What is energy efficient light?

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Jensen, Charlotte Louise

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Charlotte Louise Jensen
Aalborg University, Copenhagen
Department of Development and Planning.

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Author: Charlotte Louise Jensen, Department of Development and Planning
Supervisor: Kirsten Gram-Hanssen - Danish Building Research Centre
Co-supervisors: Arne Remmen, Michael Søgaard Jørgensen and Stig Hirsbak - Department of Development and Planning, Aalborg University

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Dansk Resume

I forbindelse med et øget fokus på at nedbringe CO_2 udledning og mindske klimaforandringer, har EU igangsat en reguleringsproces for at effektivisere energiforbrugende og energirelaterede produkter. Dette gøres ved at stille mindstekrav til produkters energivirkningsgrad. En af produktgrupperne der underlægges disse mindstekrav er belysningsprodukter, og det har været medvirkende til at en række nye belysningsprodukter de seneste år er kommet på markedet. Som det dokumenteres i denne afhandling, er denne reguleringsform imidlertid ikke særlig effektfuld i forhold til belysning, da nye belysningsmønstre samtidigt er opstået, som ikke er særligt energieffektive. Dette skal ses i sammenhæng med de mange sociale og kuturelle aspekter ved belysning, som ikke er indkluderet i reguleringsprocessen.

Denne afhandling viser derfor, i første halvdel, hvordan mennesker bruger og lever med lys i hjemmet, og stiller spørgsmål ved hvordan og hvorfor bestemte belysningsmønstre opstår og udvikler sig. Denne undersøgelse foretages med udgangspunkt i et praksisteoretisk perspektiv. Via en række interviews der foregår i en række forskellige hjem fastlægges det, at belysning og belysningsprodukter er meningsfulde igennem de aktiviteter som lys indgår i, og at disse aktiviteter er bestemmende for hvordan belysningmønstre udvikler sig. At det enkelte belysningsprodukt bliver mere energieffektivit er derfor ikke det eneste der har betydning for om brugen af belysning bliver mere energibesparende. Tvært imod synes nye belysningsmønste at udvikler sig, fordi mange af de energieffektive lyskilder ikke passer ind i de aktiviteter og praksisser, der foregår i hjemmet, og som resultere i at nye belysningsmønstre opstår, som måske endda er mere energiforbrugende end tidligere belysningsmønstre.

I mange tilfælde er glødepæren stadig den foretrukne lyskilde. Hvad vigtigere er, at glødepæren også stadig anses for at være den 'normale' lyskilde, medførende at andre lyskilder som halogen spots (i nogen grad), sparepærer og særligt LED anses for at være 'unormale' eller 'alternative' lyskilder.

Afhandlingen fokuserer derfor, i anden halvdel, på hvordan bestemte praksisser omkring brugen af lys er opstået, og hvilke aspekter der synes at have haft indflydelse på at glødepæren er tæt forbundet med en 'normal' måde at belyse på. Dette gøres med henblik på at undersøge, hvordan man bedst muligt kan forsøge at 'normalisere' en mere energieffektiv lyskilde, som for eksempel LEDen – altså at sikre at en energieffektiv lyskilde som LED anses for at være en lyskilde der er 'tilstrækkelig god'. I den sammenhæng præsenteres en historisk analyses af det elektriske lys' udvikling, og denne diskuteres i forhold til en aktør-netværk inspireret fremstilling af den nutidige danske belysningssituation. Det kan konkulderes af analysen af husholdningers belysningsmønstre, samt analyserne af den historiske og den nutidige udvikling af belysning, at belysningsmønstre er præget af mange forskellige institutionaliserede praksisser som interagere med hinanden, og har betydning for hvilke udviklingsspor der følges. Det synes derfor problematisk, at aktører i høj grad handler indenfor hver sin institutionaliserede praksis, og at der ikke samles op på erfaringer på tværs af disse, da et tværgående blik synes essentielt for at opnå energieffektive belysningsmønstre, som giver mening og virker i praksis. Til slut i afhandlingen præsenteres derfor en workshop der er afholdt, netop med henblik på at få aktører til at tale sammen på tværs af institutionaliserede praksisser, og hvordan energieffektiv belysning fremadrettet kan identifieres og definieres på en meningsfuld måde, med særligt fokus på brug af lys i hjemmet.

Abstract

As a result of the increased attention towards reducing CO_2 emissions and mitigating climate change, the EU is increasingly focusing on improving the efficiency of energy-using and energy-related products . This is done by providing minimum requirements for product efficiency through regulation. One of the product groups that is subject to these minimum requirements is lighting products. This has resulted in several new lighting products on the market. As documented in this thesis, this form of regulation does not seem particularly effectful in terms of residential lighting, as new lighting patterns have emerged that do not appear to be more energy efficient. This should be seen in relation to the many social and cultural aspects of lighting, that are not targeted or included in the regulation process.

The first half of this thesis therefore focuses on investigating how people use and live with lighting in a residential setting, and thus questions how and why certain lighting patterns have emerged and evolved. The analyses are conducted based on a practice-theoretical perspective. Based on a series of interviews taking place within a number of households, this thesis argues that lighting and lighting products are meaningful through the activities that lighting engages in, and that these activities determines how lighting patterns unfold. Focusing on making individual lighting products more efficient is therefore not solely determining for obtaining an efficient use of lighting. On the contrary, new lighting patterns seem to have evolved, due to many energy efficient light bulbs not fitting into the activities and practices carried out within the home. This has resulted in the development of lighting patterns that may in fact be more energy intense than previous ones.

In many cases, the incandescent light bulb is still the preferred light source. More importantly, it is also considered the 'normal' light source, consequently inferring that other light sources, such as halogen lights (to some extent), compact fluorescent lamps and especially LEDs are considered ' abnormal ' or 'alternative' light sources sources .

The thesis therefore goes on to explore how and why certain lighting-related practices have occurred and evolved and what aspects that seems to have influenced this development, leading to the incandescent light bulb being tightly coupled to normal ways of illuminating. These analyses are presented in the second half of the thesis, and this is done for the purpose of investigating ways to ‘normalize’ energy efficient light sources ie. the LED – that is, to ensure that the LED will be considered an ‘appropriate’ light source that is meaningful for residential use. In order to do so, a historical analysis of the development of electrical lighting is presented and discussed in relation to an actor-network inspired analysis of the current Danish lighting situation. Based on the analysis of residential lighting patterns, the historical analysis and the contemporary assessment of lighting in general, it can be concluded that lighting patterns are a result of various institutionalized practices interacting with each other, shaping the development of lighting. Therefore it seems problematic, that actors related to the contemporary development of lighting seem to act mainly within each instituationalized practice, consequently lacking exchanging of experience across the practices, which seems vital for obtaining meaningful configurations of lighting ‘that works’. The thesis therefore concludingly presents a workshop that was conducted in order to facilitate discussions across practices in order to disuss how to prospectively identify and define energy efficient light in a way that seems meaningful, with a particular focus on residential use.

INTRODUCTION

It is increasingly acknowledged that the world is facing severe challenges, such as resource depletion and excessive CO_2 pollution. A cause of these challenges is that humans draw excessively on global resources, with significant consequences for the environment, when producing and consuming products. The emissions and waste from these activities have an impact on the environment as well. This relationship can be described through the entrenched IPAT equation: Impact = Population * Affluence * Technology (Commoner, 1972). Minimizing our environmental impact means managing and streamlining our products and technologies, as well as the amount and content of our waste, but changes also need to happen in terms of what resources we use and how we use them. Not only do we need to replace fossil fuels with renewable energy resources; we also generally need to consume less energy in order for the world to withstand the current human activities on earth. In order to respond to these challenges, several things can and should be done. One way of approaching the problems is to acknowledge that 1) products have to be more efficient in relation to use of resources, waste and emissions across the entire lifecycle (from cradle to grave) and 2) *consumption patterns* and *volume issues* involving these products have to change as well.

These particular issues can be approached in many different ways. One is to look at aspects that influence innovators in the process of developing a new product, such as past versions of the product, as well as how the innovator perceives a potential user and thus inscribes a particular use into the product (Akrich, 1992). Another is to look at how people use the product in everyday life activities, and thus what kind of consumption patterns may occur involving the products. Dynamics within and *across* production and consumption are thus of importance. A growing field of academic theories and methods for exploring *transitions towards sustainability* strives to move the focus away from polarized views focusing on either production *or* consumption by demonstrating the complex and relational interconnections between innovation, social life and economic organization (McMeekin and Southerton, 2012). Similarly, recent environmental concepts such as Sustainable Consumption and Production (SCP) have been developed to respond to the increasing need to include both production and consumption dynamics in strategies for sustainable development (Jørgensen and Jensen, 2012).

However, in spite of increasing evidence of the relationship between environmental impacts and *final consumption patterns* (consumption of goods and services by private consumers), much policymaking is still mostly limited to embracing frameworks that primarily concentrate on *efficiency gains* (McMeekin and Southerton, 2012). Although optimizing products arguably may be considered as one step towards a sustainable society, it has been shown to be insufficient – which corresponds well to the implications of the IPAT equation. In fact, the pursuit of instruments such as standard-setting that are designed to help consumers make informed choices concerning efficient products have been shown to be sometimes counterproductive, *in tacitly accepting and legitimizing certain energy-intensive consumption patterns* (Shove, 2004). This means that the underlying demands for certain products, efficient or not, becomes taken for granted and thus is not included in the overall considerations (e.g. Wilhite et al, 2000). For instance, a recent study shows that in spite of minimum requirements for energy efficiency of TV screens having been put in place, changes in how people use TVs in relation to social purposes, as well as the expanding sizes of the screens, have to a large extent offset the savings that were obtained (DEA, 2012). Therefore, more research into the *underlying demands* for use of products and services is needed. This is by

no means straightforward, as people rarely tie underlying demands for consumption together with the *actual act of consuming* (Røpke, 2009). For instance, the demand for consuming leather and string for a football is often tied to the demand for *playing* football, and not the leather and string itself. In other words, demand and thereby consumption is often tied to activities that are meaningful in a social sense. It may therefore be useful to consider and approach consumption as a result of multiple, more or less routinized performances of social activities or practices and not as mere 'appropriation' of things (Warde 2005, Røpke 2009). In other words, in order to reduce the human impact on the environment, products not only need to be more efficient (or maybe even fewer in number); it is also important to understand habits and routines associated with the products in question.

One category of products and services that is currently being debated in the European Union and several national governments worldwide is *electrical lighting and its energy consumption.* Lighting accounts for approximately 20% of the world's total energy consumption (Brown, 2010), and it takes up a significant share of the energy consumption in various sectors such as industry, schools, hospitals and homes. The share in Denmark, distributed across a number of sectors, can be seen in figure 1.

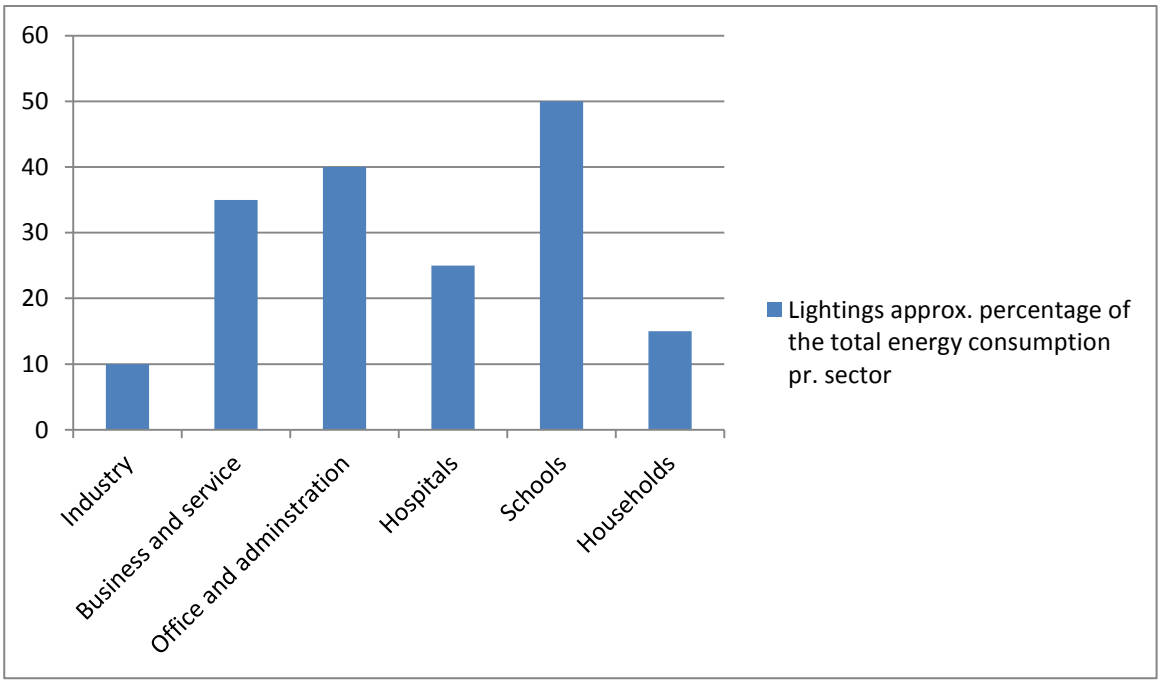

Figure 1: Percentage of total energy consumption used for lighting, in six different sectors[1].

The motives for decreasing energy consumption from lighting are thus manifold. The EU Commission has initiated several strategies to increase the efficiency of lighting products, which has led to a phasing out of classical light sources and the introduction of new ones. This has led to a transformation of the lighting industry and lighting market, which, as recognized by the EU Commission, has resulted in certain uncertainties and problems for private as well as professional consumers (EU Greenpaper, 2011). Taking a point of departure as *how lighting and the current transformations related to lighting are received, dealt with and understood by private consumers* acknowledges and responds to McMeekin and Southerton's (2012) call for developing better understandings of final consumption. Researching lighting applied by

[1] Based on http://energiwiki.dk/index.php/Belysning (translated)

private consumers in a *residential setting* specifically is interesting for several other reasons as well. For instance, it was through lighting that the first robust link was made between electrical supply systems and household demand (Gooday, 2008). In this sense, lighting has a distinct relationship with electricity, which becomes even more interesting when considering how this relationship has changed significantly within the past 100 years. From the beginning of the 1900s until the middle of the century, lighting was an important factor in getting households connected to the electricity grid, as well as getting people to use a certain (increasing) amount of electricity in order for the grid to work properly (Brox 2010, Gooday 2008, Bijker and Law 1992). Now, reducing the amount of energy consumed by lighting is becoming a matter of increasingly interest worldwide as part of a transition towards a low-carbon economy. Lighting as an energy-consuming product thus has a *significant historical account*. Further, lighting is not only a technical, energy-using product but also a highly cultural (e.g. Wilhite et al 1996) and socio-material phenomenon that does not only mediate something, but also evokes agency (Bille and Sørensen 2006). Lighting patterns are therefore interesting to investigate for several reasons, as technological as well as cultural and socio-material dimensions play a role in energy efficient lighting solutions becoming 'configurations that work' (Rip and Kemp, 1998), which can essentially transform the level of energy consumption from lighting.

The following thesis and collection of papers therefore explores how light is defined and used and what that means for a transformation towards more energy efficient lighting patterns. Yet, prior to this, introducing the current legislative and state-of-the-art academic discussions and considerations of (residential) lighting is important. The following section therefore seeks to 'set the stage' by briefly introducing the phenomenon *lighting* with three different but interdependent foci, namely 1) Lighting as a legislative matter, 2) lighting as a matter of energy consumption and 3) Lighting as something seemingly beyond (current) matters of legislation and energy deliberations.

1. The multiplicity of light

In order to be able to understand the current changes within the lighting sector as well as the changes in 'user' patterns, it is important to understand what role lighting has as a current legislative matter. The following section gives a short description of the strategies that the European Commission has set in motion as part of the requirements of the European 2020 goal for sustainable energy and climate (ECON, 2007). After this, a discussion is provided of how lighting is approached in these strategies compared to what existing research emphasizes about the cultural and socio-material aspects of lighting, which generally seem to be overlooked in the EC strategies.

1.1. Lighting as a legislative matter

In 2008, efficiency targets for light sources were implemented in the Ecodesign Directive 2005/32/EC (EC, 2005). The Ecodesign Directive aims to reduce the energy consumption and related environmental impacts from various energy-related products (ErP) that are widely used. The aim is to reduce energy consumption from the corresponding products by 20% by 2020. The ErP product groups are chosen based on life cycle assessments and includes *products for which an introduction of minimum requirements will entail the biggest accumulated effect in terms of reductions in energy consumption and environmental impacts, without negative outcomes from a consumer perspective* (Øbro, 2009). The assessments are conducted by consultants acquired by the EU Commission and are based on the MEEUP method (EC, 2005a). As a result

of the assessment, lighting in both the domestic and tertiary sector was chosen to be subject for setting up minimum requirements to the directive.

As a result of an implementing measure for residential non-directional lighting and corresponding efficiency requirements (please see appendix 1 for details), the classic incandescent light bulb was phased out by 2012.[2] According to Øbro (2009), lighting products became subject to the directive, because it was assessed that a 230V halogen light bulb could substitute for an incandescent light bulb without any deterioration in terms of colour rendering[3] or brilliance, and the incandescent light bulb could be replaced with a compact fluorescent light bulb in cases *where the quality of the light plays a smaller role than the economic incentive.* Further, this could be implemented fairly easily without the need for additional technological developments, as the 230V halogen bulb as well as the compact fluorescent light bulb existed at the time of the efficiency requirements. However, the feasibility studies conducted prior to implementation suggested that the supposed plan for potential substitution would not be enough to reach the 2020 goal aiming to save 20% of energy consumption in the housing sector (Øbro, 2009).

Therefore, a number of alternative requirements were put up, yet the best scenario for lighting quality would not result in adequate energy savings. This created tension between obtaining a certain level of quality while also obtaining the required energy efficiency. Øbro (2009) states that some European countries did not mind going for an alternative in which the halogen light bulb was phased out too, as it does not meet the required efficiency level. However, it was decided not to go through with this, as it "would lead to what most people would regard as a breach of the underlying rule about avoiding quality deterioration" (Øbro, 2009 p.25, quote translated), for instance in terms of the required brilliance for certain lighting arrangements (chandeliers). Therefore a compromise was made, where incandescent and halogen light sources with frosted bulbs were to be phased out first, whereas light bulbs (incandescent as well as halogen light bulbs) with a smooth and clear bulb were to stay on the market, however subject to a step by step phase out process a long with 'adequate' alternatives becoming available.

A myriad of new lighting products have become available over the past few years, spanning more efficient kinds of halogen light bulbs and spots, variations of compact fluorescent light bulbs and recently a number of Light Emitting Diode (LED) light bulbs and spots. All of these can, in principle, technically replace the incandescent light bulb. However, *issues with the quality of light have developed in the aftermath of the implemented efficiency requirements*. In order to ensure a certain level of light quality, several initiatives have been developed attempting to set up standardized requirements for functional quality, such as the Quality Charters for compact fluorescent light and LEDs respectively (EC 2009b, EC 2011a).

