



CASE STUDY

Standardization in Emerging Technologies: A Case Study for Smart Lighting Products and Systems

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Executive Summary

A previous report, titled “The Role of Standardization in Emerging Technologies” [1], proposed a standardization and assessment framework to provide consumers and other stakeholders greater confidence that the new generation of “smart” products and services will meet their expectations. This report responds to a recommendation in the previous report that the framework be validated using a test case. Smart lighting was selected since it is typical of the kinds of intelligent Internet-connected products being viewed with increased concern. This report aims to show, by example, how the elements of the framework can be used to help consumers and other stakeholders gain more confidence that these products and services will meet their expectations.

New lighting technology such as that employing light-emitting diodes (LEDs) is common today; however, the “smart lighting” referred to in this report includes the increased use of computer and communications technologies to allow traditional lighting products to perform additional functions, be integrated into home and building automation, and access Internet-based services.

The proposed framework to be validated in this report is based on the use of two documents written by the vendor and on two assessment steps. The first document, the Policy document, contains the specifications, terms of service, and other information needed by consumers and regulators to satisfy their concerns about the product or service. The second document, the Practice profile, defines the standards and practices the vendor uses to support the Policy. The Policy document is a public document, while the Practice profile defines internal, often proprietary, vendor details. The first assessment is between these two documents, while the second assesses the implementation of the Practice profile by the vendor.

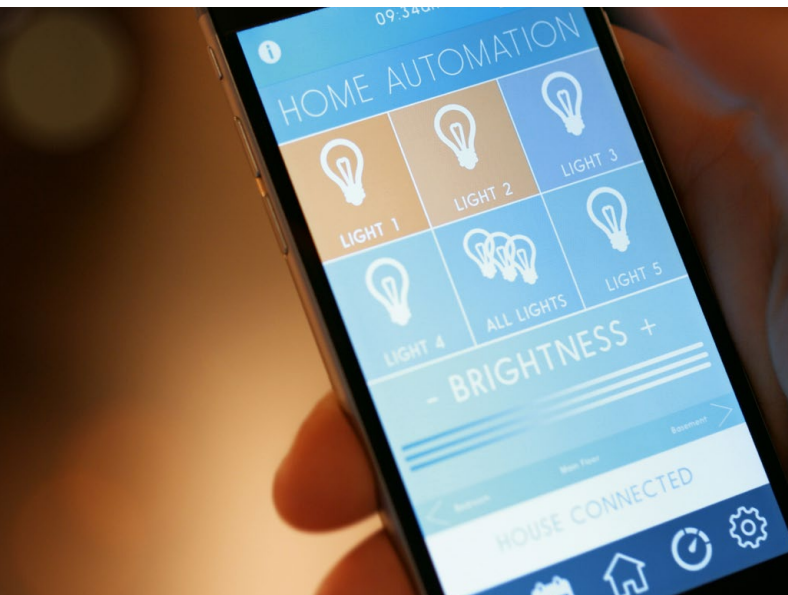
This report identifies a number of topics that should be addressed in the Policy and Practice documents and shows how the assessments can be used to assure consumers and regulators that the practices of the vendor are sufficient to address their concerns.

The report provides a “strawman” table of contents for each of the two documents as an initial step in developing standardized formats for these two documents. It also summarizes ten initial topics that should be covered in these documents, namely, identification, quality, safety, energy efficiency, security of operation, privacy protection, compatibility and expandability, warranty, service life, and ethical sourcing and the circular economy.

The report identifies the following areas for future potential work:

- Further refining and standardizing the format and content of the Policy document and Practice profile based on the strawman formats provided in Appendix A of the report;
- Further investigating the use of assessments between the Policy and Practice documents, especially to address growing challenges related to the certification of products subject to firmware updates and new privacy and security legislation;
- Further investigating the use of ongoing assessments against the Practice profile to verify ongoing performance, including the maintenance of safety, security, and privacy over the service life of the product or system; and

- Further investigating specific topics identified in the original report and confirmed during the preparation of this report by:
 - Defining how the service life of products and systems can be specified;
 - Standardizing the requirements for privacy protection; and
 - Defining better means to communicate residual risk issues, especially related to the risk of security and privacy breaches.



“Smart lighting is representative of the type of intelligent internet-connected products that are growing in popularity but that are also exposing consumers to new safety, security, and privacy risks”

1.0 Introduction

Continued advances in information and communications technology have enabled the delivery of new and increasingly complex products (and systems), including new “intelligent” Internet-connected products for the workplace and the home.

Consumers and governments are becoming increasingly concerned that the use of these products may impact their safety, security, and privacy. Vendors are concerned that the resulting loss of customer confidence will limit product popularity or may result in regulatory requirements that are overly costly to implement. Standardization and assessment organizations are concerned that traditional methods to specify, test, and certify products do not fully address the growing technical challenges of these complex products and systems.

A previous report, titled “The Role of Standardization in Emerging Technologies” [1], examined the growing concerns of these stakeholders, including users, regulators, assessors, standards developers, and vendors, in seven technology sectors (social media, artificial intelligence, electronic commerce, Internet of Things, cloud computing, health care, and smart “everything”). It proposed a standardization and assessment framework that could be used to increase consumer and regulator confidence that their concerns

are addressed, while also taking into account the concerns of assessors, standards developers, and vendors¹.

This report addresses a recommendation of the previous report that the framework be validated by applying it to a test case. Smart lighting was selected as the test case since it is representative of the type of intelligent internet-connected products that are growing in popularity but that are also exposing consumers to new safety, security, and privacy risks.

This report is organized as follows:

- The balance of this introduction provides a brief overview of the previous report’s framework, outlines the research method used to identify the smart lighting topics, and summarizes the topics identified during this research;
- Section 2 summarizes the current and future state of the art in smart lighting;
- Section 3 validates the relationship between the elements of the framework, by using two selected topics from those identified for smart lighting;
- Section 4 describes the balance of the smart lighting topics identified for smart lighting;
- Section 5 provides the conclusions and recommendations; and

¹The reader is invited to review the previous report for further details regarding the concerns raised by these stakeholders and the development of the framework to address these concerns.

- Appendix A provides additional details and an example of strawman content for each of the two documents defined in the framework.

1.1 Overview of the Framework

Figure 1 illustrates the framework proposed in the previous report.

