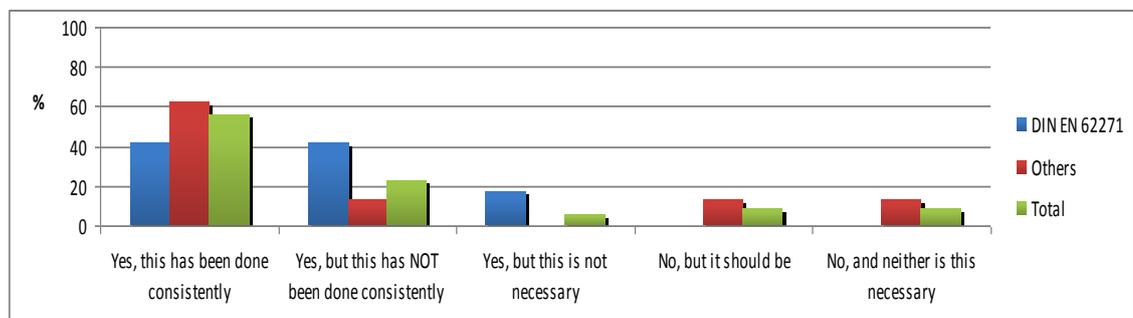


Figure 11 - Distribution of responses in the survey on the structure of standards - Question 7

Question 8 - Is the length of the standard commensurate with the size and scope (depth/breadth) of the topic and is it still practicable to work with a standard of this length?

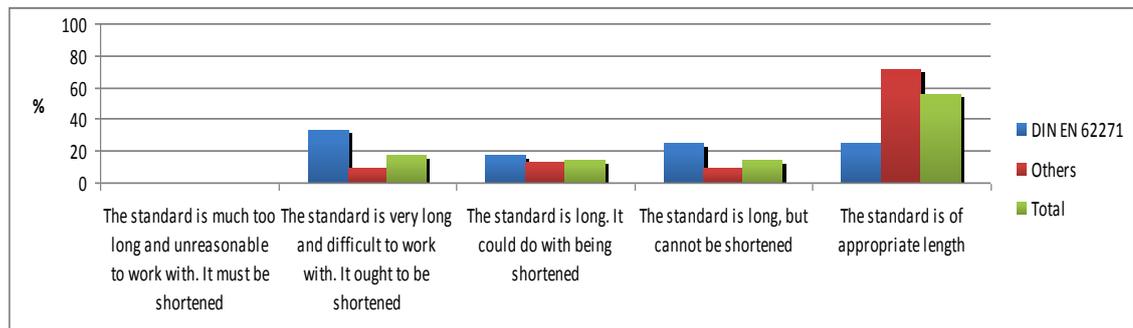


Figure 12 - Distribution of responses in the survey on the structure of standards - Question 8

### Structure of the standard

Question 9 - Is the structure of the standard or its division into sections appropriate for practical use?

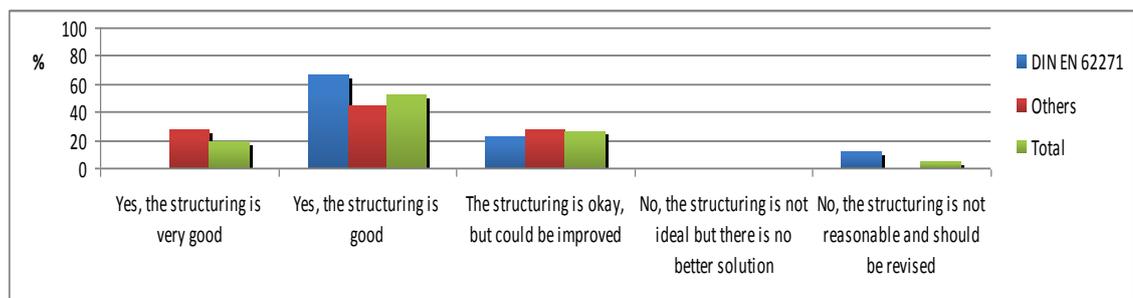


Figure 13 - Distribution of responses in the survey on the structure of standards - Question 9

Question 10 - Is information that is interconnected or only of interest to particular user groups presented in a coherent manner in the standard?

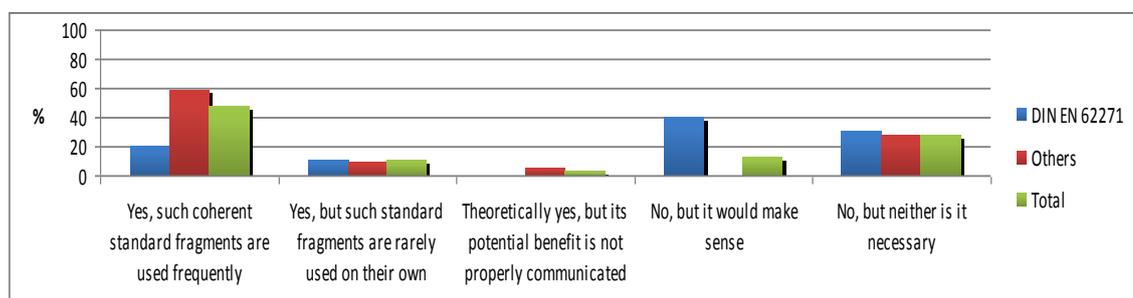


Figure 14 - Distribution of responses in the survey on the structure of standards - Question 10

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