As the legislative requirements for residential use have focused on requirements for the products available in the market, *it becomes important to look further into the (national) residential correspondence to the resulting configurations of the lighting market*, especially since the directive seems to be built on various somewhat implicit assumptions about 1) what light quality is as well as 2) the consumer's incentive to use and buy light sources. In the negotiation process among the stakeholders, it is aimed not to compromise

[2] Only bulbs for special use (odd specifications) as well as incandescent reflector lamps are still available on the market.

[3] Colour rendering means the light source's capability to render surrounding colors in a 'natural' way. Often these measures are compared with the colour-rendering capability of an incandescent light bulb. Paper 3 in Part 2 gives further explanations on this topic.

any aspects of quality that the consumers require, but it is difficult to assess what quality means other than a certain level of colour-rendering capabilities and a certain level of brilliance. This is interesting as the resulting requirements for the field of lighting did in fact compromise the very aspect of quality corresponding to colour rendering and brilliance, which will be elaborated further in Part 2. Lastly, stating that an incandescent light bulb can be replaced with a compact fluorescent light bulb *in cases where quality is valued lower than economic gains* seemingly assumes that light is a matter of semi-rational decision making, as is implied in much policy making although rarely the case (Macnagthen and Urry, 1998). This will be further elaborated in Part 1 of this thesis.

The Ecodesign Directive is based on a command-and-control approach to legislation, in banning certain products that do not live up to minimum energy performance requirements. This process is based on intensive stakeholder consultations. The EU Energy Label and the EU Eco-label schemes go beyond minimum requirements in appealing to producers and consumers to choose energy efficient or environmentally friendly products. For details on how lighting is included in these schemes, please see appendix 1. The label schemes therefore rely on people (consumers) choosing the 'right' product, where the Ecodesign Directive makes the minimum requirement decisions *for* the consumer. However, both the Ecodesign Directive and the label schemes tend to presume that environmental and economic values are significant for the consumer – and that these values are the same all over Europe. Moreover, the Energy (and to some extent the Eco) Label assumes that the monetary aspects of light will make people choose the most rationally viable product option, e.g. by informing the consumer of the economic gains from choosing an environmentally sound lighting product.

It is therefore interesting not only to look into how lighting quality is defined, but especially to look further into what *light quality* consists of for residential consumers, as well as to assess *when, how and whether purchase and use of light is determined by economic incentives* that can be pursued through sheer substitution. In the following, a number of studies of the appropriation and use of (energy efficient) light will be presented in order to approach these questions.

1.2. Lighting as an energy consuming phenomenon: a matter of substitution or something else?

In a joint EU research study, Bertoldi and Atanasiu (2006) conducted an investigation assessing the potential energy savings in lighting consumption in the member state countries. The analysis was mainly based on an assessment of the success of various campaigns introducing compact fluorescent light bulbs (CFL). Bertoldi and Atanasiu (2006) suggest that although many citizens are aware that lighting is an important part of their electricity consumption, many are still 'unaware' or 'reluctant' to install efficient lighting technologies due to lack of knowledge about the actual energy savings. As Bertoldi and Atanasiu put it: "Most people are not aware that many types of traditional (and some new) lamps they use have very low efficiency and that installing more energy efficient lamps, could save [a] large amount of energy and money while preserving or increasing the lighting service." (Bertoldi and Atanasiu, 2006, p. 1).

Bertoldi and Atanasiu therefore concluded that although policies and programmes, information campaigns and energy and eco-label schemes had resulted in substantial market transformation in some countries, there were still large cost-saving potentials in other countries. They suggest that more aggressive policies, including information campaigns, could achieve substantial savings. Bertoldi and Atanasiu found that the

most significant barrier for adopting efficient lighting technologies was a lack of knowledge about the short payback periods for the more expensive CFL compared to the incandescent light bulb. Further, they argue that quality played a role for many consumers, and that consumers mistrusted the CFL due to the experience of bulb failure before the claimed lifetime as well as aesthetic aspects such as size, shape and colour temperature of the CFLs. Lastly, the increasing uptake of halogen bulbs further reduced the options for substituting incandescent light bulbs with CFL bulbs. In discussing these barriers, they draw on a study of the German market (Bertoldi and Atanasiu, 2006, p. 3) about whether customers planned to still buy CFLs in the future. The study confirmed that high price is one of the major barriers. However, interestingly, the German study also found that higher percentages are allocated to barriers termed 'actually already have enough CFLs' and 'do not match all cases', suggesting that the consumers interviewed have a definition of when one has enough CFLs and that the CFL does not fit all situations (Bertoldi and Atanasiu, 2006, p. 3). These aspects are not treated further in Bertoldi and Atanasiu's analysis. On the contrary, Bertoldi and Atanasiu utilize two different scenarios for calculating further saving potentials which indeed presuppose an *additional* uptake of the CFL. Based on their analysis, they conclude the paper by suggesting a number of initiatives for promoting the use of efficient lighting such as CFL. Some of them form the basis for implementing the Ecodesign Directive for lighting, where others are related to promoting campaigns.

Obviously, price and lack of knowledge in terms of the parameters to base one's product purchase upon are important and valid sources for what can be termed as barriers to energy efficient products. However, there are several other important aspects that seem, more or less implicitly, to be revealed in the analysis without being further dealt with. First, as already mentioned, the respondents in the German study seem to have definitions of when one has *enough* CFLs and what *situations* the CFL *'matches'.* The paper does not explain the German study in detail, so these findings are interesting to explore further. Additionally, Bertoldi and Atanasiu (2006) found that uptake varied from country to country, and they found no explicit correlation between initiatives (policies and information campaigns) and the actual uptake of CFLs. As mentioned, Bertoldi and Atanasiu (2006) seem to suggest that low uptake can be addressed through more aggressive policies and initiatives, in spite of the fact that these kinds of policies have not worked for all situations.

In a more recent study published as a Green Paper by the European Commission (EU, 2011), the saving potentials of switching to SSL [solid-state lighting] technologies, such as LEDs, are emphasized and discussed. The paper acknowledges *LED arrangements as potential solutions to the energy consumption issues related to lighting*, headlining the paper "Lighting the Future – Accelerating the deployment of innovative lighting technologies ". The study does not limit itself to discussing residential lighting, but includes potentials for professional lighting, public spaces and other applications such as advertising panels and street and traffic lights. In the Green Paper it is suggested "to launch a number of new policy initiatives and a public debate in Europe with all interested parties for accelerating the pace of SSL deployment. It has the ambition to proactively define a coherent set of strategic objectives in the Union addressing both the demand and the supply side, as well as to lay down the generic conditions for achieving these objectives as a basis for future action for all involved players. The research and business related stakeholders, governments, civil society communities and citizens are called upon to engage in this debate" (EU, 2011, p 3).

The findings in the Green Paper therefore differ a bit from the study presented in Bertoldi and Atanasiu (2006) by focusing not only on a residential uptake of efficient light and how that can be facilitated through policies and campaigns, but also on speeding up general deployment as well as including civil society in the debate. However, the Green Paper presents the same kind of barriers to uptake of SSLs as the study from 2006 presents for CFLs. Besides confirming price and technological teething troubles, it also implies that policies and information labelling are sufficient. In that way, the Green Paper seems to equally assume that the consumer acts as a semi-rational decision maker and bases purchase and use mainly on economics, facilitated by adequate information.

Applying these assumptions as a basis for policy instruments is however not surprising, as much policy making is focused on aspects such as attitude, behaviour and choice (ABC) in opting for a solution through 'behaviour change' (Shove, 2010). Relying on the consumer to choose the right product is therefore essential for these policy instruments to adequately work, and if the consumer does not make "the right choice" it is a matter of attitude and behaviour that can be targeted through campaigns. However, these rationales are questioned, if not confuted, in more *socio*-technically oriented research. As Watson (2012) emphasizes through the example of low-carbon transportation, "education, publicity and price signals are the primary instruments for engendering behaviour change, complemented with variable and generally low levels of intervention through targeted investment in infrastructures. Meanwhile, most faith is placed in technological change to deliver low-carbon transport with minimal intervention to expectations of mobility, speed and convenience" (Watson, 2012, p 493). This argument can to a large extent be used in relation to lighting as well. With a primary focus on technological *substitution*, the *underlying expectations and structures* that support, for instance, the light-intensive "24-7 day", as well as changes in house design (such as houses becoming bigger and bigger) and related expectations of comfort that may very well have a significant influence on the way people purchase and use light risk being left unaddressed. These underlying socio-material structures are therefore important to acknowledge when opting for a change towards a more sustainable production and consumption of light. In the following, some of these social and perhaps less tangible aspects of lighting are presented.

1.3. The social aspects of lighting

A number of studies have identified several social, underlying, unquestioned and inconspicuous aspects of lighting that cannot be adequately captured or approached through the aforementioned ABC-based assumption (Shove, 2010). In the following a few examples are briefly presented.

Bladh and Krantz (2008) conducted a qualitative assessment of a small sample of households to understand implicit dimensions of the behavioural aspects behind the patterns of using light. They conclude that lighting consumption is highly complex and describes a number of influential dimensions – such as the aspect of 'switching on and off' (whether you have influence or not), the number of lighting points, to what extent lamps fit the CFL bulbs, the geographical aspects of preferring 'warm' or 'cold' light (cultural aspects), prices of electricity, as well as the number of daylight hours available (also geographically dependent). Costs of CFLs and misunderstandings in relation to economic benefits (a common misapprehension that wattage is related to light output) are also important factors. The aggregated monthly bill that does not show details in electricity consumption (how much is used for what appliances) also makes it difficult for residents to relate to potential savings. In this sense they detect some of the same obstructions in introducing CFLs as Bertoldi and Atanasiu (2006) do, such as costs and misfit, but also elaborate on aspects of cultural difference and the fact that people may misunderstand what energy-saving

light bulbs are in fact saving (lack of decoupling between wattage and light output). They further touch upon an interesting aspect of 'consuming energy':

"People generally know very little about their electric energy consumption. Electricity is an input into lamps and appliances, that is used in a different logic – a logic of household chores and of living (…) They do not use electricity directly; they use other things which, in turn, must be powered by electricity in order to function. The link between routine and electricity consumption is not known by the people involved (…) people are primarily interested in lighting functions – not the consumption of electricity. Because of the indirectness, contradictory patterns of installations and use appears." (Bladh and Krantz, 2008, p. 3529).

This is interesting as Bertoldi and Atanasiu (2006) in fact detect the same issues: as already mentioned, they state that people are unaware of the efficiency levels of their lamps (see quote above, p. 11). They do not, however, go on to explore why this is so. Bladh and Krantz's findings correspond very well with what Røpke (2009) emphasizes about consumption being a result of 'doing meaningful activities', and are interesting in relation to the conclusions made by Bertoldi and Atanasiu (2006). They seem to assume that a further uptake of energy efficient lighting will happen because people will be choosing this option *due* to its energy efficiency. If people consume light and not energy when buying lamps, an assumption like this may prove very misleading.

Wall and Crosbie (2009) looked into energy efficient lighting in the UK, which has seemingly had limited 'uptake' of energy efficient light technologies. They base their study on the assumption that household energy consumption arises from interactions between people and technology. In their paper from 2009 they further argue that behaviours of interest when looking at energy consumption are frequent, routinized and habitual. They therefore conduct a qualitative study to try to uncover motivational support and constraints for the uptake of energy efficient lighting. In this sense, their approach to analysis is close to that conducted by Bladh and Krantz (2008). They conclude some of the same things as well, such as bad experience and misfit being some of the constraining factors. Like Bladh and Krantz (2008) they also conclude that the uptake of halogens is greater than the uptake of CFLs and LEDs, and that this is a problem since halogen light bulbs are not as energy efficient as CFLs and LEDs. As they argue, even though CFLs and LEDs are beginning to have some of the same qualities as halogen bulbs (such as colour temperature), the halogen bulb is still preferred. Both papers argue that this may be due to the fact that early versions of CFLs (and LEDs) were of poor quality, resulting in people maintaining that *association,* much in line with what Bertoldi and Atanasiu (2006) and the Green Paper (EU 2011) conclude. Wall and Crosbie (2009) also argue that environmental and financial aspects are important for the people they have interviewed, but they do not explicitly clarify why and how. They do however show another interesting finding, namely that only two of the interviewed households mention 'official' sources when asked where they obtain information about or ideas for lighting in their homes. All the others mention friends and family, and some point to the media. The paper concludes that *social norms* therefore play a role in lighting patterns.
There is also an example of social norms encouraging the use of inefficient lighting technologies – a woman in one of the households has halogen bulbs in her kitchen because her mother has them, and because they look 'bright and lovely' there. Many of these aspects identified by Wall and Crosbie (2009) can in one way or the other be connected to 'behaviour' being habitual or routinized. They also correspond very well with Bladh and Krantz's (2008) discussion on whether people consume *light or energy.* When people refer to the

qualitative aspects of light, such as warmness and brightness, it suggests that people do not primarily relate their lighting consumption to energy consumption.

Another aspect that may support this assumption is Wall and Crosbie's (2009) discussion of whether the people they have included in the study *are more* pro-environmental than *average* (as they have more CFLs installed than average in the UK, and generally also have lower energy consumption). If these people in fact are more pro-environmental and generally more aware of their energy consumption, it is concerning that Wall and Crosbie are able to conclude that there is further potential for energy reductions related to lighting consumption in many of the households, some of these reductions even being quite significant. In this sense it may support the argument that lighting consumption is *not mainly associated* with energy consumption.

These studies seem to imply that light is not only a matter of technology and economy, but also of implicit and sometimes highly routinized 'sayings' and 'doings' connected to *illuminating the home.* Wilhite et al (1996) support this in their study of differences in energy consumption behaviours across countries. They argue that certain habits such as energy-intensive space heating and lighting patterns have become an integral part of arrangement of a Norwegian home, whereas space heating and lighting habits are less culturally significant in Japan. Furthermore, lighting patterns are distinctively different between the two cultures. In Norway, residents prefer many small lamps instead of ceiling lamps, whereas ceiling lamps are utilized much more in Japan. Fluorescent light is preferred in Japan, not only as an efficient light source but also as a light source that creates the right kind of atmosphere. The complete opposite was to be found for the Norwegian residents that prefer incandescent light. This supports the view that 'quality' of light is socially or culturally constituted and not 'inherited' by the technology. It further implicates any global or cross-cultural standardization in terms of what quality light is and should be.

Thus, although setting up minimum requirements for energy efficiency of light as well as labelling the lighting products in terms of energy consumption may be part of a solution to energy-intensive lighting consumption, it is also now evident that aspects that are unrelated to energy play significant roles in how lighting is used and perceived. It thus seems appropriate and important to understand how lighting patterns evolve as a *socio-material* phenomenon, and how this plays a role for developing and legislating for energy efficient light and vice versa.

2. Approaching the problem

Based on the above review, it seems plausible to argue that lighting is quite complex, involving many dynamics that influence how people use light, and how (and whether) they relate to the energy aspect of lighting. Further, many of these dimensions can be connected to individual and social aspects of what can be perceived as 'normal'; that is what people refer to as 'normal' ways of illuminating the home; living with light, picking out lamps and light bulbs, how to 'place' the light, etc.

This is not only interesting in relation to understanding how people actually use and understand light, but equally relevant for a discussion of potential transitions towards a more sustainable consumption of lighting, as the review seems to indicate that a potential shift towards a more energy efficient lighting consumption may not be a linear, rational process, where economy and efficiency are the main drivers. As

it is becoming increasingly acknowledged that traditional consumer research has difficulty explaining why consumers do not always choose the 'rational' or most obvious option when purchasing products and technologies, these dynamics are interesting to look further into and seek to explain in order to understand consumption dynamics. Likewise, the above review supports that it is problematic to apply a traditional adaption curve when describing how product and technologies are used and adapted into everyday life situations (Lethonen 2003, Pantzar 1997), therefore calling for a different approach to understanding consumption patterns involving energy-consuming products and systems, such as lighting. One approach that is becoming increasingly influential and applied to studies of consumption and related policy making is the practice approach (e.g. Shove 2003, Warde 2005, Gram-Hanssen 2011, Nicolini 2012, Shove et al 2012). The practice approach comprises various theories of (social) practice that cannot and perhaps should not be unified. Yet, in relation to consumption studies, theories of practice have a number of viewpoints in common which, based on the references given above, can be summarized in the following way, and which will form the underlying assumptions for my research:

- A practice is a recurrent (performed and maintained) activity that is routinized and therefore (often) considered 'normal'. It is therefore through the performance of practice that normality, stability *and* potential change occur. Practice is thus considered the 'unit' of analysis.
- Practice theories carve a specific space for individual agency and agents. A person is neither a semi rational decision maker, nor a completely norm-following individual, but a carrier of practice. Consequently, there is space for innovative performance through each individual (which gradually changes practice). However, individual performance is only intelligible (and only takes place) as part of an ongoing practice and against the more or less stable background of other practices. Here, concepts of 'bundles and complexes of practices' (eg. Shove et al 2012, Hargreaves et al 2013) becomes important, as practices, albeit more or less tightly coupled to each other, in this way represent society and its organization.
- Practices therefore put people and things in place and thus give (or deny) people the power to do certain things and think of themselves in certain ways, leading to various forms of inequalities. However, as people are considered carriers-of practices, people in the same carries the opportunity to change practice. Practice only exists if it is reproduced.
- A practice is generally considered to be composed of an number of elements. What comprises the elements is still debated and cannot neccesarily be unified. However, across the references given above, it can be argued that elements of practice are composed of (embodied) knowledge, competences, meanings, things (materiality, products and technologies) and teleo-affective structures. The links that are *made and reproduced* between these elements are what comprise practices.
- In this sense, theories of practice therefore approach the role of knowledge, competence, meaning, discourse and things in a different way from other approaches for understanding human activity. In Nicolinis words; "Culturally understandable practices which consist in patterns of routinized conducts [are] carried out using tools and discourses" (Nicolini, 2012, p 5). So knowledge, for instance, is obtained through learning, and is required in order to recognize and perform a practice. What is especially important to make note of here is that *knowledge belong to the practice, not the individual.* Knowledge should therefore be seen in relation to intelligibility– the fact that practices

can be recognized as meaningful entities that comprise life and society. In this sense knowledge and action (practice performance) has nothing to do with rationality.

- The role of materiality is treated differently across theories of practice. For consumption studies, materiality is however agreed to be inherently important. Shove et al (2012) treat material as one of three elements of practice and argue, much like Nicolini (2012), that practices are made possible only through the use and active contribution of material resources. Gram-Hanssen (2011) brings the material element even further to the fore by arguing that energy consumption in particular is inherently dependent on material things (products and technologies) which requires knowledge and explicit rules particularly connected to material structures. Warde (2005) and Røpke (2009) emphasize that it is through practices that things are consumed, so it is not so much the things in themselves that are meaningful, but the ways in which things are used, perceived and handled through the activities of reproducing practices. Implicitly, practices and their reproduction only 'consume' though the way in which they incorporate things.
  (e.g. Shove 2003, Warde 2005, Gram-Hanssen 2011, Nicolini 2012, Shove et al 2012).