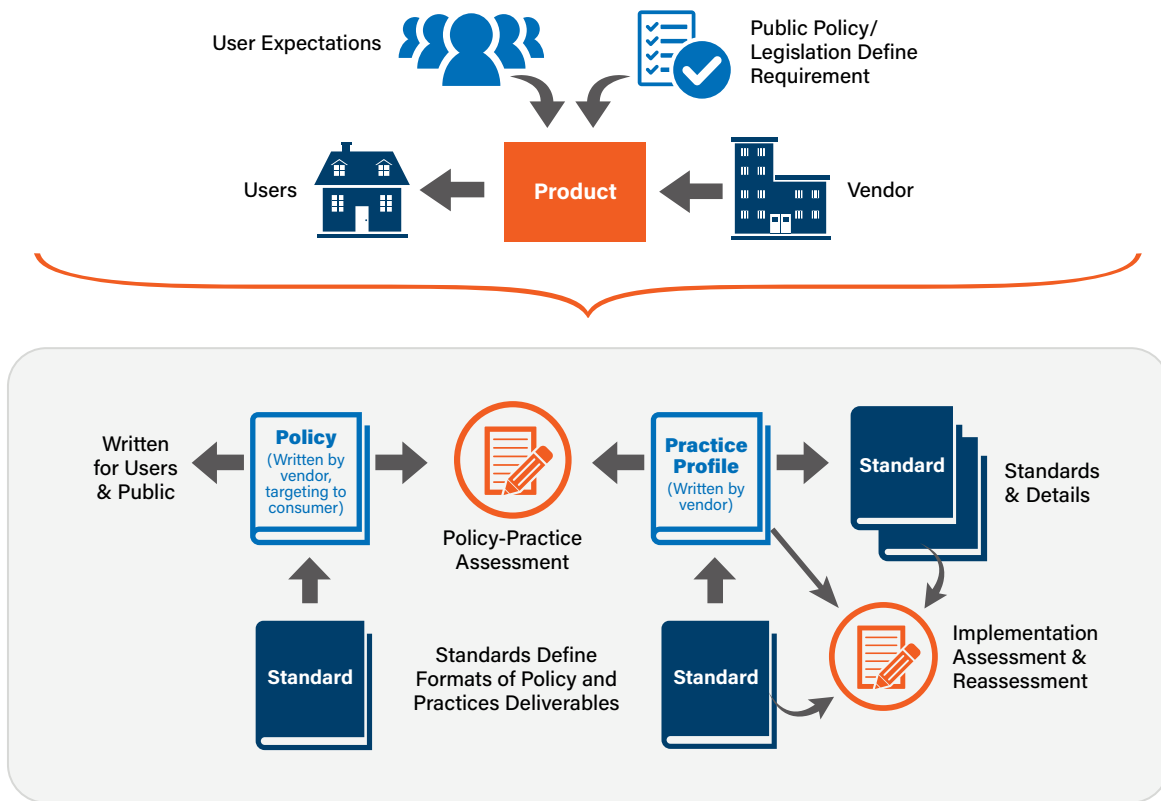
The framework defines two documents, both written by the vendor:

- The **Policy** document (shown middle-left in Figure 1) is used to define the specifications, terms of service, and other properties of the product for the user and

others with similar concerns, such as regulators. It is not expected to be highly technical except that it may reference well-known standards cited in conjunction with a product specification.

- The **Practice** profile (shown middle-right in Figure 1) is used to identify the standards and procedures the vendor is using to design, manufacture, and support the corresponding product. It is expected to be a technical document pointing to the detailed standards, practices, and organizational arrangements in use². Potentially containing vendor proprietary information, it would also define the ongoing assessment programs used to support the product over its promised service life³.

Figure 1: Framework for Standardization in Emerging Technologies [1]



²Standards may often contain internationally or nationally agreed-upon specifications applicable to various phases of the life cycle of a product or service, including agreed-upon minimum requirements for design, manufacture, use, and retirement. Procedures may define how standards are used or how the supplier will organize the resources that are needed, including management resources.

³The topic of a product's service life and required ongoing vendor support were identified in the previous report [1]. This will be discussed in more detail in Section 3.2 of this report.

The framework additionally identifies two assessments:

- The **Policy-Practice assessment** is used to ensure that the Practice profile adequately specifies what is needed to meet the vendor commitments in the Policy document. For example, topics related to safety will continue to require formal assessments, as may be required in the future for security and privacy. Other topics may only require vendor self-assessments if the user has sufficient faith in the vendor's reputation and warranty.
- **Implementation assessments** are used to ensure the vendor's initial and ongoing adherence to the standards and procedures defined in the Practice profile. This may use internal or external resources, depending on the topic's complexity. Such assessments will already be common for some topics. For example, quality assurance standards exist, and vendors can already obtain corresponding assessment services.

The original report [1] recognized that while regulators would directly interpret Policy document topics, users may require additional assistance, and this was expected to become available from traditional sources such as magazines and online consumer reviews.

1.2 Research Method

This report was developed based on both a research of the literature and interviews with strategic stakeholders in the lighting and standardization and assessment fields.

The interview strategy was to concentrate on the Policy document, to identify the topics it should contain, its language, and how it would address consumers' and regulators' concerns. Information was sought about any existing specifications, terms of services, or other documents used to communicate with customers, and views about how lighting products and systems are likely to evolve into the future. These topics were then used to identify and develop the corresponding topics to be covered in the Practice profile.

Interviews with vendors explored the potential content and language appropriate for Practice profiles by asking about the kinds of internal documents and organizational arrangements they currently use to document their internal processes.

During these interviews it quickly became apparent that "smart lighting", although popular in the literature and in early limited residential use, still represents an emerging market. While advanced lighting technology itself, and the growing use of light-emitting diodes (LEDs), organic LEDs (OLEDs), and similar energy-efficient lighting is growing rapidly, the interconnection of these components into "smart lighting systems" is suffering from the lack of widely accepted standards.

1.3 Smart Lighting Topics

During the interviews and literature research, ten topics were identified as a starting point for those that should be covered in both the Policy and Practice documents:

- **Identification** to identify how products are labelled, or otherwise capable of being authenticated against the Profile document.
- **Quality** to cover directly or by reference some of the material traditionally provided in product specification sheets and terms of service.
- **Safety** to cover both traditional intrinsic safety issues and to provide guidance on how the product or system can be safely installed and used.
- **Energy efficiency** to address consumer and regulator concerns regarding the energy efficiency of the product or system.
- **Security of operation** to identify the level of security provided by the vendor against unauthorized access.
- **Privacy protection** to define the extent to which personally identifiable information may be present and, if it is, how it is protected and potentially used by others.
- **Compatibility and expandability** to identify how the product or system can (1) interoperate with other products and systems, (2) change functionality by incorporating hardware or software (including firmware) upgrades, and (3) incorporate components from other vendors.
- **Warranty** to cover both the traditional concept of product warranties and additionally the potential use of warranty trust programs.

- **Service life** to identify the expected period (beyond the warranty) that the customer should expect to be able to use the product or system.
- **Ethical sourcing and the circular economy** to identify how the product or system, and the vendor itself, will play a part in addressing global social responsibility goals.

It was also recognized that manufacturers traditionally make available “specification sheets” and “terms of service” for marketing purposes and to form the basis for agreements with customers, and that these will continue to be required. In this report it is noted that these could be provided in annexes to the Policy document.

2.0 Smart Lighting Products and Systems

While new high-efficiency lighting technology such as that employing light-emitting diodes (LEDs) has become commonplace, “smart lighting” in the context of this report refers to the extension of such technology to add new “smart” functions through the use of computer and communications technologies. Such systems typically allow the remote and automated control of lighting. Additional non-lighting functions may also be supported, such as environmental sensing and control, user identification, and access control. Lighting system infrastructures may also be used to deliver additional building services, including communications, fire, safety, and power to other devices⁴.

The increased use of smart lighting also goes hand in hand with the global goal of more efficient energy use. Efficiencies not only arise from the more efficient lighting sources but also from the ability to offer levels of control not previously available with conventional systems. These changes offer benefits to the user and contribute to global conservation efforts.

In addition, significant research is underway on the human factors related to light and the impact of light

quality on human health⁵. Improvements in the quality of life and work efficiency are both potential benefits from the introduction of smart lighting.