In applying a practice approach, Nicolini (2012) suggests to treat the approach as weak and strong practice-based programs as described by Bloor (1976), inferring that the practice expression can be much more than a theoretical lens that one can adopt in a descriptive way. The practice idiom can also be an ontological choice; recognition of 'the practice' as a primacy in social matters, where the idea that practices are fundamental to the production, reproduction and transformation of social and organizational matters is adopted as an ontological premise. Taking on a pair of "practice-oriented glasses" when approaching consumption issues as a matter for policy making opens up a space for different objects of inquiry, questions and concerns. For one, focus is moved away from polarized foci on either production or consumption dynamics, as well as being taken away from consumption being a matter for the 'individual consumer'. Consuming becomes a result of various practices, in which people take part as carriers of practice. This not only breaks with the premise of ABC thinking in policy making (Shove, 2010), which appears insufficient for regulating lighting; it equally offers new insight into an alternative approach to understanding the social world, based on a performative perspective (Nicolini, 2012), that seems also to be needed in relation to lighting. In order to develop a meaningful, alternative approach, the practice needs to be brought to the fore, to be made visible; to become an epistemic object (Nicolini, 2012). It is therefore necessary to find ways of *identifying* practice, through different sets of methods. Nicolini (2012) suggests doing this by zooming in and out on practice(s), using what he describes as a 'toolkit'. The actual package should be seen as an invitation to reiterate two basic movements and the iteration between these steps:

- Firstly, it is appropriate to be *zooming in* on the accomplishments of practice. In taking point of departure in the details of accomplishment of a practice in a specific place, one can start making sense of the local accomplishment and the other more or less distant activities.
- Secondly, it is appropriate to *be zooming out* to discern practices' relationship in space and time. This step makes it possible to expand the scope of the observation, by following the trails of connections between practices and their products.

The iterative zooming in and out stops when we can provide an account of both practice and its effects on the dynamics of organizing, showing how and which local accomplishments contribute to the generation of broader effects (Nicolini, 2012).

Understanding the worlds as comprising practices through which society is organized in more or less standardized ways consequently will be the ontological foundation for my research. It seems to make sense to understand lighting through a practice perspective in order to make sense of how lighting shapes, and is shaped by, the organization of everyday life and society. Identification of practices concerning light is therefore presented in the first part of this thesis. Mainly focusing on the challenges connected to residential lighting, the process of making sense of the local accomplishments of practices related to *lighting in the home* is therefore the underlying rationale for the papers that are presented as part of this first part of the thesis. Zooming out to understand the practices related to residential lighting in a broader societal sense of space and time is the underlying rationale for the papers and discussion presented in the second part of this thesis. This is done in order to understand why certain ways of using light are considered normal and other ways are considered unusual. Exploring these dimensions may offer insights into potential and perhaps alternative ways of finding 'energy efficient light' that may turn into 'energy efficient ways of using light'.

As suggested by Nicolini (2012), the zooming-in and zooming-out processes may require different theoretical lenses, which will be presented specifically for this thesis in PART 1 and PART 2 respectively.

RESEARCH QUESTIONS & READING GUIDE

Based on the above introduction it seems important to further investigate and obtain an understanding of the following research areas:

1) How do people use light? In what ways are lighting used as part of various practices through which lighting becomes meaningful? What does the residential setting imply for the way people use light?
2) (How) are people trying to transform ideas and meanings of energy efficiency (if any) into their everyday practices? What is easy and what is difficult and (how) do shared conventions play a role in shaping this?
3) How are current ways of using lighting included in the current processes of obtaining energy efficient lighting, if at all?
4) How can the understanding obtained through 1), 2) and 3) be included in policy making processes for obtaining energy efficient light?

The thesis and appurtenant papers will explore these three research areas of interest through the structure described in the following:

PART 1 focuses on zooming in on local accomplishments of practices involving the use of light. An introduction of a practice theoretical approach specifically related to (energy) consumption studies will be given, whereafter a methodology for exploring practices related to lighting will be presented. The theoretical and methodological overviews provide the basis for paper 1, entitled '**What does it require to understand energy-related consumption patterns? An example of residential lighting and related energy consumption'**, and paper 2, entitled '**Sharing conventions for energy efficient lighting?'**, both of which explore practices related to residential use of light in two different residential settings. The results of the analyses conducted in the papers are then introduced and discussed.

PART 2 focuses on zooming out to discern the explored practices in space and time. An introduction of a theoretical framework for informing transitions studies through a practice approach will be given. Hereafter, the applied methodological framework will be presented. This theoretical and methodological framework provides the basis for three steps of zooming out. The first step provides the basis for paper 3, entitled **'Illuminating the Home according to the Danish Energy Savings Trust – From focusing on everyday life to focusing on technical terms'**, which discusses the role that information has in current processes of trying to enrol residents in using energy efficient light. The second step provides the basis for paper 4, entitled **'From energy efficient lighting products to energy efficient lighting patterns?'**, which seeks to explain how and why current lighting patterns exist based on a historical assessment of the development of light. The third step provides the basis for exploring the current field of lighting as a complex socio-technical phenomenon. Analyses and results of all three steps are then presented and discussed. The four papers are positioned in the end of the thesis.

PART 1: ZOOMING *IN* ON LIGHTING AND PRACTICES

Exploring local accomplishments of practices related to lighting requires the detailed study of practices related to lighting. In order to do this, I have chosen to look at different local settings of households, conducting interviews and observations through a practice-based approach. Before going on to explain the methods used in conducting the interviews as well as the results of my residential case-strudies, below I provide an introduction to the theoretical strand I have chosen to follow within social practice theory.

In order to perform a task that is zooming in on practices, Nicolini (2012) suggests the following palette of considerations:

- What are people doing and saying? What are they trying to do when they speak? This means to approach practices as an act of 'practising'; a real-time doing and saying of something in a specific place and time.
- As practices only exist when enacted and re-enacted, this means focusing on practice in taking the *social and material doing* as the main focus of inquiry.

This palette fits well with the general notions behind theories of practice, which will be presented in detail below.

3. Theoretical approach for zooming in on practices related to lighting

As presented in the introduction, numerous aspects influence people's ways of using and relating to light – and energy efficiency is not necessarily that influential. Traditions and habits are of great importance when investigating how people use, relate to and talk about light, such as family structures and inherited perceptions of what light should look like/be able to facilitate in different situations (Wall and Crosbie, 2009). As mentioned, Bladh and Krantz (2008) describe that *people are primarily interested in (lighting) functions – not the consumption of electricity.* This is a rather interesting phenomenon which is emphasized in much social practice theory. As mentioned in the introduction, Røpke (2009) explains that people generally relate to the practice which a certain consumption pattern is an outcome of and not the consumption in itself. Buying a football means having a good time with friends, whereas the resulting consumption of the resources put into manufacturing the football are less recognizable. In order to understand how to reduce energy consumption in lighting, it is therefore important to assess what aspects of social practice and habitual use influence the way we use (consume) lighting. When analysing 'how we live with technology/products', certain strands within the practice approach are relevant for and increasingly applied to consumption studies.

3.1. Practices in relation to consumption

In short, the strand of theories of practice that relates to consumption and environmental issues stems from – and builds on – sociology, and especially structuration theory (Giddens, 1984). The main point is that day-to-day activities of social actors draw upon *and* reproduce structural features of wider social systems.

Structuration is then neither individual actors nor a social totality, but social practices ordered through time and space (Giddens, 1984), which is central for the practice approach in general.
Practices are often understood in two different ways: as practice-as-entity and practice-as-performance (Reckwitz, 2002). This means that a practice exists as a conjunction of elements that figures as a recognizable 'entity', but this 'entity' is only recognizable because the conjunction of practices is reproduced and maintained (Shove et al, 2012). Practice-as-performance is, in other words, denoting how people perform/oppose certain practices, as people as carriers contribute to practices in different ways though performance (Gram-Hanssen, 2010, 2011, Røpke 2009). To recite a widely used example of the practice approach, (in the western world) showering is a recognizable phenomenon to a lot of us, but only as long as we shower. However, we only shower the way we do because there is a recognizable pattern behind how to shower, which we then reproduce. The practice approach is therefore helpful in terms of understanding how certain normal, taken-for-granted aspects of life and society are organized, and how people engage with them.

3.2. Elements of practice

In spite of an increasing utilization of theories of practice in relation to consumption studies, what actually constitutes a practice is still under discussion. One of the more recent and widely utilized versions (visualized in figure 2) suggests that a practice is constituted of three different elements: images or meanings, skills or competences and products or materials (Reckwitz 2002, Pantzar and Shove 2010, Warde 2005, and Gram-Hanssen 2010, 2011, Shove et al 2012).

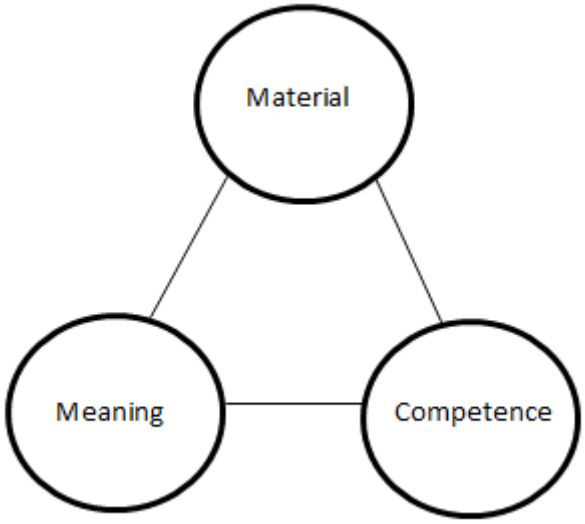

Figure 2: A visual respresentation of the interrelation between elements of practice (eg. Shove et al 2012).

While approaching 'practice' as something that is held together through the reproduction of linkages between certain elements, there are a number of disagreements in terms of what elements to include. For instance, there is disagreement in terms of how to incorporate materiality and what role materiality and things play in performing practices (e.g. Gram-Hanssen 2011). Reckwitz, Warde, Shove and Pantzar, Gram-Hanssen emphasize products/technology or things as a significant part of practice, especially for consumption studies, as consumption happens through the use of 'things'. Schatzki (1996) however tends

to “side-track” objects as outcomes of practice (Halkier et al, 2011), which, by effect, is unhelpful when trying to understanding *consumption* as such, as consumption can be seen as a result of a practice that is materialized through the engagement with these objects. Objects, therefore, hold a crucial role in practice in consumption studies. In this respect, Gram-Hanssen (2011) elaborates the interplay of images, skills and material into four dimensions particularly for understanding energy consumption: 1) Practical understandings/know-how/embodied habits; 2) Institutionalized knowledge/explicit rules/language; 3) Engagement/meanings; and 4) Products/things/technologies.
Practical understandings, embodied habits and know-how are closely related to how Reckwitz (2002) denotes the role of individuals, namely as *carriers* of practice. By performing in a certain way, people respond to patterns that constitute and sustain a certain practice. Gram-Hanssen notes that the element of knowledge, rules and/or language is dealt with differently by different authors of social practice, but for the purpose of understanding energy consumption in terms of practice, Gram-Hanssen puts emphasis on technical knowledge and cultural myths in procedures and discourses. Engagements or meanings are dealt with in the same way in Gram-Hanssen (2011) as in Warde (2005) and Shove and Pantzar (2005) – practitioners are engaged in practice, and meaning accumulates through their actions (Gram-Hanssen, 2011).

3.3. Connections and intersections between practices

Practices are either loosely or tightly connected to other practices – and thereby form a system of practices. If a practice is loosely connected to other practices based on co-location or co-existence, these practices can be characterized as *bundles* of practices, whereas tightly connected practices – practices that to some extent presuppose each other – are characterized as *complexes* of practices. Complexes of practices represent more integrated arrangements in which practices co-depend on each other through certain forms of sequence and synchronization (Shove et al 2012). Practices such as showering and laundering may be characterized as practices that are part of the same complex of practices, as meanings connected to cleanliness are a strong element in both practices. Wearing ‘clean’ clothes presupposes that you are ‘clean’ yourself, and these practices therefore need to be conducted sequentially accordingly. Daily rhythms that are a crucial aspect of organizing a household are maintained by but also reproduce these systems of practices. There is thus a certain momentum connected to these systems of practices that reproduce and maintain existing ways of doing certain things. As McMeekein and Southerton (2012) state it, “the ‘elements’ that coordinate practices as entities, whether historically entrenched conventions, socio-technical infrastructures, temporal organization and so on, present forms of path dependency that reproduce existing ways of doing” (McMeekin and Southerton, 2012, p. 352). As lighting is involved in various household-related practices, intersections between practices are important for understanding what lighting ‘is’.

3.4. Changing practices?

Dealing with the need for reducing energy consumption that is a result of maintenance and reproduction of various bundles as well as complexes of practices thus make it especially important to bring practices to the fore of the study. Energy consumption from laundering and showering is inevitable connected to integration between material, meanings and competence; When showering and laundering often due to meanings related to cleanliness and comfort maintain a certain level of energy consumption due to heating of water, producing and maintaining the products involved in these practices etc. Therefore, in order to account for change, recent contributions within social practice theories (Shove et al, 2012) emphasize that

practices – as entities and performances – have to be *configured*. The links made between materials, meanings and competences are in this sense crucial. Viewing people as carriers of practices thus becomes important, as well as distinguishing between practice-as entity and practice-as-performance, as this distinction allows us to show how novel combinations of the three elements are enacted and produced (Shove et al, 2012). However, novel combinations of the elements do not just appear. Links have to be made, and the new combinations of elements have to be performed and become entrenched in society as a 'normal thing to do'. How can carriers be recruited to perform and maintain energy efficient practices, thus reducing energy-intensive practices? In order to approach this, one needs to assume that the practices in question are momentarily stable, with the purpose of describing who is actually or potentially a carrier of the practice (Shove et al, 2012). People are inherently part of the practices they are recruited to or have defected from, and regarding carriers and practices as being in a mutual relationship makes it possible to talk about the social relations in which people and practices reproduce or transform each other (Lave and Wenger, 1991). According to Shove et al (2012), innovation in practices is often explained by emphasizing the significance of networks and communities. A certain practice can be established and spread by means of 'social contagion', moving between people who already know each other and share interests and experiences (Shove and Pantzar, 2005). Although this does not explain why certain practices such as showering are performed and maintained in a certain, slightly innovative, way through generations, nor how practices become so embedded that carriers may be required to adopt them (for instance wearing a seatbelt while driving; Shove et al, 2012), it is a helpful starting point in terms of approaching *why* certain new things happen, and may explain some of the dynamics behind it. Communities of practice often define locally distributed systems of social interaction, where community and practices constitute each other (Wenger, 1999) through social learning. It also fits well with Nicolini's (2012) suggestion of zooming in on the local accomplishments of practices as an aspect of understanding the more embedded and entangled dynamics behind systems of certain practices.

According to Wenger (2000), a framework for understanding social learning is essential to understand learning as a social process. Wenger (2000) defines learning in terms of social competence and personal experience, as well as three modes of belonging, through which we participate in social leaning systems. Social learning systems and modes of belonging can be anything from global to local interactions, and it is the latter that could be interesting to follow up on in terms of zooming in on local accomplishments. Global interactions may then be uncovered when zooming out on practices to understand their workings through time and space. According to Wenger (2000), the following three modes of belonging are essential for a community of practice to work: 1) engagement in terms of doing things together, talking and helping out; 2) imagination in terms of constructing an image of oneself and the community ones belong to; and 3) alignment in terms of making sure that local activities are sufficiently aligned with processes so that they can be effective beyond one's own engagement. Warde (2005) notes that "empirical evidence indicates differences between groups of people with regard to their understandings of a practice, the procedures they adopt and the values to which they aspire (…) It is worth considering that the three components (…) understandings, procedures and engagements may vary independently of one another between groups of participants" (Warde, 2005, p. 139). It may be possible to understand and further pin down some of the differences that can occur in the connections made between elements of practices across locally situated groups of people, by applying Wenger's (2000) framework of social learning to the practice approach.

This framework for understanding and empirically approaching practices, elements of practices and potential change in and across practices, potentially through means of social learning, provides an approach to understanding some of the dynamics behind how lighting is deployed and used, and in what way lighting patterns may become more energy efficient.

3.5. Lighting and practices?

Adopting the idea of a practice being something that is recognizable as an entity and performed accordingly is useful in approaching lighting as a socially constituted phenomenon that is not just a matter of energy and technological optimization. It is however not straightforward to discover exactly how to embrace and study lighting through a practice approach. As the practice approach inherently takes its point of departure in the practice as the object of study, it becomes important to carefully exercise how to *treat* light. It is questionable whether lighting can be seen as a practice in itself; yet lighting can be seen as a technological system providing a service to which people relate (Shove, 2012). Thus 'service' consumption can only be understood in relation to the social practices of which it is part. This corresponds very well to Bladh and Krantz's (2008) findings in their empirical study of residential lighting. As lighting supports or serves various activities in the home, it is therefore difficult to treat it purely as a material element connected to one practice, such as the shower cubicle would be to the more or less unambiguous showering practice. However, light could be seen as a shared material element that may 'vary' from practice to practice. Just as Shove and Hand (2007) follow the freezer as a material element shared between various freezing practices that, as opposed to the more or less established showering practice, appear to be manifold with completely different intentions and aims, it makes sense to follow lighting as a shared element between various household-related practices too. In the following, the methodological approach I have chosen to uncover lighting's role in household-related practices will be presented.

4. Methodological approach for zooming in on practices related to lighting

As part of Nicolini's (2012) toolkit for zooming in on local accomplishments of practice as a first step to understand and explain certain actions (and related consumption patterns), Nicolini suggests seeking inspiration in ethnographic approaches. Nicolini suggests following the practice-carrier, uncovering elements of practice that way. This of course presupposes that the practice in question is regarded, at least momentarily, as stable, which is also required when determining potentials for change (Shove et al, 2012). Given our concern with understanding the role lighting plays in a household practice in order to understand the underlying energy consumption patterns, following the practice-carrier of household-related practices seems to be a legitimate starting point. Not presupposing *what* role lighting plays for the various activities or practices played out in the household, it becomes important to uncover the elements of practice in each household-related practice that appears relevant. As practice can be viewed as a temporally unfolding and spatially dispersed nexus of doings and sayings (Schatzki 1996, Warde 2005), investigating the performance of the *doings and sayings* through which practice is realized and sustained therefore becomes important.

4.1. The ethnographic interview

Acknowledging that it is difficult to be explicit about something that is regarded as a 'normal order of things' (Nicolini, 2012), it is appropriate to cast a glance at ethnographic approaches that essentially deal with uncovering cultures that are mundane to the people observed, but new to the observer. It is equally

important to remember that since practices are about a normal order of things, carriers of practices – that is, people – are indeed brilliant informants of practice.