Simultaneously, customers are also becoming accustomed to controlling the devices around them from smartphones and using voice interfaces. These functions often rely on connections to cloud-based vendor services that further complicates their safe use.

These benefits do not come without consequences. Smart lighting also implies the gathering and use of more information and the potential exposure of these systems to more security threats.

2.1 Smart Lighting Today

Applications of smart lighting span the entire range of domains, including residential, office, industrial, and public space (e.g., street) lighting. Furthermore, smart lighting is becoming integrated with other applications and becoming an integral part of overall building automation.

Smart lighting systems rely on the networking of components and a number of communications standards are competing to become the industry standard for smart lighting. Interviewees noted that the absence of a clear winner suitable for standardization is delaying the more widespread supply of universally standardized smart lighting systems⁶. This has opened the way for smaller vendors, and the open software community, to offer components using more narrow technology-based standards.

Some traditional lighting vendors are providing a limited number of components that may be interconnected using some of these competing data networking approaches. Traditional WiFi networking is used by some of these products. However, limitations arising from the need to use very low power, lower radio frequencies, and mesh-type topologies to achieve sufficient range between devices has led to a number of standards that are better suited than WiFi for smart lighting. Some manufacturers offer product options for several of these standards⁷.

⁴High-efficiency lighting can use new energy distribution approaches, for example using direct current, which can also be used to power other low-energy consumption, often “smart”, devices.

⁵For example, see the Lighting Research Center at Rensselaer Polytechnic Institute, <https://www.lrc.rpi.edu/>

⁶There is also some risk for early adopters. Standards are typically written for mature technology and this technology is still under rapid development. The level of risk associated with potential privacy and security breaches, and vendor legal liability, may also be a barrier to market entry.

⁷For example, Leviton currently markets lighting switches for each of four common (but each incompatible with the other) networking standards: Zwave, Zigbee, WiFi, and Bluetooth.

Additionally, some vendors are offering proprietary solutions. For example, the Lutron Caséta lighting solution uses its proprietary network technology⁸.

Today, most efforts appear to be targeting the residential sector and are being driven by users with the technical confidence to deploy these early products. Popular products such as Amazon's Alexa and Apple's Siri have provided the springboard for the deployment of residential automation, including smart lighting systems. These and other smart lighting solutions are already using cloud-based services to augment their users' experiences⁹. This was identified in the previous report as being of increasing concern to users due to privacy and security issues.

2.2 Smart Lighting Tomorrow

As smart lighting becomes more common and continues to use multiple competing approaches, assurances of long-term support for maintenance and upgrades will become increasingly important. This is especially true considering that many smart lighting systems rely on ongoing vendor-hosted services accessed via the Internet.

The importance of complete life-cycle support and product longevity for lighting systems was raised as a key element during the interviews. Traditional lighting products have conformed to well-established "plug and socket" standards which has allowed a stable product supply, replacement, and maintenance regime to be established. If a component fails, users are confident that a replacement will be readily available from multiple sources. Future "smart" replacement components must meet more complex technical interoperability specifications that may be unique to the system and vendor, leading to the need for the vendor to increase its long-term support. Users will also rely on the vendor to continue to supply all necessary cloud-based services.

3.0 Validating the Elements of the Framework

The framework proposed in the original report [1], and summarized earlier in Section 1.1, requires that the framework's Policy and Practice documents, and the actual work carried out by the vendor to produce and support the product or system, be linked together using the two assessments also identified in the framework.

This section validates the ability of the framework to support such linking, by using two selected topics from those identified for smart lighting. The two topics are discussed in detail, with emphasis on the roles of the corresponding assessments, to show how these assessments can be used to provide the necessary confidence to consumers and regulators that the vendor commitments in the Policy document are actually being met by the vendor.

3.1 Energy Efficiency

There is widespread support for the increased use of more energy-efficient products, including more efficient lighting products and systems. Governments, and often electrical utilities, are emphasizing such use, sometimes offering financial and other incentives for qualifying products. Consumers are also looking for energy-efficient products but may be concerned that the lighting products they purchase are not meeting their energy efficiency expectations, including energy-related cost savings.

Vendors incorporating lighting components made by others into systems they sell will also want to be assured that the outsourced components meet the efficiency requirements they specify.

3.1.1 Policy Document

In the lighting industry, most standards available today apply to components, for example to light sources and

⁸ For further information on Caséta by Lutron, see www.casetawireless.com.

⁹ Cloud-based services are often used today for voice recognition and to support web-based graphical applications. Some current home automation products allow the user to program light control functions that are executed remotely in the cloud.



fixtures, rather than systems. Thus, for **components**, the Policy document will be relatively straightforward and will only need to address a subset of the topics needed for systems.

A Policy document for smart lighting **systems** would need to document overall system energy performance. For example, if the lighting system offers environmental monitoring, the energy consumption of the added functions may reduce the apparent energy efficiency rating unless the benefits of the added functions are also recognized in the explanation of the efficiency rating.

Another example is related to the assumptions that the vendor may make regarding the operation of automated lighting, such as the time periods when lighting is provided. Trade-offs exist between the extra energy required to power this automation and the efficiency gains. This has been discussed in the report by Econoler [2].

The Policy document would identify the standards to which compliance is claimed and the corresponding assessment mechanism used. Assumptions regarding systems operations would be provided. If certifications are required to meet legislated requirements or qualify for incentives, a commitment to conduct required testing and affix required labels (e.g., energy efficiency labels) would be included.

¹⁰ The Energy Efficiency act and regulations relate to energy efficiency for lighting products.

¹¹ The EU energy efficiency labelling rules use a scale from A (most efficient) to G (least efficient).

"If the lighting system offers environmental monitoring, the energy consumption of the added functions may reduce the apparent energy efficiency rating unless the benefits of the added functions are also recognized in the explanation of the efficiency rating."

Example energy efficiency standards and government rule-making that could be cited in a Policy document include the following:

- Compliance to [Energy Star](#) [5] energy-efficiency standards;
- Compliance to government rule-making such as:
 - The Canadian government and [Natural Resources Canada](#) Energy Efficiency Act and corresponding [regulations](#) [6]¹⁰; and
 - The European Union energy efficiency labelling [rule](#) [7]¹¹;
- National standards such as CAN/CSA C866-17 *Performance of LED Luminaires*; and
- International standards such as IEC 62717 *LED Modules for General Lighting – Performance Requirements*, and IEC 62722 *Luminaire Performance*.

3.1.2 Practice Profile

The Practice profile would identify the processes and standards used by the vendor to meet the energy efficiency commitments in the Policy, and the assessment plans used to monitor the execution of these processes.

For lighting **components**, the Practice profile identifies the processes used to manufacture the product. It defines the quality assurance, supply chain, and other production measures that ensure that the product continues to meet requirements. Test reports and other documentation are specified along with retention practices. For certified products, the arrangements used by the vendor to obtain and retain the certification are identified.

For lighting **systems**, the Practice profile is more complicated since it must additionally document the design and verification processes used to determine the lighting system efficiency, taking into account the efficiencies of components, the effect of control actions, and the provision of other building functions as discussed earlier.

3.1.3 Policy to Practice Assessment

For lighting **components**, the correspondence between the Policy and Practice should be straightforward. This will be the case when the cited standard(s) define the assessment or product certification method that must be used.

For lighting **systems**, the correspondence between the Policy and Practice requires a more complex assessment since it must evaluate the vendor's general assumptions about how the system will be used, and must additionally assess the processes used by the vendor to support the system over its service life, as will be discussed in Section 3.2.

3.1.4 Practice to Actual Vendor Performance Assessment

For smart lighting **components** where well-established standards are available, the requirement to manage compliance to the standard over the production cycle will be documented in the standard's certification documents. For example, it is common practice to test a sample of the component for energy efficiency and apply the result to all components of the same manufacturer's design. However, if the component is subject to firmware updates that may affect efficiency, additional measures, discussed below for systems, must be addressed.

For smart lighting **systems**, more attention will be required to ensure the ongoing efficiency of the system. In these systems, software updates or the addition of new capabilities via software upgrades can alter the way controls are applied, affecting the energy efficiency of the system. Thus, it will be necessary to go beyond a relatively simple one-time test of the design and also consider the ongoing support of the system, including any vendor-provided cloud-based services.

3.1.5 Public Review of the Policy Document

As indicated at the end of Section 1.1, while regulators may directly interpret the contents of Policy documents, consumers may require additional assistance.

For smart lighting **components**, energy efficiency literature is available to assist in understanding the benefits of efficiency standards. For example, Energy Star labelling provides information related to annual expected dollar savings on electrical energy bills, which can be directly interpreted by consumers. Ratings using common metrics allow consumers to judge the relative energy savings for comparable products.

For smart lighting **systems**, the overall energy efficiency estimated by the vendor and disclosed in the Policy will be based on various vendor assumptions. If these assumptions do not match the consumers' intended use, the expected efficiency will need to be adjusted. By making the Policy widely available, magazines and online reviewers can assess these vendor assumptions and provide additional insight to consumers about the expected efficiency of the system.

3.2 Service Life

Consumers have growing concerns about the service life of the products and systems they buy. While vendors normally specify warranty periods, the expected service life is seldom if ever explicitly defined. This has been less of an issue in the past for light bulbs and related electrical components because a long-term stable and competitive market has developed for replacements, enabled by the existence of widely accepted technical standards.

This assumption of long-term use is not valid for smart lighting systems for the following reasons:

- A long-term market for replacement components cannot be assumed since the common standards needed for a stable market are still evolving;
- Systems relying on cloud-based services to either augment functionality or provide remote access will rely on their long-term provision by the vendor;
- Systems exposed to the Internet will rely on software updates to maintain security as new security threats appear; and
- Vendors may terminate a product line, or otherwise cease support, leading to the system no longer being useable.

Consumers may be concerned that the solution they buy today will quickly become obsolete and need to be replaced for the reasons cited above.

3.2.1 Policy Document

For the Policy document, this topic would be covered with suitable statements that identify, in addition to a product warranty period, the expected service life and service support guarantees.

The extent to which the product relies on ongoing support by the vendor would be clearly defined, along with the corresponding terms of service, the duration, and any additional costs associated with the ongoing services needed. If standardized services or those offered by another vendor can be used, these would be identified. Options would also be described by which the customer can extend the life of the product either by operating it in a reduced-capability state¹² or choosing to migrate to a replacement solution.

Depending upon the vendor, it may be appropriate to identify any strategies in place to continue support

should the vendor become unable to do so. This might be addressed either by the offer of escrow arrangements¹³ or a commitment to use standards, including cloud-based service standards, which will allow support to be obtained from the general market.

3.2.2 Practice Profile

The Practice profile would detail the means by which the promised service life will be assured. This will include details related to any cloud-based service needed by the system.

The vendors would identify the way in which they plan to support ongoing cloud-based services, how they will monitor security threat environments and create and update their product as needed, and the arrangements they will make to ensure that they remain able to offer support over the service life. For example, if the Policy promises ten years of support to combat security threats, the Practices would identify the plan to ensure that a suitably capable team is in place and has the resources needed to monitor the security-threat environment, identify any product vulnerabilities, and develop and distribute all needed updates.

The Practice profile would also include the plans used to ensure ongoing compliance to these standards and practices over the service life of the product. For example, it will define how and when periodic reviews would be carried out and how these would be reported to vendors or other¹⁴ management companies.

3.2.3 Practice Profile to Policy Document Assessment

The Practice profile would be assessed for its adequacy to address the period(s) of support defined in the Policy. For example, if an escrow arrangement is identified to ensure long-term support, the terms of any agreement would need to be assessed. The standards and practices identified would need to be reviewed and any profiling of these standards evaluated for adequacy.

¹² For example, if a reduced state is available that does not rely on cloud-based services but can still provide basic functions.

¹³ An escrow arrangement would be one whereby the vendor commits to deposit critical technology with a third party that commits to resume support should the original vendor be unable to do so.

¹⁴ "Other" since for some regulatory or other important practices reports to external parties may be required.

This assessment would need updating should either the Policy or the Practice document be changed.

3.2.4 Practice to Actual Performance Assessment

The Practice profile would include the identification of the measures used to ensure ongoing compliance. Periodic assessments would be conducted to verify that such monitoring is in place and security updates are being distributed when necessary. Records would be kept according to the procedures identified in the Practice document.

3.2.5 Public Review of the Policy Document

The expected service life of products, while often not explicitly defined by vendors today, is of growing concern to consumers. While warranty periods are normally explicitly identified, many products are accepted by consumers without any specific commitments related to how long they can expect to use the product. Smart lighting products and systems also exist within a rapidly evolving technological environment, where innovation may make a lighting product obsolete because it is superseded by a more efficient or less expensive solution.

Consumers may have a basic idea about how long they want to use a product and might directly interpret such specifications in the Policy document. However, opinions provided by magazines and online reviewers will likely take a wider view and provide general recommendations about whether the promised life is adequate compared with other options within the market today or that are expected in the future. Return on investment and other calculations may also be provided to assist the consumer.

3.3 Ensuring Consumer and Regulator Confidence

As shown in this section, by using two example topics, assessments between the Policy and Practice documents, and between the vendor's practices and the vendor's execution of these practices, can allow complex products and systems to be specified using consumer and regulator-friendly language in the Policy document.

Furthermore, they can be traced, in a trustworthy way, to the actual performance of the vendor.

4.0 Policy and Practice Documents for Smart Lighting

This section discusses the topics that should be addressed when drafting Policy and Practice documents for smart lighting.

4.1 General Considerations for Policy and Practice Documents

The Policy document must address all stakeholder concerns. A standardized format for the Policy document would make it easier for its content to be understood, would facilitate the comparison of different products, and would enhance confidence that all needed topics are covered by the vendor. The Policy document is most closely related to traditional specification sheets, terms of service, and service-level agreements.

The Practice profile must address the processes and standards to be used by the vendor, and must have its format aligned to the Policy document to facilitate the assessment of its adequacy to address Policy requirements. The Practice profile would identify the standards and procedures in use, often by reference to existing general documentation with additional detail as necessary for the lighting product or system.

A single Practice profile might support a range of products and systems. Each product within the range would have a specific Policy document to identify major versions or model differences. Thus, a Practice profile may support multiple Policy documents¹⁵.