Spradley (1979) offers a way to make ethnographic descriptions through interviews and observation through his framework of 'the ethnographic interview'. The ethnographic interview is an ethnographic method for understanding cultural aspects and Spradley describes the typical definition of culture as behaviour patterns associated with particular groups of people – a people's 'way of life'. This can of course be defined, interpreted and described from more than one perspective; ethnography is just one, but it takes the 'natives' perspective. Ethnography is thus not just about studying people; it is about learning from people (Spradley, 1979). Spradley goes on to refer to culture as "the acquired knowledge that people use to interpret experience and generate social behaviour" (Spradley 1979, p. 5). This approach fits well with the practice approach. As studying practices to a large extent means studying *how* people perform and maintain the practices, it is useful to take on the underlying idea of an ethnographic study, namely to *learn from* people. As people everywhere learn their culture by observing other people, listening to them and then making inferences (Spradley, 1979), the ethnographer needs to employ the same process of going beyond what is seen and heard to infer what people know. Ethnographers make inferences from three sources: what people say, the way people act, and the artefacts people use (Spradley, 1979). This fits very well with exploring practices connected to consumption as people live their lives and do certain things involving artefacts, such as lighting. Learning from people in terms of listening to what they say and how they act in relation to the artefact in question is therefore essential, and the ethnographic interviews thus can help us to do this. The ethnographic interview is a qualitative research interview process which can be utilized in many different ways and for different purposes (King, 1994). King (1994) suggests that the qualitative interview is appropriate if the researcher is interested in *meaning* and where *individual historical accounts are required for how a particular phenomenon developed*. Kvale (1996) defines the qualitative interview as an interview whose purpose is to gather descriptions of the *life-world of the interviewee* with respect to the *interpretation* of the meaning of the described phenomena. In order to understand how people use and relate to lighting in a residential setting, these considerations can help set up an appropriate framework. Learning from people and about their way of life with certain material artefacts can come about through the historical accounts that the practice-carrier presents. However, *sayings* and meanings related to the phenomenon in question – in this case, lighting – are not enough. The embodied, untold and implicit aspects of practice need to be uncovered as well, in order to determine the dynamics and relations between all elements of practice. Spradley (1979) offers help in this relation as he proposes a guide for how to conduct an ethnographic interview, introducing a list of *ethnographic elements* (hereunder the *ethnographic questions*) that may help the interviewer learn from the interviewee through uncovering both sayings and particular doings.

Spradley (1979) does however, through his account of the ethnographic interview, essentially stress that the researcher should stay completely ignorant of the topic he/she is exploring, and that the information of a 'culture' can only be gathered and analysed if the interviewer has no hypothesis. In this sense Spradley presupposes that knowledge is obtained through induction and dismisses deductive reasoning entirely. He however simultaneously infers that ethnography always implies a theory of culture; that culture exists. As I have already based my research for this thesis on the assumption that the world is constituted of social practices, and consumption thus can be presented and explained as a result of the performance of practices, to some extent I have a presupposed idea of what I wish to investigate. This does potentially

cause problems for applying Spradley's account of the ethnographic interview process. However, as theories of practice can be seen as a development within 'culturalist theorizing' (Reckwitz, 2002), the ethnographic interview approach may nonetheless be an appropriate inspiration for my methodological approach. Further, the idea of staying open to appropriate findings within the frame of the research area is essential for exploring practices.

4.1.1 Ethnographic questions

In order to get knowledge about practices through the life-worlds and historical accounts of the practice-carriers, it is important to get an idea of how the practice-carrier (the interviewee) talks about the activities in question. What Spradley calls 'Descriptive Questions' can help the interviewer to uncover an interviewee's 'language' – what he or she chooses to express, and in what way. The interviewer can enable this by asking the interviewee to talk freely about a certain activity. If the interviewee finds it difficult to do that, the interviewer can ask Grand Tour questions or Mini Tour questions, essentially meaning that the interviewee can give the interviewer a 'tour' of the way he or she performs certain activities. They can be more or less specifically oriented, hence the terms 'Grand Tour' or 'Mini Tour'. The interviewer can then ask more specific questions about the different activities through 'Structural Questions'. These kinds of questions allow the interviewer to get insight into how the interviewee is organizing his or her knowledge. While the descriptive questions can help the interviewer to understand how the practices are described and how they are 'laid out', the structural questions are useful when trying to specifically identify elements of competence. Lastly, Contrast Questions can be used to identify what the practice-carrier means, without directly asking for meaning. When asking contrast questions, the interviewer instead tries to uncover what the activities that the interviewee talks about *do not imply*, so that the interviewer can get an idea of what is *not* part of the practice.

4.1.2 The interview guide

Based on the categorization of questions presented above, a number of questions should be prepared prior to the interview as part of a semi-structured interview guide (Spradley 1979, Kvale 1996). The semi-structured interview guide helps the interviewer stay on track during the interview session, as the interview is conducted to uncover *certain* things, acknowledging that the interview has to be *led* by the interviewee.

In uncovering and unfolding practice in which lighting plays a role, it is useful to treat the *lighting products and systems* in the home as the material element of practices. Asking descriptive, structural and contrast questions according to the lighting layout of the home therefore seems appropriate. I therefore chose to build my semi-structured interview guide around a number of descriptive questions about the interviewees' general use of lighting (Grand Tour questions), followed by a number of mini-tours around every lamp or lighting arrangement in the interviewee's home. During the mini-tours I asked a number of structural questions as well as contrast questions, to pin down the specific competences and meanings related to every lighting arrangement. *Touring the lighting arrangements* while picking out competence and meanings related to the lighting arrangement in question makes it possible to open up a space for the embodied aspects of practice; when the interview is conducted 'at the scene', the interviewee is 'reminded' of the actual actions related to turning lights off and on, when light is used, why and for what *occasions*. What are actually rather embodied and taken-for-granted activities become more tangible for the practice-carrier when the practice-carrier is able to perform some of the activities while talking about them. Touring the house with the interviewee thus makes the performative role of the material visible (Nicolini, 2012).

An example of one of the original Danish interview guides, as well as the translated version, can be seen in appendix 2.

4.2. Local accomplishments through case studies

In order to understand local accomplishments of practices involving lighting, I chose to conduct ethnographic interviews in two different local, Danish settings. Choosing two household settings would allow me to explore the following significant aspects, namely:

1. If practices involving lighting can be identified across the settings and thereby represent aspects of practice-as-entities through *shared* and taken-for-granted *understandings* of how to perform these practices.
2. What the performance of practices involving lighting means for energy consumption, and whether any differences in *local* performance may matter in terms of the related energy consumption.

To particularly exemplify the second aspect, I chose to conduct interviews in two different settings: interviews with eight households within a low-energy house setting in a Danish municipality (Stenløse Syd), and interviews with eight households within an ecologically oriented co-housing community called Munksøgaard in another Danish municipality (Roskilde).

4.2.1. The cases and the interviewees names – ethical considerations

The interviewees are presented in tables 1 and 2 below. The names provided for the interviewees from Stenløse Syd are fictional, as that were the agreement between the project manager and the interviewees (for clarification, please see section 4.2.2.). The names provided for the interviewees from Munksøgaard are their real first names. Before conducting the interviews, I asked if the interviewees wanted full privacy, but none of them required it, as they said that the topics I asked about were not sensitive. I have therefore chosen to state their first names, as some of the interviewed residents are also mentioned in newspapers in relation to the lighting showroom, that some of them has participated in developing. Giving them entirely different names, would then be confusing for readers knowing of the newspaper articles. I have however not provided surnames, to provide the informants a minimum level of privacy.

Low Energy Households (Stenløse Syd)		
Name of main interviewee	**Number of residents**	**Type of residency**
Mathias	2 adults and 3 children	Owner-occupied, one family house
Kenneth	2 adults and 2 children	Owner-occupied, one family house
Morten	2 adults and 2 children	Owner-occupied one family house
Louise	2 adults and 3 children	Owner-occupied one family house
Tim	2 adults and 2 children	Owner-occupied, one family house
Leanne	1 adult	Rental apartment

Laura	1 adult and 2 children	Rental apartment
Mona and Peter	2 adults and 2 children	Owner-occupied, one family house.

Table 1: Overview of interviews with residents in low energy households in Stenløse Syd

Ecological Community Households (Munksøgaard)		
Name of main interviewee	**Number of residents**	**Type of residency**
Mick and Trine	2 adults and 1 child	Rental apartment
Bolette	1 adult	Rental apartment
Anna	2 adults and 2 children	Owner-occupied terraced house
Lotte	2 adults and 2 children	Owner-occupied terraced house
Niels	1 adult	Owner-occupied terraced house
Claus	1 adult and 3 children (part time)	Owner-occupied terraced house
Tina	2 adults and 2 children	Owner-occupied terraced house
Ina	1 adult and 1 child (part time)	Cooporative terraced hose

Table 2: Overview of interviews with residents in ecological community Munksøgaard

The reason for exploring how light is used in *low-energy houses* is that residents in this kind of household may presumably be able to relate to and talk about energy consumption, as the energy consumption is made 'visible' through various meters and information schemes. For instance, the households have smart meters installed that can give an overview of energy consumption (also called 'housekeepers').[4] From a policy point of view, these residents would be considered a target group that presumably 'understands' and 'chooses' energy efficiency. Therefore this case comprises a *critical case study* (Yin, 2009).
However, none of the residents chose to live in the area due to the low-energy aspect, and as the interviews showed, only a few of them seemed to be more 'aware' of their daily electricity use, in spite of the smart meters. Therefore it may equally be argued that some of the patterns uncovered in this study may apply to more 'conventional' households as well, which in this way in parallel feeds into a discussion of how general Danish households interact and live with lighting. This actually gives the case a twofold purpose, as it questions policy-makers' emphasis on information and awareness by providing insight into how 'conventional' lighting patterns unfold, in spite of an 'unconventional' building envelope.

The reason for exploring how light is used in an ecologically oriented co-housing community was, as mentioned, to see whether some of the same aspects of practices involving lighting could be found across

[4] The issues of making energy visible will not be further developed in this paper, but are discussed in Hargreaves et al (2010).

the two cases, but also to explore whether a *co-housing* set up with broader focus on energy efficiency *as well as* social responsibility and environment would facilitate less energy-intensive lighting patterns, and how practices involved with these patterns might interact with the shaping of these patterns. As the ecologically oriented co-housing community explored is a result of a project establishing a community focused on social functions, environmental considerations and local management (Munksøgård homepage, 2013), the background and reasoning of the scheme is thus wider than the background of the low-energy house case, where complying with building regulations for low-energy houses was the main focus. Therefore the intention in exploring household-related practices involving lighting across these settings is not only to explore the potential similarities and differences between elements of practices performed across the cases, but also to explore how and whether adjacent practices influence each other, perhaps helped by *sharing* conventions and meanings in a local context through social learning (Wenger 1999).

4.2.2. Getting to the informants

The interviews conducted in Stenløse Syd was made possible as I became part of an ongoing research study exploring residential heating-related practices. The interviews therefore explored heating-related as well as lighting-related practices and the residents were already enrolled in the study, making interview access easy. The interviews in Munksøgaard were acquired a bit differently, as I had to find a way to gain access to the residents and ask them to participate in my research. I initiated my inquiry by emailing a spokesperson from Munksøgaard who normally establishes guided tours at the premises. I was invited to visit their café and put up flyers advertising my project. While there, I got in contact with two residents who had been involved in setting up a lighting showroom in the local shop (please see paper 2 for details on this). Through one of the initiators – Claus, who is listed in table 2 – I was invited to a communal dinner at Munksøgaard the following week. The residents involved in the interview processes were consequently enrolled partly through my advertising at the local café and partly through personal request at the communal dinner. Prior to the interview, all residents involved in the study knew that the interview would be carried out at their home and that it would be about (include) topics related to their lighting at home and the way they use light.

5. Results and discussion of zooming in on local accomplishments of practice related to lighting

Each of the residential case studies has produced some interesting results in relation to the way people use light, and how lighting engages with various practices. In the following, a short presentation and discussion of each study is given. These constitute the basis for paper 1 and paper 2 respectively.

5.1. Presentation and discussion of the paper 1 on lighting throuhg a social practice perspective and policy implications

Paper 1, entitled 'What does it require to understand energy-related consumption patterns? An example of residential lighting and related energy consumption', explores the ways the interviewed households in Stenløse Syd use and relate to lighting, through the practices theoretical framework presented above. In treating light as a material aspect of various practices, the paper concludes that light means something in relation to the activity it is meant for, and bears little meaning as a product in itself. Table 3 summarizes the ways in which the residents talk about, use and relate to various kinds of light in relation to certain household activities. The paper suggests that the logic of energy efficiency as internalized by policy-makers

has to intersect with everyday, inconspicuous activities in which energy is used for people to be able to 'internalize' energy efficiency accordingly. In fact, the paper concludes by suggesting that the EU Commission's efforts in terms of obtaining a reduction in energy consumption from lighting through substituting lighting products may on the contrary have resulted in alternate lighting patterns that may not be as energy efficient as intended. The halogen spot used as part of the steps towards developing more efficient lighting products has resulted in lighting patterns that are based on a relatively large number of spots in ceilings and kitchen furniture, which easily equals or exceeds energy consumption from previous lighting patterns based on lamps with the now banned incandescent light bulb. The equal or increased energy consumption from the use of halogen spots is therefore not just a matter of rebound effects often occurring when an energy efficient version of a product becomes available. It is just as much a matter of new ways of using the product – light – that depend on the technological possibilities, the competences and skills that develop and the meanings associated with the product. The halogen spot provides entirely new ways of utilizing light in the home, due to its design. Further, the halogen spot offers the same warm and brilliant light that the incandescent light offers, whereas the energy efficient compact fluorescent offers colder and duller light. Generally the residents associates this kind of light with light of low quality, suggesting that the 'most efficient alternative' is regarded as least attractive, inherently complicating the concept of 'the rational actor' that to a large extent still influences much policy making (Macnagthen and Urry, 1998).

In spite of this being a relatively small-scale case study, the lighting patterns and ways of living with light identified in the paper correspond well to other studies of Nordic and Scandinavian lighting patterns, such as those proposed by Wilhite et al (1996). Further, in considering the Stenløse Syd case as a critical case study in terms of the explicit energy usage embedded in the development of the Stenløse Syd area, the case study strongly implies that energy is not a main consideration in terms of choosing and using light.

The analysis in the paper therefore offers the possibility to suggest that there are aspects of residential lighting not included in current policy making related to lighting, which potentially should be considered in order to obtain energy efficient consumption of light. It also suggests that practices and activities in which light is engaged should be included in policy considerations. This is an interesting discussion in terms of the development of LED light, as the LED technology indeed bears the possibility of *designing* light and spectral distributions to match user requests that have not been an option with any previous existing lighting technologies. However, designing for certain usages is one thing; how to obtain *overall* energy efficient lighting patterns is another. In order to look into this, more research is needed in terms of what actually makes people use energy efficient light. Paper 2 offers one explanation for this, which is presented and discussed in the next section.

5.2. Presentation and discussion of paper 2 on sharing conventions for energy efficient lighting solutions

Paper 2, entitled 'Sharing conventions for energy efficient lighting?', explores similarities and differences in the way residential light is used in Munksøgaard; a residential setting that, as mentioned in the methodology section, is different from the residential setting in Stenløse Syd. This case study has two purposes: the intention behind it was both to explore whether any similarities could be found across the case studies and thereby support the findings in paper 1, as well as to explore whether the social dimension of living in an ecologically oriented household community would influence the way people use light.

Therefore the paper initially introduces the findings from Stenløse Syd, in order to provide a comparison. Interestingly, 1) the ways in which lighting is distributed in the home, 2) the associations made between lighting and the activities it is used for and 3) how appropriate light is described bear much resemblance to the findings in paper 1. However, what is even more interesting is that these lighting patterns are carried out in utilizing a much higher number of energy efficient lighting products, such as compact fluorescent light (CFL) and LEDs. Further, where CFL and LED are deemed low-quality light in Stenløse Syd, they are deemed high-quality light in Munksøgaard. Additionally, where CFLs and LEDs are often talked about as cold light in Stenløse Syd, they are referred to as warm light in Munksøgaard. There are two further interesting aspects related to the high usage of CFLs and LEDs. Firstly, the residents do not reflect much on use of CFLs until asked about them, and even then most of them seem to approach CFL as the 'normal' kind of light. In Stenløse Syd, the normal kind of light was still considered incandescent light. Secondly, exploring LED lights was generally seen as a positive challenge and the residents who had installed a very large amount of LEDs were interested in investigating different kinds and types of LED lights; they had tried out different approaches in terms of incorporating LED lights in existing systems, such as spotlight systems that would normally involve halogen spots. In the time during which the case study was conducted it was not always possible to substitute a halogen spot with an LED spot due to a lack of compatibility with the corresponding transformers. Therefore, the residents would often need to keep on halogen spot in the system in order to maintain the electricity flow needed. For further clarification, please see paper 2. In Stenløse Syd, LEDs were mostly regarded as a nuisance and as something that would require a lot of effort first to identify, and not least to then install.

In generally having the same kinds of lighting *layouts*, including the utilization of spot lighting, the differences in lighting *patterns* suggest that different meanings and different competences are required in order to successfully include different kinds of light, such as CFL and LED in the same household-related practices involving the use of light, where the incandescent light would be considered 'normal'. My suggested similarities and differences within each element of practice are summarized in table 3.

Elements of dwelling practices	**Stenløse Syd Households**	**Munksøgård Households**
Material: product/technology	Incandescent light bulbs, halogen spots, few CFLs – large amounts of halogen spots are installed, and many, small lamps are distributed around the house, mostly in corners of the rooms. Ceiling lights are considered functional light that is used when there is a need for a lot of light, to see details or to find things.	CFLs, LEDs and halogen spots. The layout of having a number of spots in kitchen and bathroom is repeated in this case, however a number of LEDs have been installed instead of halogen spots. Small lamps in various corners are also present, as well as the ceiling light being viewed as functional light. So many of the same 'structures'/layouts seem to be reproduced in the Munksøgård case, however the products deployed differ.
Skills: a) institutionalized knowledge/language + b) embodied habits and know-how	The incandescent light bulb is referred to as 'normal' light. Terms such as warm, cold, ugly and unpleasant are used, and only few refers to technical terms such as colour temperature, wattage etc. Turning lights on and off is to some extent associated with creating the right mood in	CFL is referred to as the 'normal' light. Terms such as warm and cold, pleasant and unpleasant are also used in this case, however the cold light that some CFLs emit is not regarded as unpleasant. Unpleasant light is only referred to

	the areas of the house. Less associated with saving energy. The residents generally discuss what kind of light they prefer, as well as the amount of light they think they need in terms of activities. For instance, dimmed light is associated with cosiness, which would be needed for dining and entertaining guests, where as bright light would be needed for working (such as studying or cooking). These aspects seem unquestioned across the households, and are referred to in more or less the same manner. Few of the residents are able to clearly differentiate between the various lighting technologies, and most of the residents have in general had bad experiences with LEDs mostly in terms of what they refer to as the colour and quality of the light. Most, if not all, of the residents seem to have more or less rejected the LED as an alternative.	as ceiling light without any smaller lamps to support it. Technical terms are expressed and used to a larger extent than in Stenløse Syd. Turning lights on and off seem to be a bit more associated with saving energy, however using light and no light in order to create a certain mood in the room seems to be of importance as well. Light is in general explained in relation to relevant dwelling activities. In spite of many of the residents having had bad or unsuccessful experiences with LEDs they have far from rejected the technology.
Meanings/engagements	Light is used to facilitate different forms of homeliness, connected to activities in the home (cooking, reading, dining, bathroom activities etc). Incandescent light is associated with 'warm' and 'comfortable' light, whereas light from CFLs and LEDs is generally associated with 'cold' and 'unpleasant' light. Halogen spots and bulbs are preferred as substitution for incandescent bulbs, and a number of spots are deployed mostly in the kitchen and bathroom, which has entailed new and more ambient lighting patterns in these rooms in particular in relation to previous constellations. Energy efficiency in terms of lighting is primarily viewed as a sacrifice on quality, or something one would have to 'go the extra mile' to get.	Light is used to facilitate forms of homeliness and is associated with activities in the home as well. However, incandescent light is not associated with the appropriate light source to facilitate this, whereas many of the residents in fact refer to the CFL as being a cosy, yellowish light (compared to LED light). The halogen spot is in general referred to as a somewhat energy intensive technology, in opposition to how it is generally referred to in Stenløse Syd. The tendency to install spots and thereby obtain an ambient lighting pattern in kitchen and bathroom seems unquestioned in Munksøgård as well. Energy efficiency generally seems to be treated as something 'one would of course try to pursue'. For instance CFLs are treated as the light source, and not necessarily referred to as energy saving, implying that energy saving is more implicitly integrated in the Munksøgård lighting patterns.