The allocation of the needed information between the two documents will vary, depending upon whether it is considered proprietary by the vendor and the extent to which the consumer would be willing to trust the assessment between them. For example, statements in the Policy document citing standards supported by recognized testing and certification will require less details since the user can rely on the assessment of the certification organization.

¹⁵ As smart and flexible manufacturing becomes increasingly common, the framework contemplates the need to provide a flexible means to document customized variants of products and services. The objective is to allow a Practice profile to support multiple Policy documents and to allow common assessments to support a range of products.

Appendix A offers initial proposals of content for the Policy and Practice documents. These tables of contents include a preliminary list of topics that would be included and are presented as a starting example of how the format of these documents could be standardized.

A potential next step in the development of the framework would be to expand and standardize these tables of contents for more general applications beyond the current case for smart lighting. For example, the further development of standardized terms of service and specification sheets would facilitate their inclusion in the Policy document. Many formats for specification sheets are in use today¹⁶ and there is no consensus on their format. Terms of service agreements are often very long and complicated and vary significantly in format (this is discussed further in Section 4.7 in relation to privacy protection).

The balance of this section covers the topics expected to be included in the Policy and Practice documents and those identified during the interview process and the review of the literature.

4.2 Identification

Today, user and regulator trust typically relies on the labels on the product or the use of authentication protocols when obtaining services¹⁷. The increasing complexity of the product or service, the customizability of the product or service, and the ongoing support and update services needed mean that trust must be looked at differently.

All stakeholders, including vendors, want to ensure that the products and systems are authentic¹⁸. For this framework, this means that there needs to be a binding trust between each instance of the product or system throughout its service life and the vendor's Policy document that describes its properties.

For lighting systems connected to the Internet, it is important that there be confidence in the authenticity of the initially delivered product and that any software updates do not lead to a loss of this confidence. For example, cryptographic mechanisms¹⁹ might be used to permit the user to confirm the continued authenticity of the product or system. In addition, systems accessing cloud-based services will need to authenticate their use of those services (and be authenticated by the service so that services are not provided to non-authentic systems).

The Policy document would identify the labels and identifiers to be bound to the smart lighting components, and would confirm that secure protocols are used to ensure the authenticity of the components and any services they use (e.g., cloud-based services). Wherever feasible, the Policy could identify how customers can identify and report potential fraudulent copies.

The Practice profile would specify how labels and identifiers are used and how suitable records are kept. Authentication mechanisms such as cryptography mechanisms would be identified along with any necessary measures needed to maintain them. Vendors may describe monitoring and action plans to identify and respond to the presence of fraudulent copies, including the processing of corresponding customer reports.

4.3 Quality

Vendor commitments and specifications for product and system quality would follow current approaches and would not differ significantly from existing practices where this information is detailed in separate product specification sheets.

Existing standards used to test, classify, or certify would be listed for the relevant quality, for example spectrum light content, colour rendering, light output, flicker, and electromagnetic compatibility.

¹⁶ For a summary of many existing approaches to specification sheets, see <https://baymard.com/product-page/benchmark/page-designs/product-spec-sheet>

¹⁷ For example, when accessing an online banking service, customers are cautioned to ensure that they access the banking website using a secure protocol prior to entering their credentials.

¹⁸ The identification of products as a defence against forgery is an important topic beyond the scope of this report.

¹⁹ Cryptographic mechanisms might include the embedding of electronic keying material that resists forgery, which can be interrogated to confirm authenticity.



“For lighting systems connected to the Internet, it is important that there be confidence in the authenticity of the initially delivered product and that any software updates do not lead to a loss of this confidence.”

The Policy document would list the standards to which compliance is claimed, along with identifying how these claims have or will be verified by the vendor or a third party. Sources for standards that might be cited²⁰ include the following examples:

- Publications of the [International Commission on Illumination \(CIE\)](#) [8] on light illumination, colour temperature, colour rendering, etc.;
- Relevant international standards such as the [International Electrotechnical Commission's IEC 62493 Assessment of Lighting Equipment Related to Human Exposure to Electromagnetic Fields](#) [9];
- Other relevant national, regional, or internationally adopted lighting standards published by recognized standards development organizations such as the ISO, IEC, and IEEE;
- Publications of the International commercial LED lighting qualification program, managed by the [Northeast Energy Efficiency Partnerships](#) [10]; and
- Publications of the [Design Light Consortium \(DLC\)](#) that provide product qualification programs for lighting products [11].

The Practice profile would provide the vendor's description of the processes used to initially confirm and then maintain the product or system's quality over its service life, including supply chain and manufacturing controls²¹. Typically, these are internal proprietary documents that specify the measures and staffing responsibilities, including design, manufacturing, production, support, and retirement (recycling). Sources for practices and standards might include the following examples:

- Quality assurance standards such as the ISO 9001 *Quality Management* (series);
- Environmental management, such as ISO 14001 *Environmental Management* (series);
- Vendor internal supply chain and manufacturing/production standards;
- Vendor internal engineering and management procedures and standards; and
- Vendor end-of-life and recycling plans.

The Policy document to Practice profile assessment may rely on the vendor's own internal assessment provided the vendor has a sufficient market reputation. In some

²⁰ Smart lighting systems go far beyond merely replacing lamps. A Policy document applying to smart lighting must address additional quality factors, such as how to reproduce arbitrary spectra, colour temperatures, and intensities, and how smart sensors and actuators will operate in conjunction with lighting. For example, how accurately and promptly will the smart lighting system shift light intensity and colour to increase visual comfort.

²¹ This material may be provided directly in the Practice, but may also be provided by normative reference to company internal documents.

cases, a standard cited in the Policy may require a third-party assessment process (for example for ISO 9001). In other cases, the vendor may choose to leverage a third-party assessment to increase the reputation and market competitiveness of the product, especially when competing in a market containing perceived substandard products.

4.4 Safety

Addressing safety will continue to be an important topic for users and regulators. A key concern identified during the interviews was not only the intrinsic safety of the product itself but also how the product can be installed and used in a safe manner.

The increased use of online software updating, and the dependence on cloud-based services complicate the traditional approaches to product safety. As was discussed in the previous report [1], if the safety of the product depends upon software that is subject to online updates or whose functions reside in the cloud, the simple testing of the product at the time of manufacturing can no longer be depended upon over its full service life.

The Policy document would cite the relevant safety standards to which compliance is claimed. Additionally, interviewees noted that installation practices may also affect safety and thus information to ensure that safe installation would also be provided. Many user manuals already address this topic, and these would be referenced in the Policy. Safety standards that might be referenced include the following examples:

- IEC 62560 *Self-Ballasted LED-Lamps for General Lighting Services by Voltage > 50 V – Safety Specifications*, IEC 62776 *Double-Capped LED Lamps Designed to Retrofit Linear Fluorescent Lamps – Safety Specifications*;
- IEC 60598-2-1 *Luminaires – Part 2-1: Particular Requirements – Fixed General Purpose Luminaires*;
- CSA C22.2 No. 250.0 *Luminaires (Trinational standard with UL 1598 and NMX-J-307/1-ANCE)*, CSA C22.2 No. 250.4 *Portable Luminaires* and

- CSA C22.2 No. 1993 *Self-Ballasted Lamps and Lamp Adapters* (Trinational standard with NMX-J-578/1-ANCE and UL 1993).