Table 3 Overview of similarities and differences in the role lighting plays in practices, across the residential cases. This table is also provided in paper 2.

The differences in meanings and competences seem to be facilitated and developed through the sort of engagement with environmental issues that one arguably will possess when wanting to live in an ecologically oriented community, and which indeed is identified across the interviews. However, none of the residents considered themselves environmental fanatics, and it seems to be just as much the social aspects of living together and generally sharing things and experiences that facilitate the relatively different

competences that seem to be at play in Munksøgaard in terms of finding ways of utilizing energy efficient light such as LED. As the paper discusses, the residents share experiences with lighting at the same level that they share experiences with other things related to daily life at Munksøgaard. Therefore the paper concludes that elements of social learning may indeed be a way to reconfigure practices. This does however also imply that social learning needs to be facilitated, and in terms of obtaining energy efficient light and lighting patterns, it may arguably be appropriate to facilitate local initiatives or forums for social learning in terms of 'appropriate lighting' that may also inform the development process of appropriate energy efficient light so that it in fact internalizes the practices with which lighting engages.

PART 2: ZOOMING *OUT* ON LIGHTING AND PRACTICES

Throughout Part 1, exploring local accomplishments of practices involving lighting has led to an understanding of the role that lighting plays in a household setting. As described, the case studies imply that even in settings where energy and environment play a more visible role than in 'conventional' households, energy is not the most important aspect of lighting. Although there are differences in the way 'good lighting' is defined across the cases, several general traits are found. For instance, there is a general tendency to connect cosiness with lighting, which corresponds well with the findings of Wilhite et al (1996). Further, the layout of the light – the way the lamps are positioned, and what lights will be turned on for what reasons and occasions – is more or less the same across the cases. There also seems to be a general agreement of what bad light is, namely cold and glary light that is positioned in the middle of the room – which for other cultures is the preferred kind of light (Wilhite et al, 1996). These traits can be said to comprise a certain *lighting pattern* that seems common for Danish households.

It is therefore interesting to explore these tendencies to a greater extent. How have these lighting patterns developed? And what do they imply for current changes in the lighting industry and lighting market, which are starting to provide significantly different lighting technologies, such as LED, that potentially require and acquire relatively different lighting patterns?

Following Nicolini's (2012) tool kit, it is thus appropriate to start 'zooming out'. Zooming out means looking at how local activity is affected by other practices; how other practices are affected, constrained or enabled by the practice under consideration; and what the material consequences are of such relationships.

In order to zoom out, Nicolini (2012) suggests the following palette of considerations:

- What are the connections between the 'here and now' of the practising and the 'then and there' of other practices?
- How do the practices under consideration contribute to the 'wider picture'?
- How did we get to where we are?

This palette corresponds well to McMeekin and Southerton's (2012) claim that the performance of practices is path dependent whether by historically entrenched conventions, socio-technical infrastructures or temporal organization. We need to look at the performance of practices as *situated between other practices that form a socio-technical infrastructure (network) that is a result of the accumulative performance of practices that are historically contingent.* Uncovering connections between practices can be done by exploring how practices are materially linked to each other (Nicolini, 2012).

By zooming in on local accomplishments of *several* practices involving lighting, I have to some extent already started this process. It does, however, make sense to go even further to look at how household-related practices that involve the use of light are connected with other kinds of practices that involve the use of lighting, and how these connections have been formed over time, together forming a socio-technical network or 'diagram', as it is termed by Akrich et al (2002). Part 2 of this thesis therefore presents socio-

technical analyses of the historical and contemporary developments within lighting, and focuses on how these findings can be utilized in the current socio-technical diagram of lighting. Finaly, a presentation of a workshop I have conducted based on my findings from Part 1 as well as Part 2 will be given.

The following theoretical chapter hence aims to open up a discussion not only on what the *current* 'socio-technical diagram' looks like in the case of residential lighting, but also on how this current 'diagram' has been shaped and developed historically.

6. Theoretical approach for zooming out on practices related to lighting

In zooming out, Nicolini (2012) suggests looking at references to the sociology of translation and actor network theory (ANT) (e.g. Callon 1986, Ackrick et al 2002). Although ANT authors *cannot* be considered practice theorists, Nicolini points out that they have developed a set of methodological recommendations that may be taken into consideration profitably when exploring practices and their spatiotemporal distributions, as well as displacements in performances of practices. Nicolini argues that this can be explored by "following the actors, tracing analytically the work that goes into making *associations* come about, and observing the effect produced by the ensuing socio-technical arrangement" (Nicolini, 2012, p. 230, emphasis added). In pursuing that, looking towards the sociology of translation and the notion of 'interessement processes' (Callon, 1986) is interesting to call on when trying to understand the current changes in (electrical) lighting and how they come about as a *process and result* of a particular development of an actor network. It is clear that residents – as carriers of practices – relate to lighting through a number of certain things that explicitly or implicitly influence how they choose and why they prefer lighting arrangements. It is therefore interesting to look further into *how* new kinds of lighting, such as LEDs, are aimed to be implemented through various (strategic) processes.

The notion of interessement processes suggests looking into

1. in *which* ways
2. *who and what* seek to make the LED *an intelligible solution to the problem: lighting is a problem in terms of energy consumption,*

and whether it actually is the energy consumption issues that are used to define the *LED as an intelligible lighting solution*.

Essential to the notion of interessement is that *if the LED is to become a successful lighting innovation, it needs to be intelligible to the environment it is intended for* (Akrich et al, 2002). As identified in Part 1, lighting carries a certain role in the practice it is involved in, and for LED to be a successful technology as a lighting product, it too needs to make sense for the practices it is to engage with. Alternatively, the LED as a material element needs to connect with certain/other elements of meanings and competences and in that way develop new intelligible lighting-related practices. In either way, the LED needs to find *allies* (Akrich et al, 2001) in order to become a 'configuration that works' (Rip and Kemp, 1998).

In order to understand what an intelligible residential lighting solution may be and why this is so, it is equally important to understand how residential lighting-related practices have come about and what that means for current interessement processes. In this way it is possible to discuss *whether and why*

associations are made between household-related practices that involve the use of light and notions of 'energy efficient' light. Therefore the following two sections will present a theoretical framework for describing current processes of the socio-technical lighting diagram, as well as the historic processes that have shaped the current 'diagram'.

6.1. Practices and associations (not) made about 'good and energy efficient lighting' through processes of translation

In taking point of departure in a practice approach as well as drawing upon the sociology of translation, it is essential to stress that good and energy efficient lighting needs to be *made*. In this view, good and efficient lighting does not exist as something detached from a dynamic actor network or performance practices that involve the use of light, but as a result of these processes and the performance and maintenance of them. It is thus important to look into *how associations* of good and energy efficient lighting are made, *whether* they are made, and if not, why this is so. Following how actors interweave associations also helps us to understand how practices are connected in time and space (Nicolini, 2012). Practices involving lighting are in other words intelligible due to the production and maintenance of the associations that tie them together in one way or another. These associations are kept (and potentially made) through mediators such as discursive practices, plans, rules and spaces (Nicolini, 2012), which I will come back to in the following sections.

6.1.1. Sociology of translation

According to Callon, understanding the sociology of 'translation' is to follow all actors that are involved in a certain 'controversy' and *"to identify the manner in which these [the actors] define and associate the different elements by which they build and explain their world, whether it be social or natural"* (Callon, 1986, p. 4). It is important to acknowledge that the *"simultaneous production of knowledge and construction of a network of social and natural entities mutually control who they are and what they want"* (Callon, 1986, p. 6). This argument suggests that the social as well as the material evokes agency and therefore they mutually shape the socio-technical configuration in question. Taking point of departure in these ground rules, it is important to stress that all actors who are involved in the process of obtaining energy efficient lighting systems go through a process of negotiating and delimiting what the problem is and how it needs to be solved, which implies that no actor or network between these actors can be regarded as an unambiguously fixed entity that knows exactly 'where to go' and what role, for instance, the LED has in this process.

In order to explore the dynamics of an actor network related to a given controversy, Callon proposes four moments of translation that are inherent to the process of making associations:

1. Problematization
2. Interessement
3. Enrolment
4. Mobilization

These moments "constitute the different phases (…) during which the identity of actors, the possibility of interaction and the margins of manoeuvre are negotiated and delimited" (Callon, 1986, p. 6). Thus, in order to understand what currently happens in the 'socio-technical diagram' (Akrich et al, 2002) of lighting, identifying processes comprised of these moments is essential.

6.1.1.1. Problematization

Problematization happens when a solution to a certain problem is sought through certain sets of questions that for some reason seem intelligible for solving the problem. If the questions and the underlying assumptions behind the questions are *uncontested* as a suitable way to approach the problem, relevant actors are already at this stage determined and defined and the assumptions become an obligatory passage point in the network of relationships that emerges (Callon, 1986). In terms of exploring the changing 'socio-technical diagram' of lighting, it is therefore important to investigate what the problem is deemed to be (e.g. energy consumption) and what is a reasonable way of approaching the problem (e.g. energy efficient light). This suggests that problematization processes only happen when certain criteria are already imposed on what needs to happen with lighting. For instance, current changes within the socio-technical diagram of lighting seem primarily to be initiated through EU initiatives built on the underlying assumption that it is important to reduce energy consumption from lighting, and that this can be done by making lighting products more efficient (EU 2005, EU 2011, EC 2012, Bertoldi and Atanasiu 2006). Further, it seems that LED has come to play an essential role in this process, and that the LED in this approach is expected to solve the problems (e.g. EU 2011, EU 2013).

6.1.1.2. Interessement

According to Callon, processes of problematization are sought to be legitimized through processes of interessement. Interessement "is the group of actions by which an entity (…) attempts to impose and stabilize the identity of the other actors it defines through its problematization. Different devices are used to implement these actions" (Callon, 1986, p. 8). In the case of lighting, the EU lighting policies are instrumental for the interessement processes that the EU develops. It is through the configuration of policies that the EU Commission defines and stabilizes the identity of residents and existing lighting systems in the process of obtaining 'energy efficient light'. This, however, does open up for certain critical issues. Callon states that during the process of interessement, actors "carefully define the identity, the goals or the inclinations of their allies. But these allies are tentatively implicated in the problematizations of other actors. Their identities are consequently defined in other competitive ways. It is in this sense that one should understand interessement. To interest other actors is to build devices which can be placed between them and all other entities who want to define their identities otherwise" (Callon, 1986, p. 9). Consequently, it is important to acknowledge that other kinds of problematization processes may occur, due to other actors experiencing (or defining) obstacle problems with the problematization that is put forward. For instance, as we have seen from Part 1, residents do not define lighting in the same way as seems implied by the EU Commission and delegated researchers (e.g. Bertoldi and Atanasiu 2006, EU 2011). The EU Commission and delegated actors seem engaged in the problematization; 'lighting is too energy consuming, and that can be dealt with by introducing energy efficient lighting products', which is subject to certain 'obstacle problems' (Callon, 1986) such as residents defining lighting in terms of whether it facilitates certain household activities in a 'good' or 'bad' way, and not necessarily as a matter of energy.

One explanation of the apparent clash between what the EU Commission deems to be a suitable strategy for reducing energy consumption from lighting and the role that light plays in a residential setting may be due to an inappropriate definition of *when an innovation is successful*. As Akrich et al (2002) describe, an invention only becomes an innovation when the product/technology in question receives its first positive sanction from the user (Akrich et al, 2002). Therefore an innovation "is perpetually in search of allies" (Akrich et al, 2002, p. 203). These 'allies' are actors who can fix the product/technology when it is broken,

and physical structures that support the intended (and wanted) use of the product etc. Choices made for the product/technology/innovation in question therefore give shape to the device and its socio-technical destiny (Akrich et al, 2002). The assumptions behind these choices are therefore of importance. If a certain product/technology is developed with the model of diffusion in mind, the choices made on behalf of the product may be different than if they are made with the model of interessement in mind. As Akrich et al (2002) explain, "the model of diffusion supposes an irremediable separation between an innovation and its socio-economic environment. On the other hand, the model of interessement emphasises the existence of a bundle of links which unite the object to all of those which handle it" (Akrich et al, 2002, p. 205). The model of diffusion presupposes that the product, by virtue of its own qualities, ends up spreading throughout society through its demonstration (Akrich et al, 2002). Therefore, the model of diffusion can distinguish between technology and its environment, as it is maintained that the product in itself holds the necessary qualities. Often these qualities presuppose that efficiency, profitability and productivity are values that will lead to general success. However, this does not explain why certain products and technologies are not successful in spreading out, in spite of being technologically efficient and profitable. The model of interessement presupposes that the innovation is only what it is due to the alliances it makes.

This is interesting in relation to the clash between the efficiency strategy as laid out by the EU Commission and the way people use lighting within the home. It seems that the focus on substitution has put certain development schemes in motion that in fact are based on the model of diffusion, assuming the energy (and economic) efficiency in itself is a quality that to some extent will promote energy efficient lighting, while only to a limited extent including the environment that the energy efficient lighting products are to engage with (existing lamps, lamp layout, emerging lighting patterns (spots), practices involving lighting such as cooking and dining and so on). As the current problematization of lighting, therefore, does seem to be contested, other problematization processes may occur with corresponding interessement processes. In any case, for a certain problematization to be agreed upon, actors need to be 'interested' in the given process of solving the problem and hence *enrolled* in the actions leading to consensus.

6.1.1.3. Enrolment and Mobilization

The enrolment therefore only happens if the interessement device is successful. And the interessement device is only successful if the problematization and the alliance it implies proves valid. Keeping in mind the ontological differences of theories of practice that put practice as a central focus point and ANT that puts actors and emerging networks between them as a central focus point, it seems legitimate to compare the moment of enrolment to the moment of recruitment to a certain practice. A practice as well as an interessement process has to be intelligible in order for actors or practice carriers to accept it. Consequently, mobilization only happens if the process of enrolment is successful. And since enrolment means disrupting certain associations and creating new ones, mobilization emphasizes the neccessity of displacement (Callon, 1986). In a practice approach this is equal to the process of defecting from certain practices and establishing other practices. However, although the practice approach explains what conditions that need to change, and how the underlying demands for change should be understood, the practice approach is, as mentioned, sometimes criticized for not fully exemplifying how a change/recruitment process happens. Bringing in the ideas behind the sociology of translation may help to explain these kinds of processes, as they approach both the social and the material and their role in certain controversies, and explain how change processes are set in motion through the workings of the actor network, which develops through problematization, interessement, enrolment and mobilization processes.

If the processes of enrolment and thus mobilization do not happen, it means that the underlying assumptions behind the given problematization are contested. Callon calls this a controversy of representivity, when actors do not do what they are 'supposed to'. In this way the obligatory passage point becomes disputed and questioned, and new networks and alliances need to be forged.

In terms of understanding the current developments within the socio-technical diagram of lighting, it is therefore interesting to explore whether any enrolment and mobilization processes are happening, and if not, why this is so. This is helpful in terms of understanding whether the problematization process and corresponding interessement devices are successful or not, which is interesting as well from a practice perspective. If the problematization behind a certain change process is not intelligible, this may be due to the way in which the practices that are subject to the changes are reproduced.

All things considered, borrowing ideas from the sociology of translation when exploring the socio-technical diagram of lighting therefore seems to be a process of uncovering 'where' lighting evolves and due to what kind of action. It is important to understand the devices through which certain interessement processes are sought to be accomplished – is the ontology behind the model of diffusion maintained or are there different processes at hand?

6.1.2. Processes of translation across practices?

Remembering that this research ultimately is based on the assumption that society is constituted of practices, it seems to make sense to go on to exploring how the household-related practices that involve the use of lighting are situated between other kinds of practices involving lighting and the corresponding development of (energy efficient) lighting. This consequently implies exploring also whether *no* associations are made between developments of *energy efficient lighting and household-related practices involving the use of light.* If energy efficient lighting developments are made and intended *for* household-related use, but without any meaningful associations with household-related practices, the changes risk staying immobilized and thereby immaterialized.

So as to understand how associations are made (or not made) between household-related practices and the use of light, it is important to understand what kind of associations have *already* been moulded and established. In order to do so, Nicolini (2012) suggests including historical analysis of the practice(s) in question. The following section therefore presents a theoretical framework for approaching historic dynamics in household-related practices involving the use of light as well as how these historic processes can be discussed in relation to current developments.

6.2. The history of practices related to light - a potential for transition?

As household-related practices involving the use of light are in focus, I have chosen to go on with following lighting as a material element shared by many practices, and how these practices have been shaped by – and equally have shaped – household-related lighting arrangements through history. In order to approach a historical analysis with specific focus on when practices (as spatiotemporally organized socio-technical infrastructures) were developed, routinized and eventually *changed*, it makes sense to apply a framework that captures innovations in the local accomplishments of practices and how these have developed into institutionalized, more or less unquestioned socio-technical systems that support and maintain the performance of practices.

I have thus chosen to discuss and draw upon currently discussed frameworks for socio-technical *transitions*, and in that way discuss the developments of household-related lighting practices.

The following section will thus present and discuss some of the main theories within the field of transition research, and how they can be related to studying changes in the 'socio-technical diagram' for lighting.

6.2.1. Socio-technical transitions towards sustainability

One of the approaches that currently play a predominant role within the field of socio-technical transition studies is the multi-level perspective (MLP) as proposed by Geels. Although it is highly debated and increasingly challenged by other approaches (e.g. Jørgensen, 2012), the middle-range scope of the MLP approach, as well as its structural and institutional focus, has over the years gained popularity and is widely applied and discussed (e.g. Belz 2004, Raven 2004, Næss and Vogel 2012, Kern 2012).

In short, the MLP builds on and combines concepts from evolutionary economics (trajectories, regimes, niches, speciation, path dependency, routines), science and technology studies (sense making, social networks, innovation in the form of social processes shaped by broader societal contexts), structuration theory and neo-institutional theory (rules and institutions int the form of deep structures that actors draw upon; structures are both context and outcomes of actions) (Geels, 2011). The MLP describes society as a nested hierarchy of niches (micro), regimes (meso) and landscape (macro) levels, and transitions are provoked through a so-called exogenous socio-technical landscape putting pressure on the regime level, potentially disrupting the regime level, and thus creating windows of opportunity for the niches to exploit. The linkages between the components that constitute society as a socio-technical system are reproduced by, and through interactions between, several actors in various social groups. The stability of the system varies through the three levels, with the landscape level being the most stable, and the niche level the least stable. Niches are to be regarded as 'incubation rooms' for radical innovations, and they run by other/different 'selection criteria' than the existing regime (Geels, 2011). The landscape level is a phenomenon that is wider than what is constituted by the regime and (for the analysis) relevant niches – it forms the room for action from which it is difficult to deviate, and Geels proposes it to be beyond *direct* influence from actors, although actors and their misalignment do indirectly influence the landscape level (Geels, 2005). Transitions happen when radical reconfigurations occur through the system – *essentially transitions are defined as shifts from one regime to another* (Geels, 2011). The regimes are thus essential for the framework.