The Practice profile would identify the vendor's documentation of how the claim is supported, for example by defining the responsibility centre and procedures used to maintain compliance.

4.5 Energy Efficiency

This topic is discussed in detail in Section 3.1.

4.6 Security of Operation

Security of operation addresses the security measures used to protect the product and system from being compromised. Compromises may allow an unauthorized entity to improperly access the lighting system to obtain information, to control smart lighting operation, or to launch attacks on other components or systems connected to the lighting system. The related topic of privacy protection, which deals with the treatment of personally identifiable information, is dealt with separately in Section 4.7.

Many smart lighting systems use cloud-based services accessed by a connection to the public Internet. Such connections expose the system to threats originating directly from the Internet and indirectly via the cloud-based service. For example, several current smart lighting systems in residential use today offer the ability to interconnect to other smart automation systems using a connection within the cloud²². Such interconnections can expose the system to threats originating from other connected systems as well as from attacks originating from the global Internet, including denial of service attacks.

As discussed in Section 2, the market for smart lighting systems remains fragmented and until industry-wide common approaches become mature, individual vendors must decide upon the measures (and standards) they consider appropriate.

²² For example, the Samsung SmartThings Hub is connected to a cloud-based service that can be configured to interconnect to other cloud-based services such as those provided by Lutron and Honeywell.

The Policy document would ideally define the residual risk to the consumer that the lighting component or system will be compromised. In practice, the provision of such risk information is difficult if not impossible, since there are no common metrics available to define residual risk that are easily understood by users²³. As a consequence, the vendor will typically offer assurances in the Policy document that it stands behind the product and will address promptly any significant security threats identified. Some assistance may eventually be provided by legislation, since governments are becoming increasingly concerned about the protection of critical infrastructure and this concern may eventually lead to criteria applicable to smart lighting systems.

For smart lighting components, vendors may simply reference security features bundled with the interface standards to which they comply. Vendors that might be cited as examples include:

- Z-Wave Plus, from the [Z-Wave Alliance](#), defines the security measures for Z-Wave communications and this alliance offers a program to test products for conformance;
- Zigbee, from the [Zigbee Alliance](#), augments the security features of the IEEE 802.15.4 *Low-Rate Wireless Networks* standard, and this alliance also offers a compliance program; and
- WiFi, from the [WiFi Alliance](#), offers various well-known security options that would need to be specified if they are being used.

The Policy may provide general assurances that the included security features are appropriate for smart lighting applications. It would indicate if the vendor or any other party can access the system, for example during software updates or for the provision of backup or system recovery services.

The Practice profile would need to address this complex topic by providing sufficient information for a technical assessment that the mechanisms are adequate to meet

the vendor commitments of the Policy document, by applying the appropriate degree of prudence and caution to reduce the risk of legal liability. There are many technical security standards that may be selected by the vendor to meet the operation's security requirements, including the following:

- A range of information security management standards (ISMS) in the ISO/IEC 27000 series²⁴;
- Standards from the Cloud Security Alliance;
- A range of security standards issued by the Internet Engineering Task Force (IETF), including RFC 8446 – The Transport Layer Security (TLS); and
- Evolving security assessment standards such as the IEC 62443 *Security for Industrial Automation and Control Systems* series.

Some standards may be appropriately identified in both the Policy and the Practice documents since many standards include details of relevance to both. For example, the citing of a specific security standard in the Policy document may reassure consumers and regulators about the general strength of the security mechanisms in use; and the Practice profile would also cite the standard along with specific details about its implementation and ongoing maintenance.

4.7 Privacy Protection

Privacy protection deals with the appropriate treatment of personally identifiable information. Considerable national and international work is underway to define standards for the protection of such information.

Notable contributions in this area include: the [General Data Protection Regulation](#) (GDPR) issued by the European Union [12]; the [California Consumer Privacy Act](#) [13] in the US; and, in Canada, the Privacy Act [14] and the [Personal Information Protection and Electronic Documents Act](#) (PIPEDA) [15]²⁵. Primarily aimed at giving individuals control over their personal data, these

²³ One approach that has been used is to define a dollar value and recommend that a product only be used if the consequence of a security breach result in a loss below that value. This may additionally be accompanied by a warranty to cover costs up to this value.

²⁴ The ISO/IEC ISMS standards include the "ISO/IEC 27000 series" which consists of a number of documents, including ISO/IEC 27000 *Information Security Management Systems – Overview and Vocabulary*, and 27001 *Information Technology – Security Techniques – Information Security Management Systems – Requirements*.

²⁵ The CSA standard Q830:03 *Model Code for the Protection of Personal Information* is incorporated into PIPEDA.

have become drivers for action worldwide. In Canada, the Privacy Act lays out the rules for how the federal government retains personal information, while PIPEDA addresses all organizations.

Smart lighting components will seldom host personally identifiable information and thus are unlikely to need to address this topic in a Policy document. However, the added capabilities of smart lighting systems may allow these systems to acquire such information [3], for example by monitoring the activation of lights from mobile applications²⁶.

The Policy document for smart lighting systems would identify whether any personally identifiable information is hosted in the system or can be derived from its operation. If that is the case: a) the information is identified; b) the details of how it is protected are specified; and c) any use the vendor may make of such information is disclosed. Data that reside in the cloud may potentially reside anywhere in the world and be subject to foreign, rather than local, laws.

The residency of the data may need to be declared if the residency is outside the country of its owner.

For some systems, options may be provided to allow “anonymous” information to be used in place of personally identifiable information. Such options would be explained.

The Practice profile for smart lighting would indicate how personally identifiable information is protected and the means used to ensure that the Policy requirements are met. If compliance to legislated requirements are declared in the Policy document, the standards and practices used to obtain and retain compliance would be described.

Alwani and Urban [4] have recommended that terms of service (ToS) agreements leverage the best practices

identified by the European Union's GDPR and California's CCPA. Consumer concerns related to privacy protection would be addressed in the Policy document, while the Practice profile would document the vendor's specific standards and practices used to implement the ToS²⁷.

4.8 Compatibility and Expandability

Compatibility and expandability refer to the ability of the product or system to interoperate with other smart components or systems, to add functionality (for example by software upgrades) and to incorporate components from other vendors.

The Policy document for smart lighting components must include specific statements about whether the component is only intended for use in vendor proprietary systems or is intended for wider use. For wider use, applicable standards to specify communications protocols, security, and common semantics are emerging in the residential market, which include the following examples²⁸:

- Wired Ethernet as defined in many IEEE 802 standards²⁹, but applicable semantic interoperability standards must be defined in other standards;
- WiFi, from the [WiFi Alliance](#), defines a wireless communications standard compatible with the wired Ethernet (and also requiring additional semantic standards);
- Z-Wave, from the [Z-Wave Alliance](#), defines the communications and semantics to interconnect various smart lighting and other components;
- Zigbee, from the [Zigbee Alliance](#), defines the communications and semantics to interconnect various smart lighting and other components; and
- Google Home, Amazon Alexa, and Apple HomeKit each define industry-led approaches that support multi-vendor smart lighting components.

²⁶ Some smart lighting systems use “geolocation” functions based on location tracking of mobile phones to activate lights and other functions, exposing such personal information to misuse.