The regimes are defined as socio-technical systems that are derived from societal functions. Thus, regimes are defined in terms of transportation, housing, health care, energy supply and the like (Geels, 2005). To give an example of the MLP applied, Geels (2005) explains the shifts in the American urban passenger transport system over a period of 70 years, with the shift from horse-drawn transportation to gasoline car-based transportation.[5] Horse-drawn transportation is treated as a regime that is influenced by landscape pressures such as urbanization and industrialization, cultural changes in terms of health and hygiene, and suburbanization. Through these forms of landscape pressures, several new technologies/modes of transportation have developed in niches, such as electric trams, bicycles and gasoline cars, which link positively with landscape levels, and therefore have gained power through windows of opportunities, as the existing regime has been challenged by the landscape pressures. Some of the niche developments

[5] For a more detailed description, see Geels (2005).

directly challenged the existing regime, for instance gasoline cars, and by linking up with ongoing landscape dynamics, for instance suburbanization, which creates a 'latent demand for cars', the gasoline cars then disrupted the existing regime, and created a new one (Geels, 2005).

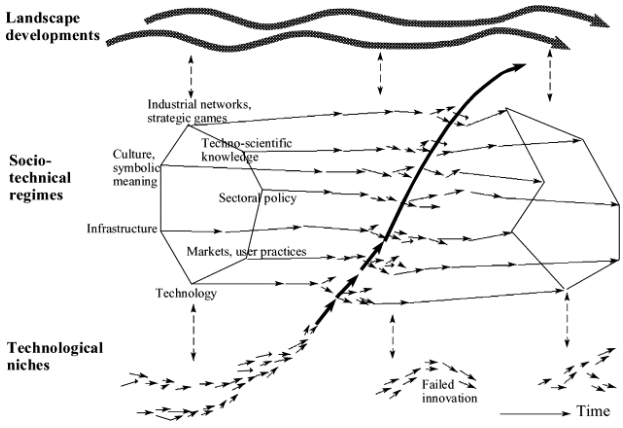

Figure 3: Overview of niches, regimes and landscape – presented in Geels (2002)

Due to the theory's capabilities in approaching large-scale changes, the MLP has undergone several forms of critique, questioning the reliability of the framework. As the MLP intentionally seeks to be a middle-range theory that describes longitudinal, large-scale societal change processes that are to some extent provoked by external forces, the framework is bound to be confronted by frameworks that suggest that society is comprised of spatiotemporal reproduction (such as the practice perspective), and that there is no such thing as external forces. From a practice perspective, there are further issues with the hierarchical approach in the MLP, particularly in terms of the landscape level, as this proposes exogenous forces that are somehow not a part of the performance and transformation of practices (Shove and Walker, 2010). In response, Geels (2011) proposes dropping the nested hierarchy notion and instead leaving the regime in focus, with landscape and niche levels as *derived* concepts that are thus related to the regime in question. This does to some extent meet the practice perspective-based objections of 'external' forces, but Geels (2011) argues that it includes the pragmatic inclusion of 'broader contexts' in empirical studies as proposed by Røpke (2009), as cultural, legal and economical institutions are not only an outcome of practices but also provide a context for the performance of practices (Røpke 2009, Geels 2011). Treating niches and landscapes as derived concepts of a certain socio-technical arrangement seems to acknowledge Shove's (2003) way of describing accumulated performance of practices as spatiotemporal 'systems' that have become institutionalized and therefore difficult to break with.

Rejecting the nested hierarchy of the micro, meso and macro levels also responds to related kinds of critiques of the MLP's vague definitions of the landscape level, which somehow appears detached and universal, as well as the critique of niches being treated as somewhat independent and autonomous entities (e.g. Genus and Coles, 2008). Jørgensen (2012) points out three critical concerns with how to make sense of the three levels, particularly in relation to dealing with contemporary and future transitions. One of the concerns is focused on the role of actors involved in ongoing transition processes. As Jørgensen (2012) argues, transition processes are often characterized by conflicts over the fundamental constitution of problems and visions that informs the initiatives and directions taken. This is an important reflection to include for assessing the socio-technical diagram of lighting, as problematizations of lighting primarily being defined through its energy consumption seems contested. Jørgensen (2012) therefore proposes that

theories of transition should offer navigational support for actors. This also applies for critiques of theories of practice. As pointed out by, for example, Gram-Hanssen (2011) and Watson (2012), the practice perspective is strong in explaining continuity, but not as developed in explaining change. Consequently, the perspective is not as strong in offering navigational support for how to obtain change. There are many ongoing debates about this subject, and several suggestions are made in relation to how to understand societal changes while maintaining the point of departure that a practice perspective offers, namely that society is constituted by practices, and *change thus has to happen through the performance of practices*. Some of them are discussed in the following.

6.2.2. Practices and systems – different approaches, same goal?

In terms of understanding change through a practice perspective, it is imperative to start by explaining what theories of practice presuppose as essential for change. To illustrate this, Shove et al (2012) also explain American transportation, or more specifically the *doing of driving*, through a practice perspective. Where Geels (2005) presents the gasoline car as a niche development that disrupted the existing electric tram transportation regime, by linking up to landscape pressures in the form of suburbanization, Shove et al (2012) claim that the elements of the driving practice pre-date the arrival of the car itself. Rules of the road (e.g. travelling on the right side of the road) and related forms of competences (e.g. how to navigate on the road) have crossed over from the world (or regime) of the horse to the world (or regime) of the car. So have several features of the material aspects of the design (position of wheels, signalling systems etc.). Based on these, and more, examples, Shove et al (2012) suggest that the only really new element of driving was the gasoline engine itself along with the knowledge of how to maintain and repair the engine. Shove et al (2012) further suggest that the change was due to the relation between requisite elements and the relative scarcity of necessary competence (it being difficult to operate steam engines, which was a competing technology, treated as a niche development by Geels (2005)), and that this structured the character of driving and the manner in which it took hold. This seems to suggest that change has actually just been technical, and in this sense, according to Geels (2005), incremental. This is in itself quite interesting. The difference seems to lie in what a practice perspective denotes as the *duality* of structures and actions that shape and reproduce each other becomes essential – everything can be considered as practices, and as the outcome of practices. Therefore change happens through the stepwise reconfiguration of practices. This raises some interesting questions in terms of what radical versus incremental change actually is and when it happens.

6.2.3. How theories of practice may inform studies of transition

Watson (2012) suggests that the *performance* that lies behind 'doing' something – performing a practice – is what creates the link between what people do and the rest of any given socio-technical system. In this sense, Watson emphasizes that practices are partly constituted by the socio-technical systems of which they are part, and those socio-technical systems are constituted and sustained by the continued performance of these practices that comprise the systems (Watson, 2012). This corresponds well with what Nicolini (2012) explains: social structures (institutions etc.) are kept in existence through the recurrent performance of material activities. With this in mind, changes in either practices or systems are therefore inherently co-dependent, and this lays the ground for exploring how to bridge the practice and the systems approach further.

In order to utilize the practice perspective when looking at systemic change, Watson confronts the main critiques of theories of practice in relation to studying change. In responding to theories of practice being too focused on stability, Watson reminds us that although a practice is only a practice if it is widely recognized as a practice – an entity – performances of practice inherently differ as practitioners, in the process of doing, do the active work of integrating the elements of practice into a contingently effective configuration (Watson, 2012). Therefore the performance of practice not only entails routine and habit, but also innovation and change. Although the innovation in a moment of performance is always incremental, the overall accumulation of different performances results in the practices – as an entity – changing over time. Theories of practice therefore account for, and deal with, change as a result of performance of practices over time, which is, however, distinctively different from the way the multilevel approach deals with it, as change is here the analytical focal point. In other words, what may be regarded as change by the two approaches respectively is inherently different.

Another aspect of change processes connected to the practice approach is that practices relate to each other at the level of how people perform them in the organization of their lives, so practice can therefore change as adjacent practices change. This means that interdependent but also competitive relations between practices become important when exploring possibilities for change. As change in a practice consequently happens due to displacements in systems of practices, theories of practice may therefore help illuminate processes *across* what can be understood as systemic scales (the micro, meso and macro level), and this is how a bridge can be formed between the social practice perspective and the multilevel perspective (Watson, 2012). Essentially, Watson suggests regarding socio-technical systems as systems of practices, and thereby understanding systemic shifts as matters of the dynamics of practice.

So far it has been established that a practice perspective and a multilevel systems perspective may say something different about change and when it happens, so bridging the approaches may be valuable in terms of understanding a broader spectrum of a certain change process. Further, it has been established that utilizing a practice perspective may say something about change *across systems* that is beneficial for the process of zooming out on practices.

Additionally, Watson emphasizes that a practice perspective does not take current patterns of activity as given or regard them as something static, so “by understanding the shifting interdependencies between practices over time and the consequences of those interdependencies of any one practice, the contingency of what seems like the necessary practices – such as overseas holidays or long-distance commuting – is revealed and opportunities for intervention may become visible” (Watson, 2012, p. 494). Here, Watson offers insight that can suggest ways of offering navigational support in terms of changing practices, by elaborating that “… understanding transport as a system of practice promises to enable identification of intervention points which initiate or give momentum to positive feedback processes, by which increases in recruitment to less carbon-intensive practices of mobility, and in defection from more carbon-intensive practice, speed up” (Watson, 2012, p. 493). Importantly, Watson notes that shifts at the regime level do not relate to shifts in single products, technologies or practices. Rather they represent the co-evolving dynamics of practices. As Watson argues, shifts in velo- and automobility are dependent on changes in patterns of recruitment to driving and cycling respectively, but these patterns have only changed because patterns within other systems have happened as well: practices of road building and maintenance, practices of legislation and governing etc. Practices therefore recruit carriers as much in board rooms and

government rooms as they do in the streets and in homes, which underpins the point that a socio-technical system can be seen as consisting of practices. As a result, Watson argues that there are various processes within a socio-technical system that lead to a particular dominant structure of, for instance, personal mobility. This is very similar to what Shove (2003) equally argued for in the case of comfort. This brings about questions in terms of how to analytically scope a system: are we talking about energy, transport and heating regimes, or are we talking about a standardized technologically embodied system based on the accumulation of performed practices around, for instance, comfort that essentially includes all of these regimes? These are essential questions for the mapping of the socio-technical diagram of lighting. If lighting is regarded as a shared material element between practices, which seems to be evident from Part 1, lighting is then part of various practices, and, consequently, various systems. It is therefore interesting to explore how practices involving lighting have accumulated into various kinds of systems that support and maintain certain ways of using and defining light.

6.2.4. Understanding systems as a standardized accumulation of performed practices

In drawing on Watson's useful elaborations while revisiting the work of Shove (2003) in relation to standardized systems of comfort and related practices, it seems to become possible to point out some extra details in how certain technologically embodied, standardized ways of living with certain things (a system of certain practices) can be *analytically approached*. Shove (2003) deals with the matter of standardized, embodied systems and interrelated practices in terms of the relations between what she calls a vertical approach looking at the stabilization and standardization (path-dependent ratcheting) of certain ways of living with certain products and systems, and then what she calls the 'horizontal approach' dealing with how people order and perform meaningful configurations of what is normal *across* these technologically embodied stabilized systems. Shove (2003) argues that the purpose of suggesting a 'vertical' and a 'horizontal' approach is to show how socio-technical systems *intersect* rather than how they co-evolve. Shove's 'vertical' approach is to some extent compatible with the vertical multilevel perspective, however with the focus on intersections between systems that comprise a scientifically defined, technological embodied concept – such as the standardized concept of comfort – that arguably cannot be limited to an energy regime, a transport regime or a heating regime, but is comprised of them all. The horizontal approach, then, represents the 'normality' that is missing in the regime discussion, by focusing on the circulation of elements of practices that holds patchworks of regimes together – practices such as cooking, showering etc., which are all practices that interrelate with a standardized system comprising comfort, and which also cut across energy, transportation and waste regimes.

6.2.5. Moments of innovations between standardized systems and the practices reproducing the systems

Hargreaves et al (2013) build on Shove's integrative framework, however, by relating the vertical approach directly to the multilevel perspective and the horizontal approach to the circulation of elements of practice, comprising a system of practices. In doing this, their aim is to emphasize and draw attention to the way *regimes and practices intersect with one another in innovation processes*. So although this version of the approach moves slightly away from Shove's interpretation of the vertical approach and back to a regime-based vertical approach, *this is done to offer insights into processes that can serve to hinder or potentially help sustainability transitions through innovation* (Hargreaves et al, 2013) and the particular definition of what exactly comprises a system may be less important – yet, this is, of course, important to be aware of when applying the framework empirically, as the definition of the systems included in the studies is

important. Essentially, Hargreaves et al (2013) emphasize Shove's (2003) and Watson's (2012) argument that looking at intersections between systems and practices is useful, by stressing that the multilevel perspective focus on single regimes around energy, food, transport etc. consequently underplays multi-regime interactions and actors that cut across regimes, which is essential to understanding transitions, as also emphasized by Jørgensen (2012).

In Hargreaves et al's (2013) model of intersections, the notion of *elements* of practice is brought to our attention. Much like Watson (2012), Hargreaves et al (2013) propose that stability derives from the repeated reproduction of practices, and they particularly emphasize that this happens due to a *certain integration of elements, which consequently also implies that innovation in practices derives from the making and breaking of links between elements*. They expand on this by referring to Shove and Pantzer's (2010) three circuits of reproduction: the first relates to how elements become integrated to form a certain practice, the second relates to how various practices come to hold each other in place (a system of practices) and the third refers to temporal dynamics and path dependence, exploring how current practices evolved out of past ones. Through this, the *elements of practice* become an important analytical component, and the relation between practices and the circulation of elements between these also becomes important. As the practices approach, as mentioned, is not yet sufficiently well equipped to explore the emergency of novelty, Gram-Hanssen (2011) has developed on this and is illustrating how practices can result from adjustments in the various elements of which they are comprised – with special emphasis on technologies.

Bearing this in mind, it is beginning to become possible to explore practices and systems where products or technologies play a crucial role, such as in matters of energy consumption. Further, following Hargreaves et al's (2013) framework, the history of practices becomes essential in order to understand their current configurations. These aspects are important for further study of the socio-technical diagram of lighting, and meets the suggestions that Nicolini (2012) puts forward for zooming out on practices involving lighting.

A stylized model of the framework can be seen in figure 4.

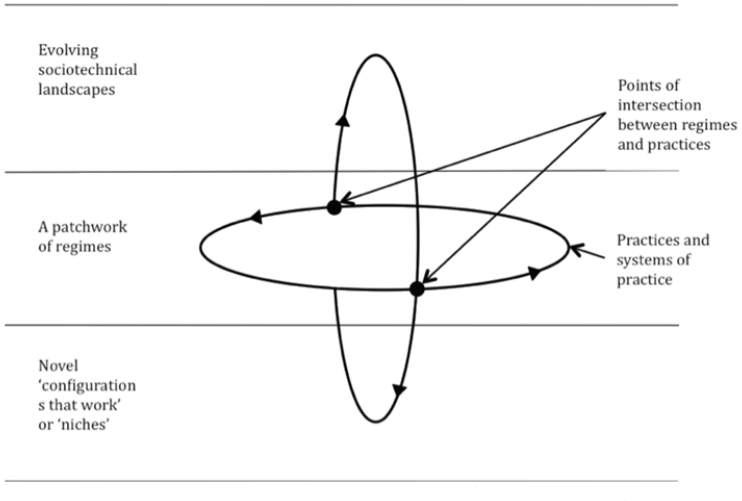

Figure 4: Hargreaves et al's (2013) model of intersections betweens systems and practices.

The model focuses on specific intersections between systems of practices and a certain system. Hargreaves et al (2012) give the example of a local UK initiative that proposes an alternative way of supplying local food, avoiding the big established supermarkets, also seeking to make it affordable for suppliers to sell their produce locally, which makes it more sustainable (no transportation). However, the project runs into problems, not only due to issues connected to what in MLP terminology could be termed the food regime, but also due to the initiative failing to approach practices such as shopping routines and cooking practices. These practices are arguably part of what can be termed a food regime, but are without argument also related to other systems/regimes such as transportation, energy and waste regimes (Hargreaves et al, 2013). This essentially supports what Shove (2003) argues, that practices cannot be captured through one regime. Yet, the point is that looking at moments where systems and practices intersect, or bump into each other, therefore arguably makes it possible to assess what hinders or facilitates certain changes, but it also makes it possible to try to understand the multiple and complex dynamics at play in a change process, as several systems and several practices that may intersect can cause problems or possibilities for these change processes. Hargreaves et al (2013) thus offer great possibilities for exploring the socio-technical diagram of lighting as lighting neither seems to be easily captured through single regimes such as energy or housing regimes as is discussed in paper 4, nor does it seem to comprise a practice in itself as is evident from paper 1 and paper 2.

The presented web of theoretical perspectives on changes in practices and the systems that evolve from the accumulated performances of practices has guided my methodological approach for exploring and tentatively mapping the current socio-technical diagram of lighting, and how it has become what it is.

Hargreaves et al's (2013) framework for exploring intersections between systems of practices and the accumulated systems that support and maintain these performances will be the main framework for approaching the historical developments of and changes within (Danish) household-related lighting patterns. Further, Callon's sociology of translation will be inspirational for the explorations of the current dynamics of the socio-technical diagram of lighting, in an attempt to meet Jørgensen's (2012) concern about the lack of understanding of current transition processes being filled with controversies and different kinds of problematization processes.

7. Methodological approach for zooming out on practices related to lighting

Equipped with the theoretical framework presented above, I am thus able to address both the current developments of the socio-technical diagram of lighting and how these developments are historically shaped. Throughout my research, the focal point for investigation and analysis has been *light* as a material element of practices and therefore the processes of attempting to establish energy efficient light as part of those are interesting. As these processes of promoting energy efficient light appear to be filled with controversies, it is interesting to explore the network of actors (and practices) that unfolds through following these processes.

Therefore, by following the actors that are involved in the process of *changing* lighting, I have explored the socio-technical diagram of lighting through the following three steps:

1. what assumptions and interessement processes current changes seem to be based on, and how the accomplishment of these processes is sought through information;
2. what the historic links made between household-related practices and the use of light may mean for current interessement processes;
3. how the role of light seems to change in institutionalized systems of practices due to certain interessement processes and what these dimensions together with the results from Part 1 mean for obtaining 'good and energy efficient residential lighting patterns'.

In the following section, the methodology for the three steps presented above will be presented. The first two steps provide the basis for the subjoined papers 3 and 4. The last step provides the basis for a workshop I have conducted, all of which will be discussed further in the Results section.

7.1. Methodology for paper 3: exploring the role of information in lighting related interessement processes and translations.