²⁷ The terms of service must address topics in addition to privacy protection. The strawman content for the Policy document provided in Appendix A to this report shows the ToS as an annex to the Policy document. This annex would contain a copy of the complete ToS with the corresponding topic within the body of the document identifying the specific relevant sections of the ToS along with any additional explanatory information needed by the consumer.

²⁸ In addition to the example communications standards listed in this Section, the IEC has recently published “Semantic Interoperability: Challenges in the Digital Transformation Age” [16].

²⁹ Many standards applicable to the wired Ethernet have been issued by the IEEE 802 committee with most vendors supporting a common subset based on IEEE/ISO 8802-3 *Information Technology — Telecommunications and Information Exchange Between Systems — Local and Metropolitan Area Networks — Specific Requirements — Part 3: Standard for Ethernet*.



“Some vendors offer the ability to interconnect their systems with those of other vendors. This would allow, for example, a user’s smart lighting system from one vendor to interoperate with the customer’s smart building HVAC controls from another vendor.”

The Policy document for smart lighting systems would include statements regarding its ability to interoperate with other systems, incorporate components from other vendors, and be upgraded to include additional functions. For example, the smart lighting system may also support functions such as environmental sensing and control:

- For systems to use components from other vendors, the Policy document would need to specify the required standards to which compliance is required. Example standards would include those listed above as candidates for smart lighting components.
- Some vendors offer the ability to interconnect their systems with those of other vendors³⁰. This would allow, for example, a user’s smart lighting system from one vendor to interoperate with the customer’s smart building HVAC controls from another vendor. These may rely on negotiated agreements between the vendors or rely on the vendors identifying application programming interface standards that allow suitable secure access to the needed information.

The Practice profile will need to detail the measures taken by the vendors to ensure the ongoing compatibility of the product or system, recognizing that the technical environment for smart lighting is subject to rapid

change. It will be important for the vendors to implement technology monitoring and upgrading activities to ensure the products and systems they deploy continue to meet the standards they have committed to support.

Where system interconnections between vendors is offered, sufficient details of the corresponding agreements and the procedures and any common standards in use would be documented to ensure that these interfaces are maintained over the intended service life of the system. If the interconnections are supported by the vendors, this documentation might be provided in the corresponding vendors’ Practice profiles. If open interfaces or application programming interfaces are offered, these would be identified in the Policy document along with the required security measures.

4.9 Warranty

Product warranty terms are an expected deliverable for products. The related topic of service life was addressed in Section 3.2.

During the interviews, the existence and use of “Warranty Trust Programs” was discussed. It was explained that some stakeholders, such as lighting designers, distributors, contractors, and other

³⁰ The Samsung SmartThings Hub supports multiple communications protocols that allow other vendors’ components to be used and allow access to other vendors’ systems via the cloud. An open source community is also supported that allows the public open source development of software interfaces to additional vendors’ components and cloud-based services.

commercial stakeholders, would prefer to specify, buy, and install lighting products from companies that have had their warranty terms independently assessed. The main intent of such programs would be to promote excellence in responding to warranty issues and to give industry stakeholders increased confidence in the warranty program.

The Policy document would define the warranty terms, ideally using a common standardized format. The terms would cover the following aspects:

- Whether labour to change/repair the product is covered;
- Whether improper installation voids the warranty, and a specification of what is considered improper;
- The length of the warranty period;
- The components/systems covered by the warranty;
- Who provides the warranty service if it is not the vendor;
- How assistance is obtained should a problem arise; and
- How such assistance is costed and charged if outside the warranty terms.

Many smart lighting warranties last three to five years and cover the cost of replacing the product only. Options to extend the warranty, either by the vendor or a third party, may also be identified. The use of warranty trust programs would also be identified.

The Practice profile would identify the vendor's internal processes used to support the warranty. It would cover the customer support program if one is offered in the Policy, how replacement parts are stocked, and how and who will provide the repair services. If warranty or spare parts support is to be provided by third parties, this would be documented along with the measures used to maintain the necessary ongoing agreements with the third party.

4.10 Service Life

The service life of a smart lighting product or system is discussed in Section 3.2.

4.11 Ethical Sourcing and the Circular Economy

Users are increasingly concerned that the products they use and the vendors they do business with play a part in addressing global social responsibility goals.

Ethical sourcing is a component of the circular economy, which aims to minimize waste across all industries by assuring the reuse of goods and their materials once an item's original usefulness has expired. Circular principles minimize waste, wherever possible, turning it into new value. In lighting, vendors may extend the life of products by shifting to modular designs that allow easy replacement of parts such as LED light sources and modules, by using more recycled materials, and by recovering metal or plastic housings for reuse.

The Policy document would include statements about the ethical sourcing and use of materials, energy, and employment practices. Commitments that the Policy would indicate include the following:

- Ethics of the organization by statements on actions to meet the [UN Sustainability Goals](#) (SDGs) [17] and/or references to Corporate Social Responsibility (CSR) statements;
- Compliance to Restriction of Hazardous Substances Directive (RoHS 1 and [RoHS 2](#) [18]) from the European Union;
- Use of best practices for efficient energy use, for example by citing energy management systems, such as [ISO 50001 Energy Management](#) [19]; and
- Use of ethical labour and hiring practices, and commitments to source materials only from others meeting similar workplace standards.

The Practice profile would then cite the supporting standards and the internal procedures used to meet the Policy, such as:

- The means and practices used to measure and report attainment of the targets for all cited UN SDGs.

5.0 Conclusions and Recommendations

The framework proposed in the previous report, “The Role of Standardization in Emerging Technologies” [1], was clarified here by applying it to the topic of smart lighting and identifying some of the topics that would be addressed in the Policy document and Practice profile.

During the preparation of the report, it became evident that while many of the topics that need to be covered in the Policy and Practice documents can be drawn from traditional existing material, some necessary additional material did not appear to be readily available. Whether this additional material will be demanded by customers in the future could not be verified during this study. However, it is considered likely that additional material related to privacy protection and security will be required by regulators in the future.

Key to the effective use of the proposed framework is the identification of the topics that need to be addressed. A standardized format for both documents, although similar to each other, will require a wider consensus before they can be finalized. This report provides initial strawman content for these documents in Appendix A, which could provide the bases for such work.

Further work could include the following:

- Assemble the appropriate stakeholders, especially including consumers and regulators, to develop a consensus on a standardized format and content for Policy documents, by identifying minimum content based on the strawman provided in this report in Appendix A.2. This might begin by reviewing typical format and content in frequently used documents, including specification sheets and terms of service agreements.
- Assemble the appropriate stakeholders, especially vendors and assessors, to develop a consensus on a standardized format and content of Practice profiles based on the above work on the Policy document, and the strawman provided in this report in Appendix A.3. This work would take into consideration the types of documents commonly in use today that describe manufacturing and production processes.
- Investigate further the requirements of assessments to link the Policy to Practice documents. For regulators, it will be important to determine whether this approach can address growing certification challenges, for example the safety certification of new smart products subject to firmware updates, and challenges arising from new privacy and security regulation.
- Investigate the use of Practice profiles to define a regime for ongoing assessments of vendor performance. As indicated in the report, some ongoing assessments may already be in place, for example to ensure product quality. Additional ongoing assessments over the service life of the product or system will be required to maintain safety, security, privacy, and other important vendor commitments made in the Policy document.
- Address concerns related to specific topics identified in the original report and confirmed during the preparation of this report:
 - Service life requirements as discussed in Section 3.2;
 - Privacy protection requirements as discussed in Section 4.7; and
 - Better means to communicate residual risk to users, especially related to the risk of security and privacy breaches, as discussed in Section 4.6.