As a first step in zooming out, I have found it important to understand how the reproduction of household-related practices that involve the use of light corresponds to, and is addressed by, the current problematization processes that lighting seems to undergo. Nicolini (2012) proposes to follow conferences where practice is debated, getting to know policymaking processes where the practice is sanctioned, and reading literature where the practice is legitimized. Further, Callon (1986) also emphasizes that the production of (new/different kinds of) scientific knowledge is an important part of moments of translation.

Following situations where practices involving light are discussed and sanctioning attempted therefore seems meaningful, and assessing public information that is meant to guide households exactly in the changing compositions of light may be an eligible starting point.

In order to do so, I have conducted an assessment of the Danish Energy Savings Trust's efforts in trying to educate the private consumer in how to use energy efficient light. These campaigns are meant to help the consumer in navigating between the different light sources and thus enable the consumer to choose the most energy efficient product. I have conducted a qualitative document analysis across the information guides provided by the Danish Energy Savings Trust (DEST), with the first one published in 2004 and the last one in 2012. The qualitative document analysis approach is based on the ethnographic content analysis approach (e.g. Altheide et al, 2008), which allows one to look for certain themes and discourses across documents. As discourses are an important part of practice normalization processes (Nicolini, 2012), it is interesting to look into what kinds of discourse the information guides are drawing on and to a certain extent seek to establish.

The information guides provided by DEST have been made in collaboration with other actors such as the Dansk Center for Lys (The Danish Lighting Center), ELFOR (Danish electricity distribution), VELUX Denmark (Danish specialist in windows) and DELTA (specialists and consultants in advanced technology). It is important to note that DEST was an impartial public organization under the Danish Ministry of Climate, Energy and Building, whereas The Danish Lighting Center and Danish Electricity Distribution are impartial trade associations, and VELUX and DELTA are private companies. Therefore, focus in the guides will presumably tend to favour solutions that will be in favour of the lighting, window and energy industries, which of course will have consequences for the content and its presentation in the guides. In table 4, a list of the guides, their title and publication year is presented.

Actors as contributors	Name of guide	Year
DEST ELFOR	"Godt Lys i Boligen" (translation: 'Good lighting for the home')	2004
DEST DCL	"Lyskilder til Boligen – din guide til energirigtig indretning med lys" (translation: 'Light sources for the home – your guide to energy efficient lighting decoration') 2008	2008
DEST	"Nyt lys på fremtiden – giv dine kunder besked om god og energieffektiv belysning" (translation: '(shedding) new light on the future – inform your customers about good and energy efficient lighting')	2009
DEST DCL	"Lysdioder til Belysning– status for fremtidens lyskilde" (translation: 'Diodes for lighting – status of the light source of the future')	2010
DEST Energy Piano ÅF Lighting Viegand & Maagøe	"Guide til nyt lys – det rigtige lys til boligen" (translation: 'A guide for new lighting – the right light for the home')	2012

Table 4: Overview of the assessed information guides, the contibutors and year of publication.

Arguably, in conducting this assessment I am defining DEST and the collaborating actors as a group of actors that to a certain extent accepts the EU Commission's problematization of lighting as something that is 'too' energy-consuming and that this can be solved through substituting 'energy-intensive' light bulbs with 'energy efficient' light bulbs. In this way, DEST can be argued to be attempting to enrol private consumers in this problematization through interessement devices such as informational campaigns about energy efficient light.

The assessment and analysis of the content of the information guides and their efforts in enrolling residents in the problematization of lighting as an energy-related matter is presented in paper 3, titled *"Illuminating the Home according to the Danish Energy Savings Trust – From focusing on everyday life to focusing on technical terms"*. A short account of the chapter is presented and discussed in the Results section.

7.2. Methodology for paper 4: exploring historic moments of innovation between household-related practices and the development of light

As residents seem to relate light to the services it provides in performing various practices within the home, and only slightly to technical information providing knowledge about energy efficiency, it is interesting to

look further into why informational campaigns tend to focus on technical information as well as why residents tend to focus on something else.

Therefore I have gone on to explore the historical shaping of these 'definitions of light', by conducting an analysis of a number of historical moments in which lighting systems and lighting-related practices seem to have been shaped and have shaped each other, and what that means for the current socio-technical lighting diagram and its potential future(s).

The historical part of the assessment is based on several secondary sources dealing with the history of light in one way or another. It is of course important to acknowledge that secondary sources are primary sources that have already been processed with a certain analysis in mind. However, when drawing on multiple sources, it is possible to detect certain trends across the accounts that may form a basis for further investigation. In order to investigate the secondary historical accounts for particular moments where residential practices involving lighting have emerged, maintained themselves or potentially changed, I have, as previously mentioned, applied the theoretical framework presented above for exploring *moments of innovation* between the local accomplishments of practices and the institutionalized systems that the reproduction of these local accomplishments has established. I mainly apply Hargreaves et al's (2013) framework that proposes that stability derives from the repeated reproduction of practices, and that changes (potentially) happen when stabilized systems meet new productions of practice due to new ways of linking elements of practice. Through this take on the historical analysis I begin the discussion of how intersections between residential practices involving lighting and developments in lighting systems have formed and changed lighting *patterns* over time. This discussion is essential for understanding how currently existing lighting patterns have developed and what that means for current efforts towards making light more efficient by focusing on the efficiency of the *product* as well as primarily emphasizing technical aspects of light.

The historical accounts that I have used for my assessment of the development of lighting patterns is presented in table 5 below.

Title of source and main analytical framework in analysis	**Author (reference)**
"An Anthropology of Luminosity: The Agency of Light" *Anthropological framework*	Bille and Sørensen (2007)
"World On the Edge: How to Prevent Environmental and Economic Collapse" *Environmental research framwork*	Brown (2010)
"Brilliant: The evolution of artificial light." *Historical framework with focus on rural and family history*	Brox (2010)
"Heat, Power and Light: Revolutions in Energy Services" *Power studies framework*	Fouquet (2008)
"Seize the day. Ethnological perspectives on light and darkness"	Garnert (1994)

Ethnographic framework	
"Energy Consumption in Homes – an historical approach to understanding new routines" *Socio-technical framework with focus on practices*	Gram-Hanssen (2008)
"Consuming technologies – developing routines." *Socio-technical framework with focus on practices*	Gram-Hanssen (2008)
"Domesticating Electricity: Technology, Uncertainty and Gender, 1880-1914" *History of Science and Technology framework.*	Gooday (2008)
"A story about modern lighting in Danish homes."	Lytken (2012)
"Da danske hjem blev elektriske; 1900-2000" (translation: When Danish homes became electrified; 1900-2000) *History of Gender framwork*	Olesen and Thorndahl (2004)
"Da natten forsvandt – om lys for der kom lys" (translation: When night disappeared – about light before there was light). Historical account divided into 4 pieces *Socio-cultural framework*	Thorndahl (2000-2001)
"A cross-cultural analysis of household energy use behavior in Japan and Norway." *Socio-technical framework*	Wilhite et al (1996)

Table 5: Overview of secondary sources used for historical assessment of lighting-related practices and derived lighting-related systems.

As can be seen from table 5, the sources used for the historical assessment of lighting-related practices and derived institutionalized systems stem from various theoretical frameworks. This is, of course, important to acknowledge when using the sources for describing the development of lighting within yet another framework. However, as the sources mainly draw upon socio-technical, socio-cultural and sociological thinking they seem compatible with the theoretical framework adapted for this research.

The analysis and discussion of the development of lighting patterns as a result of intersections between changes in the reproduction of lighting-related practices and the derived institutionalized systems is presented in the attached paper 4 titled "From energy efficient lighting products to energy efficient lighting patterns?" and a short account of the paper will be presented and discussed in the Results section

7.3. A methodology for identifying the current socio-technical diagram of lighting

In order to coherently explore what the historically shaped 'definitions' of light mean for current interessement processes behind establishing energy efficient lighting, it seems appropriate to further explore the dynamics of the *current* socio-technical diagram of lighting.

Paper 4, *"From energy efficient lighting products to energy efficient lighting patterns?"*, begins a discussion of how the historical shaping of current lighting patterns influences the current changes in the socio-technical diagram of lighting, which includes performances of various practices and resulting institutionalized systems. In order to take this discussion further, I have returned to Nicolini's and Callon's suggestions to follow the actors that are part of the problematization, interessement, enrolment and mobilization processes, which constitute the current and emerging socio-technical diagram for lighting. In this way it is possible to explore some of the (missing) connections between the studies of the 'use of light' and the emphasis put on information in certain interessement processes, as it is possible to explore and question which actors are enrolled in the underlying problematization, and what kind of 'obstacle problems' (Callon, 1986) prevents other actors from getting enrolled.

In pursuing the current processes of the socio-technical lighting diagram I have therefore followed Nicolini's (2012) aforementioned suggestions further and attended a number of national conferences and workshops dealing with current developments of lighting in one way or another. These conferences and workshops have been trailed by applying the method of 'following the actor' (Callon 1986, Nicolini 2012, Bijker and Law 1992). Based on attending the conferences and following the dialogues, I have conducted expert interviews with actors that seem to be influential or seem to carry key knowledge important for the current change processes. Further, I have followed examples of prevailing discourses about the 'role of lighting' presented in either EU-related or homeowner-related documents. In table 6 the sources (actors) used to draft the current socio-technical diagram for lighting can be seen.

Source and year	**Type of source (short description)**
Seminars, workshops and conferences:	
By, Land, Lys (translation: City, Country, Lighting) http://www.bylandlys.dk **2013**	***Conference*** about lighthing, with focus on visions and economy for future lighting within the municipalities. The conference aimed to be a frame for knowledge-sharing, exhibitions and match-making.
ATV – LED: den lysende revolution (translation: ATV – LED; the illuminating revolution) http://www.atv.dk/publikationer/projekter/led-den-lysende-revolution **2013**	***Semiar*** about LED and the new challenges and opportunites of the lighting industry.
Boligdag **2012** (translation: "Housingday" 2012) http://www.sbi.dk/arrangementer/tidligere-arrangementer/boligdag-2012-erfaringer-med-integrerede-strategier	A recurrent ***seminar*** presenting research concerened with buildings and homes. The 2012 version dealt with sustainable urban development, focusing on experiences with integrated strategies for environment, social responsibility, economy and culture in urban policymaking. A response to the EU putting integrated sustainable urban development on the political agenda in 2011. I attended this seminar to explore whether lighting would be on the agenda at a seminar focusing specifically

	on the buildings role in urban planning, but it did not have any particular role.[6]
Intelligent by via ny belysningsinfrastruktur (translation: Intelligent city through a new lightinginfrastructure) - 'Öresund Smart City Hub' project. **2013** http://www.oresundskomiteen.org/wp-content/uploads/2012/11/Invitation-til-innovationsplatform-Gadebelysning-smart-cities.pdf	A ***workshop*** focusing on creating an idea catalogue for how an intelligent lighting infrastructure can form the basis for a smart city. Response to the EU digital Agenda. *
Associate Professor at Lund University Thorbjørn Laike, specializing in environmental psychology and non-visual effects of lighting. **2012**	**Informal seminar** on environmental psychology of lighting.
SYN-TES - a research project focusing on contributing to a theoretical development transforming the field of colour and light into a coherent field of research. **2012**	I attended a **coursework** organized by the project, and I have contributed to their work package (Book Chapter)
Talks and interviews:	
Louis Poulsen – lighting designer and company – they further provided the lighting for Ørestad School project* 2012	**Interview** about challenges and opportunietes with designing for/with LED.
Lyngsaa a/s – lighting designer and company 2012	**Interview** about being a pioneer within LED lighting design.
AKJ Inventions – electronics engineer working with electronical parts of the LED. 2012	**Interview** about electronical challenges with LED as a general light source.
KHR architects – architect involved in the design of Ørestad School – dynamic LED lighting as significant aspect of the project.* 2012	**Interview** about designing a building with special emphasis on incorporating LED lighting systems. Included a tour of Ørestad School
COROS – trio of an architecht, an eletronics engineer and an industrial designer – developed a new kind of LED lamp. 2013	**Interview** about there being new possibilities in designing with LED.
OSRAM – large Danish light producer and retailer.	**Intial talk** about the emerging field of LED products

[6] Essentially actor network theorists suggest only following actors that are part of the unfolding network around the given controversy one is investigating. As lighting was hardly touched upon during this seminar, the actors attending the seminar cannot be seen as part of the socio-technical diagram of lighting. It is however interesting in itself, as the historical analysis suggests, that building- and constriction-related processes have had an influence on and have been influenced by lighting to some extent. Actors within building and construction research should arguably be part of the network, and there is thus a challenge in enrolling them.

2011	
PROLYS – small Danish LED lighting producer and retailer. 2011	**Initial talk** about the emerging field of LED products
Documents	
"Lighting the cities – accelerating the Deployment of Innovative Lighting in European Cities" - EU report (EU, 2013)*	An ***EU Commission document*** on the role of lighting in reaching the 20% energy savings by 2020. This document is part of the **Digital Agenda for Europe**, and empasizes the commissions ideas that a "larger roll-out of intelligent LED lighting systems in cities will be part of the creation of sustainable smart cities." (EU, 2013)
"Moderne danske boliger – Belysning" (translation: "Modern Danish homes – lighting") (Bolius, 2013)	A ***book provided by the Bolius Homeowners Information Center***. The book shows different ways of using LED as a general lighting within the home. It emphasizes energy savings, new architectural possibilities, build in solutions and design.
Eco-design directive, Energy Label shceme and Eco-Label scheme (see also description in Introduction and appendix 1).	***Mandatory and voluntary EU policy tools*** focusing on the energy efficiency of the individual product, as well as establishing requirements for color rendering capabilities and colour temperature, lifespan etc.

Table 6: Overview of key conferences, workshops, seminars, interviews and documents used as sources for exploring the current socio-technical diagram of lighting

The presented types of sources (actors) signify both the process and result of identifying current processes and key actors within the unfolding socio-technical diagram for current lighting. As can be seen from the table, the actors are connected in various ways. The various workshops and conferences were identified through engaging with networks such as the Danish Lighting Center. Attending the workshops and conferences then gave me the opportunity to follow what seems to be the dominant problematization ('lighting is too energy-consuming, and that can be dealt with by introducing energy efficient lighting products') as well as whether and how key actors have been enrolled in the problematization. As part of this process I identified and contacted various companies engaged with the ongoing processes about energy efficient lighting, with whom I subsequently conducted interviews. The interviews then identified new aspects of the problematization processes, or confirmed those already established. Attending workshops and interviewing actors also opened up the opportunity for exploring related documents, such as the EU report on lighting cities, which was brought to my attention through attending the Smart City innovation platform meeting. In this way, I have followed the actor, whether it be a workshop, a document or certain people and processes in certain companies engaging with the changing field of lighting that are trying to discuss and problematize certain aspects of energy efficient light in one way or another. I have kept following actors and the evolving network of actors until the references started looping around the same problematizations and interessement devices. That said, the field is dynamic, perpetually enrolling new actors and thus constantly forging new alliances.

My observations at workshops and conferences have mainly been documented by field notes and recordings, whereas my interviews have been prepared through semi-structured interview guides (e.g. King

1994, Kvale 1996) and recorded. Some of the interviews should be characterized more as talks, as they are a product of a more (unavoidably) unstructured, initial attempt to explore the field. The talks have mainly been documented through field notes. The documents have been assessed and compared to the problematization and interessement processes identified at the workshops and conferences and across the interviews.

The interviews, conferences and talks have thus been used to assess what seems to be the current, unfolding socio-technical diagram of lighting. Analytically, the various sources have formed the basis for informing the discussion in the paper *"From energy efficient lighting products to energy efficient lighting patterns?",* as well as forming the basis for conducting my own workshop *"Lighting in Transition",* which will be presented and discussed in the following.

7.3.1. "Lighting in Transition" - conducting a workshop on how to obtain 'good and efficient residential lighting patterns

Based on my studies of

- Zooming in on local accomplishments of household-related practices and connections between them,
- The accordance between 1) lighting's role in local accomplishments and 2) what seems to be one of the main problematization processes and attempted interessement processes through devices such as informational campaigns, minimum requirements and (ambiguous) standardization processes, and
- Zooming out and identifying actor networks of certain competing problematization and interessement processes that seem to occur due to the ambiguousness and disputed attempts to redefine 'appropriate light' in terms of an energy-related predicament,

I have opened up the opportunity for shaping my own problematization of 'energy efficient light' in my attempts to understand but also question the ongoing processes. In order to bring forth the importance of understanding light as a process and result of *performing practices*, I have attempted my own interessement processes through the device of a workshop. Based on the assessment of the socio-technical diagram of lighting I identified and invited a number of people representing key processes in establishing or questioning LED as a 'future light source', which seems a dominant strategy resulting from the main problematization, as mentioned in the Introduction. The participants invited to the workshop were asked to present key challenges and key opportunities for reaching energy efficient lighting patterns through the means of LED.

By facilitating this workshop, I become an engaged actor myself, and through my interessement process I impose certain identities on the other (groups of) actors by having them represent aspects of the socio-technical diagram of lighting that I argue to be important based on my assessements. This is, of course, important to make a note of.

The participants were invited to do a presentation of their experiences with opportunities and challenges related to LED as an energy efficient lighting solution. The participants were invited by an invitation along with a background description of the intentions and aims of the workshop, and an explanation of why I specifically asked them to participate. As an example, I invited Anne Bay from the Danish Lighting Center to

give an overall presentation of the current challenges and opportunities with lighting, and LED in particular. I have met Anne Bay at most of the conferences and workshops I have attended. Further, Flemming Madsen from the Danish Lighting Innovation Network was invited to speak about regional and municipal challenges with energy consumption and light. Flemming Madsen was also identified as a key actor, as he also attended most of the conferences and workshops presented above.

The workshop programme and background information can be seen in appendix 4. A list of the participants and the topic they spoke about is given below, in table 7.

Presenter and affiliation	**Topic presented**
Anne Bay, Director of Danish Lighting Centre (DCL)	'Lighting right now' – changes within the field of lighting and the potential and challenges with LED.
Lone Stidsen, Post Doc AAU	Lighting atmosphere: what does light imply for our well-being? Potentials and challgenges in designing lighting atmospheres.
Malene Lytken, PhD candidate, the Danish Schools of visual arts	The history of the lampshade: why do we illuminate our homes the way we do nowadays?
Ellen Kathrine Hansen, achitect and external lecturer at AAU	'Lighting design – mastering science, media technology and architecture' – a presentation of AAU's new lighting design education.
Rune Larsen, CEO Normasym, author of "LED-bogen" (a comprehensive book about the workings of the LED)	LED: potentials and challenges. Specific focus on technical details.
Kenneth Munck, Lighitng engineer at ÅF Lighting and Chair of Danish Standards' committee S-61 for lighting.	Standards in terms of lighting: technical and systemic challenges with LED as a new light source.
Flemming Madsen, internal affairs officer for Danish Lighting Innovation network.	Municipal and regional challenges with energy consumption and lighting – preliminary initiatives and how these are considered to have influence on private/residential lighting.
Henrik Bendz, architect and Christian Krause, electronics engineer at COROS.	Design possibilities with LED – challenges and new possibilities.

Table 7: Overview of presenters and presented topics at the SusTrans workshop "Lighting in Transition".