Appendix A – Smart Lighting Policy and Practices Documents

A.1 Policy Document

The Policy document must address the concerns of consumers and regulators. Historically, some of the information required has been provided by vendors under the general categories of “specification sheets” and “terms of service”. Today, these are not typically single documents and often this information is spread over many documents or may only be available from a vendor website.

For example, a specific product may be one of many in a catalogue that also contains information about products in the same or a similar family of products.

It is expected that much of the material for the Policy document can be drawn from these existing sources, although as noted in this report, it will be necessary to search out the information and present it in a standardized format.

A single Policy document may cover a family of products, along with the information needed to identify all variations within the family. As indicated in this report, multiple Policy documents might be supported by a single Practice profile if the families are sufficiently similar.

Vendor decisions about the number of Policy and Practice documents needed will depend upon the products and systems being considered and the vendor’s assessment of how best to combine the information that may vary between families and products within a family.

Typically, a Policy document addressing a smart lighting component will be less complex than one for smart

lighting systems, since systems will typically include assemblies of components and may make use of cloud-based services.

The following is a strawman table of contents that might be used for smart lighting. It is expected that a Policy document for a specific product, whether a component or a system, will need to be customized based on the details of the product.

A.2 Example of Policy Document Content

- Title: A title that unambiguously indicates it is a Policy document for a particular named product or family of products (or systems).
- Document issuing information: Vendor identification, date of release, version, etc.:
 - A unique filing, registration, or tracking number unique to vendor and product³¹.
 - Key dates: Dates include the approval date of the original document, the annual review date, and the latest version date.
 - History: Knowing the history is useful for understanding changes.
 - Contact information.
- Product identification: Identification (see Section 4.2):
 - Reference to instances of product to which Policy applies.
 - Method used to authenticate product.
 - How to report counterfeit products (by reference).

³¹ This could bind the document to an instance of the product. If cryptographic mechanisms are used, this unique identifier could be bound to an electronic certificate for automated authenticity testing.

- Brief description of the policy:
 - A brief description will orient users to the scope and purpose.
 - Why the policy exists. This includes such concerns as legal and regulatory needs and problems or conflicts this policy aims to avoid.
 - Audience for the policy, conditions, and restrictions for applying the policy, expectations, and exclusions.
- Responsibilities or responsible party:
 - Indicate what role, department, or group are responsible for this Policy document.
 - References to any governing regulations.
 - Identify the Practice profile supporting this Policy (by reference only).
- Definitions
 - Describe key terms, jargon, or ambiguous terms:
 - Key terms are defined to ensure a common understanding of all terms used.
 - Definitions are particularly important when they may have multiple meanings.
- References:
 - Normative list: Those needed to understand this Policy.
 - Bibliographic list: Those that are reference but not needed to understand this Policy.
 - Would identify all relevant policies, standards, procedures, regulatory documents, forms, and guidelines referenced.
- Keywords: For online documents, select keywords to facilitate searching and categorizing this document.
- Required Policy topics (note: these topics may make reference to specification sheets, terms of service, etc. provided in annexes):
 - Identification.
 - Quality.
 - Safety.
 - Energy Efficiency.
 - Security of Operation.
 - Privacy Protection.
 - Compatibility and Expandability.
 - Warranty.
 - Service Life.
 - Ethical Sourcing or the Circular Economy.
 - Others as needed.
- Recourse:
 - Means by which apparent deviation from Policy may be reported.
 - Contact information and escalation procedure.
- Annexes:
 - Specification Sheet.
 - Terms of Service.
 - Marketing Collateral.
 - Others as needed.

A.3 Practice Profile

Many of the steps for preparing policies will be echoed in the preparation of the Practice profile. For the Practice profile the vendor will describe the internal procedures and standards used to support the Policy document. Many of these procedures may already be documented and may be identified by reference. For example, new product development and quality assurance procedures may be documented in existing corporate documents.

Organizational issues would also be addressed. For example, if specific staffing roles are defined for critical processes, these would be documented along with the minimum qualifications for staff to fill these roles.

A.4 Example of Practice Profile Content

- Title: A title that unambiguously indicates it is a Practice profile for a particular named product or family of products (or systems) with associated Policy documents.
- Document issuing information: Vendor identification, date of release, version, etc.:
 - A filing number: A unique filing or tracking number unique to vendor and the practice.

- Key dates: Dates include the approval date of the original document, the annual review date, and the latest version date.
- History: Knowing the history is useful for understanding changes.
- Contact information, entity in charge of the document.
- Practice identification:
 - Unambiguous references to Policy documents supported by this Practice profile (may be online reference to facilitate addition/deletion of Policy documents).
- Brief description of the practice and range of products supported:
 - A description or introduction orients parties to the scope and purpose of the practice.
 - Why the practice exists, including such concerns as commitments made to customers as well as compliance to legal and regulatory requirements.
 - Organizational audience for the policy, expectations, and exclusions.
 - List or pointer to registry of Policy documents supported by this Practice profile³².
- Responsibilities or responsible party:
 - Indicate what role, department, or group are responsible for this practice.
 - References to any governing or corporate wide rules and regulations.
 - Identify those responsible for ensuring the practice is followed.
- Definitions: Describe key terms, jargon, or ambiguous terms:
 - Key terms are defined to ensure a common understanding of all terms used.
 - Definitions are particularly important when they may have multiple meanings.
- References:
 - Normative list: Those needed to understand this Practice profile.
 - Bibliographic list: Those that are reference but not needed to understand this Practice profile.
 - These should include other practices, procedures, regulatory documents, forms, and guidelines for reference.
- Keywords: For online documents, select keywords to facilitate searching and categorizing this document.
- Required practices for:
 - Identification (including marking, instructions, product literature).
 - Quality.
 - Safety.
 - Energy Efficiency.
 - Security of Operation.
 - Privacy Protection.
 - Compatibility and Expandability.
 - Warranty.
 - Service Life (including reliability and dependability).
 - Ethical Sourcing or the Circular Economy.
 - Engineering/New Product Development.
 - Others as needed.
- Reporting:
 - How to suggest improvements to this practice.
 - How to report deviations from this practice.
 - Contact information and escalation procedure.
- Operational reviews:
 - Summary of required audit items.
 - Frequency of ongoing assessments.
- Annexes:
 - Existing documents if they cannot be included by reference.

³²This would link the document to the Policy documents it supports. Since there may be many Policy documents, and new ones may be added without the need to change the Practice profile, this field should be easily revisable or held in a separate registration system.

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Available: <https://www.iso.org/iso-50001-energy-management.html>

CSA Group Research

In order to encourage the use of consensus-based standards solutions to promote safety and encourage innovation, CSA Group supports and conducts research in areas that address new or emerging industries, as well as topics and issues that impact a broad base of current and potential stakeholders. The output of our research programs will support the development of future standards solutions, provide interim guidance to industries on the development and adoption of new technologies, and help to demonstrate our on-going commitment to building a better, safer, more sustainable world.