In the following section, the outcomes of the *three different approaches* presented above will be accounted for and discussed.

8. Results of zooming out on practices related to lighting

Firstly, paper 3 titled *"Illuminating the Home according to the Danish Energy Savings Trust – From focusing on everyday life to focusing on technical terms."* and paper 4 *"From energy- efficient lighting products to energy efficient lighting patterns?",* will be accounted for briefly and discussed, whereafter the analysis of the assessment of the current socio-technical diagram of lighting and the workshop will be presented in more detail.

8.1. Presentation and discussion of paper 3 on the role of information in current lighting-related interessement processes.

As established in the theoretical and methodological chapters above, the first appropriate step to take in the process of zooming out on lighting-related practices and the 'weaving' of the socio-technical diagram of lighting is to start by exploring the accordance between the actual deployment of light within the home and current problematization processes of 'energy efficient light'. As introduced in the main Introduction, the dominant political problematization of lighting seems to be that "lighting is too energy-consuming, and that can be dealt with by introducing energy efficient lighting products". The EU Commission is an active actor in this process, seeking to enrol other actors through legislative tools as well as voluntary schemes such as the Eco-Label scheme. In order to make sense of the resulting explosion of new products on the market with varying quality and efficiency levels, public national bodies such as the Danish Energy Savings Trust (DEST) uncoil an informational process meant to help, in particular, the private consumer navigating the market and thus enable the consumer to choose energy efficient products. DEST and the actors that DEST has forged alliances with seem enrolled in the dominant problematization of "lighting being too energy-consuming, which can be dealt with by introducing energy efficient lighting products". This alliance thus seeks to enrol other actors through certain interessement processes. It is therefore interesting to look into whether the interessement device, here the informational guides provided by DEST, actually succeeds in enrolling private householders and their lighting systems as 'interested actors' (Akrich et al, 2002) or not – and if not, why this may be so. This is particularly interesting to follow up on for two main reasons:

1. As explained in the main introduction, the EU, besides setting out minimum requirements through the Eco-Design Directive, to some extent relies on providing information as a means of facilitating the use of energy efficient lighting, which is then done by DEST, in spite of
2. People generally relating their use of lighting to activities performed within the home, such as cooking and dining, which was uncovered through the presented case studies in Part 1. Further, the case studies showed that people generally rely on speaking to each other and trying out different arrangements before deciding on a lighting arrangement that works, rather than information provided by public bodies.

In paper 3 titled *"Illuminating the Home according to the Danish Energy Savings Trust – From focusing on everyday life to focusing on technical terms."* I therefore explore what *kind* of information is provided to help people choose energy efficient lighting and how that agrees with how people actually use light and what kind of associations they make of 'appropriate home lighting'. As the case studies conducted in the zooming-in process revealed certain ambiguous aspects of what people regard as 'quality lighting' compared to colour temperature and colour rendering capabilities of light sources, these aspects are interesting to specifically assess. As mentioned in the Introduction, exact aspects of light quality in terms of colour rendering capabilities and brilliance were *not* supposed to be compromised by the legislative initiatives. This, however, does indeed seem to have been the case, due to ambiguous standardization processes for actually defining 'quality' colour rendering. For the full analysis, please see paper 3.

As evident from paper 3, the information guides seem to have 'shifted' their approach from focusing on lighting 'situations' towards becoming more centred around technical details about the different light sources, described in more or less abstract terms. This is interesting, as the situation-centred approach to a great extent is more compatible with how people use and relate to light, as revealed in Part 1. In the

chapter I conclude that the increasing focus on technical aspects and presentations may be due to the conception of a technical or scientific language better facilitating a 'neutral', 'best' choice. This would be very much in line with the line of thought behind the concept of 'the rational actor' that to a large extent still influences much policymaking (Macnagthen and Urry, 1998); informing the consumer by providing them with technical knowledge will help them make the optimal choice, presuming that the consumer can make a choice based on this kind of information. However, this does not make much sense in a practice perspective as people relate the product to activities that are meaningful for everyday life and reproduction of societal dynamics, and rarely to the product itself. As previously described, inviting someone for dinner has a social meaning, and consuming energy (light) is merely a means of obtaining the right atmosphere, or setting an intimate scene of light above the dinner table. Relating to requiring a certain type of light for certain practices within the home would presumably be more meaningful for the consumer than reading about various technical and somewhat abstract functions and dimensions of technology.

The turn in the way the guide chooses to present and explain lighting may very well be related to the choices made on behalf of the product, as discussed by Akcrick et al's (2002) work on the differences between the ontology behind the 'model of diffusion' and the 'model of interessement'. Choosing to present energy efficient light sources primarily through a technical language in order to help people navigate the market indicates that it is sought to introduce and 'diffuse' the products based on the technical feasibility of the products rather than through the situations in which the product is to be used. Therefore, it seems that DEST buys into the rationale behind the model of diffusion; that the new kinds of light bulbs possess "unquestionable technical properties" (Akrich et al, 2002) that the consumer needs to be taught to understand – in other words, the product will spread via society via its (technical) demonstration (Akrich et al, 2002). This rationale is not only dismissed based on several examples presented by Akrich et al (2002), it also seems contested by my studies of local accomplishments presented in Part 1. It is clearly not primarily through the technical properties of the product that people make an assessment of whether a bulb, and the light from it, is 'good' or 'bad'. It is to a much larger extent through evaluations of whether the light bulb in question supports a given situation, such as dining, showering or cooking, in an 'appropriate' way, where 'appropriate' most definitely seems culturally defined or defined by history and routines. When people then display a large range of energy efficient lighting products, as is the case in the Munksøgård case study,[7] it seems primarily due to other reasons such as environmental values and sharing of knowledge, experiences and expectations about technical as well as social aspects of the light bulb in question.

Information-based agendas behind helping the 'consumer' to navigate the unfolding market of new lighting technologies would therefore most probably benefit from thinking about other ways of 'interesting' users. This could, for instance, be through emphasizing the situations in which the light bulb in question is useful, basing this assessment on studies of how householders assess and relate to their light. One example could be to go even further than recommending a certain light source for the bathroom to recommending a certain light source to support the activities performed in the bathroom, such as putting on make-up, or showering. Referring back to Shove's (2003) assessment of the showering practice as something related to comfort and cleanliness, the recommendation of a light source used in the shower cubicle could be attached to assessments of what kind of light supports a comfortable and fresh feeling, instead of just

[7] Presented in Part 1.

focusing on whether the light source is appropriate for noticing details.[8] As clarified in papers 1 and 2, people tend to 'go back' to well-known and often more energy-intensive solutions when having a bad experience with new, often more efficient lighting technologies. All of this seems to point to the fact that it is not only about making sure that products are 'good enough' before being launched on the market, but also that the 'good enough' is related to many different kinds of use, and therefore 'good enough' should be considered 'plural' in that sense; lighting products need to be 'good enough' in correspondence to the practice they are considered for. With the expanded options including LED as a lighting technology, different 'versions' of light can be designed correspondingly. Like the halogen light, the compact fluorescent light still available along with the LED, different light sources seem to correspond better with given practices than others, resulting in different lighting patterns evolving with different levels of energy efficiency as identified in paper 1. Therefore, it seems legitimate to propose that if 'practice-oriented' information is provided instead of purely technical information, the experience of having purchased the wrong light bulb for the purpose intended may be reduced, consequently facilitating potentially more efficient lighting patterns overall. The early information guides do in fact seem to have been based on this kind of recommendation to a much larger extent, so the change away from this approach is quite interesting, especially with what seems to be an increased need for actually providing this kind of information. Ultimately, the assessment of the relation between local accomplishments of the performance of household-related practices involving the use of light and emerging processes of changing light seems to suggest that it is debatable whether the change processes are based on justifications that are intelligible for carriers of lighting-related practices.

Looking further into how household-related practices involving the use of light have evolved through time, resulting in certain institutionalized systems maintaining these practices and their performances, is therefore of interest. Likewise, it is important to identify problematization- and interessement processes in developing new lighting technologies such as LED, as LED technology may be regarded as a result of the performances of a number of different practices, such as environmental policymaking and producing electronic devices and services, that so far have had little connection to lighting and thus lighting-related practices. Essentially, what seems intelligible for practices concerning production and consumption of the use of electronics may be quite different from what is intelligible for practices related to the production and consumption of more traditional forms of light, such as incandescent light and CFLs. Not surprisingly, therefore, this may result in problematizations and interessement processes that do not make sense across the 'two different kinds of lighting'. Consequently, problematizations and interessement processes may derive from very different practices and resulting institutionalized systems reproducing these practices. In the following, paper 4, titled *"From energy efficient lighting products to energy efficient lighting patterns?",* presenting a historical assessment of the mutual development of lighting and household-related practices involving the use of light, and what that means for current processes in the current socio-technical diagram for lighting, will be briefly accounted for and discussed.

8.2. Presentation and discussion of the paper 4 on the historic moments of innovation between household related practices and the development of light

Paper 4 titled*"From energy efficient lighting products to energy efficient lighting patterns?"* focuses on the moments of innovation that happen when the performance of household-related practices intersects with

[8] Which is something the information guides put emphasis on.

the resulting institutionalized systems that help maintaining the performance of these practices. As light is part of a number of practices and not a practice in itself it becomes interesting to look into what (potential) *intersections* between certain performances and certain institutionalized systems related to lighting may imply for the continuation or change of these practices and systems. Following Hargreaves et al's (2013) model for exploring intersections between systems and performances of practices, as presented above, the paper explores how lighting *patterns* have evolved during the last 100 years, with special attention to the Danish developments, and how these patterns have evolved as a result of changes within various practices that have led to different kinds of institutionalized systems comprising the socio-technical diagram of lighting. The paper concludes that lighting patterns can be viewed as a result of moments of innovation between a number of practices and systems. A visualization can be seen in figure 5.

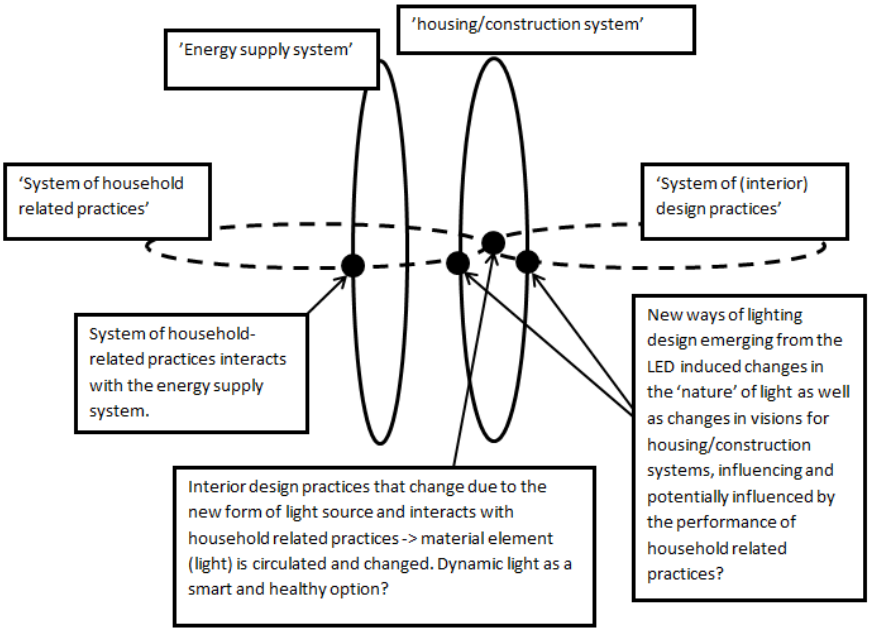

Figure 5: Exampel of Hargreaves et al's (2013) model applied to the development of lighting and household-related practices involving the use of light.

Through analysing the (disrupting and maintaining) historical intersections between the performance of practices and established institutionalized systems maintaining these performances, I argue that current Danish lighting patterns have been developed through *meetings between*

- 1) The light bulb as a first robust link between households and an electrical grid and 2) household-related practices, such as dining and socializing, that had normally evolved around a fire-based light source such as candles or kerosene lamps.
- 1) Changed dynamics of household practices such as dining, homeworking etc., as the family begins to spread out into more rooms due to new possibilities for having several light sources due to lower costs and reduced fire risks and 2) the requirements for high energy consumption in order to keep the grid stable.
- 1) Changes in interior design philosophies and 2) development of the incandescent light bulb.

- 1) Changes in requirements for energy consumption that have to be lowered due to energy security issues and resource depletion and 2) established home-lighting systems that form energy-intensive lighting patterns that may not be questioned.

For exemplification, please see paper 4. Based on these findings, lighting seems to have undergone many complex changes and stabilization processes, which arguably may result in multiple 'ripples' across current systems and performance of practices involving light. One conclusion is that developments within, for instance, the Danish building tradition potentially influence how household-related lighting is shaped and developed. The digital accessibility of LED technology thus opens up the opportunity for built-in lighting solutions that become an integrated part of the construction phase, potentially transferring the lighting-related decision-making process away from the residents and over to the architects and construction engineers. Conversely, new developments in intelligent lighting systems may shape the dynamics of household-related practices involving the use of light, as well as influencing lighting design practices. In any case, focusing only on technical aspects of light and correspondingly providing technical information captures the complexity of the workings and intelligibility of existing and emerging lighting systems.

It is therefore interesting to follow up on what kind of problematization processes and what kind of interessement processes that are carried out in terms of finding a solution for obtaining good and energy efficient light at the same time. As lighting as an actor engages with several other actors, such as designers, architects, buildings, residents, electrical and photonics engineers, the electricity grid, bulbs, lampshades, luminaires and related transformers, drivers and ballasts for making the bulbs work, just as much as with energy policy tools and building codes, the network for making intelligible lighting solutions is wide, multifaceted and complex, and needs further exploration.

Paper 3 and paper 4 illustrate that lighting patterns seem to have evolved through the establishment and the shaping of a number of practices and systems, and that there consequently seem to be a number of embedded and implicit definitions of what lighting patterns are and what they are comprised of. Thus, the problematizing of 'energy efficient lighting' to be a mere issue of product substitution seems to be contested for several reasons. It is therefore interesting to further explore what kind of interessement processes are at play in the socio-technical diagram of lighting and how and why the current main problematization seems to be bypassed and redefined. In the following, such an assessment of the current socio-technical diagram of lighting is given.

8.3. Presentation and discussion of further work in identifying the socio-technical diagram of lighting.

As presented in table 6, a number of actors have been identified through attending conferences, workshops, talks, observations and interviews. Through the entire process of unravelling the network of actors engaged in the current socio-technical diagram of lighting, a number of opposing problematizations and interessement processes seem to have appeared. So far it may be argued that EU and related policymaking processes assume that lighting-related issues are primarily a matter of reducing energy consumption. As previously mentioned, this is sought to be accomplished by making lighting products more efficient. Yet, as has been established, new (residential) lighting patterns evolve that may not be particularly efficient, and this is primarily due to people not relating their use of light directly to energy consumption and due to the layouts for existing lighting patterns having been formed through years of

history. Yet, the energy efficiency problematization is contested in a number of other ways as well. Below is an overview of the 'groups of actors' (entities) (Callon, 1986) and related processes towards reaching the 'goals of the entities' (Callon, 1996) that I have identified to be part of the shaping of the socio-technical diagram of lighting. The goals are different from each other, which consequently leads to different/competing problematizations of what needs to be solved and how, and through what kind of movements. The alliances that are sought to be forged (Callon, 1986) in order to interest actors in agreeing on the problematization in question are therefore also multiple.

Below, the abovementioned deliberations are shown on a table form, indicating groups of actors enrolled in the current socio-technical diagram of lighting. In the first half of the table, the left column groups the actors according to how they seem to problematize 'energy efficient lighting' and the right column illustrates how that problematization supports or contests the **OPP**. It further denotes what the actor groups' goals seem to be, and potentially what kind of alternative interessement processes the groups of actors are seeking to establish. The detected 'obstacle problems' (Callon, 1986) that seem to contest the obligatory passage point **(OPP):** "lighting is a problem for energy consumption, which can be solved through energy efficient lighting products" are presented in the second half of the table. This is done to show the different processes going on in the current socio-technical diagram of lighting and to show how some of the processes contest each other. The presentation is inspired by the model illustrated by Callon (1986, p. 20, figure 2). As can be seen, some actors seem to be part of more than one group, which is denoted by an *.

Group of actors (entities) enrolled in the current socio-technical diagram of lighting	***Interessement processes and devices applied by actors seemingly enrolled in OPP:***
• EU policy tools, • DEST information guides • (Homeowners Information Centres book on modern danish houses and lighting patterns.)* • Certain kinds of LED products that are energy efficient but does not meet (ambigous) quality requirements, for instance for color rendering capabilities and color temperatures.	**Interessment process:** Energy consumption can be reduced by substituting energy-intensive light sources with energy efficient light sources – as few other changes as possible – technical information and voluntary policy schemes are used as interessement devices in order to enroll actors in this problematization. **Goal: To** obtain reduction in energy consumption from lighting.
• OSRAM	**Interessement device**: New lightsources have to fit with existing lamps – therefore they need to have the same shape as existing (incandescent) light bulbs. **Goal:** Has to comply with EU regulations on minimum requirements of energy efficiency. Focus on retrofit solutions, and in that way stay in the same business (incumbent actor).
• PROLYS • AKJ inventions	**Interessement device:** Making sure that the electrical component of LED is of a certain quality. Further, setting

high standards for color rendering capabilities may enroll actors such as residents.

Goal: Energy efficient light such as LED allows new businesses to enter the lighting market. PROLYS focuses on high-quality (as in high color-rendering quality) LED to gain momentum in market as developer and supplier, where AKJ inventions focuses on developing quality electronical devices for LEDs.

- EU digital agenda.
- Related strategic projects such as 'Öresund Smart City Hub' and public employees at the municipalities.
- DOLL

Interessement devices: EU digital agenda strategy, workshops about the benefits of using outdoor lighting (the light poles) as an infrastructure for rolling out smart city strategies.

In emphasizing the *digital photonic properties as essential for intelligent = smart lighting*, a market for intelligent lighting is being established, including for private use. Opens up opportunities for entirely new ways of using light, that are relatively far away from existing household-related lighting patterns.

This group of actors do not however deal with private, residential lighting.

Goal: Intelligent LED lighting systems as a potential not only for achieving reductions in energy consumption from lighting but also as a medium for establishing smart cities. Light becomes a medium for reaching other goals.

- Lyngsaa A/S
- (Homeowners Information Centres (Bolius) book on modern danish Houses and lighting patterns.)*

Interesement device: LED as an opportunity for new ways of designing, where energy efficiency becomes an added bonus. Bolius further puts emphasis on how intelligent lighting sytstems "makes life easier in the home".

Goal: LED as gateway for other kinds of lighting design. Energy efficiency becomes an added bonus. Aestethics of lighting and lamps are emphasized.
Lyngsaa A/S is a new lighting company, developed after the EU minimum requirements for efficiency.

Group of actors (entities) enrolled in the socio-technical diagram of lighting, however seemingly opposing the dominant OPP	***Obstracle problems compromising the OPP and corresponding alternative interessement processes:***

- KHR archtects
- COROS
- (Louis Poulsen)

Obstacle problem: aesthetics are important, and energy efficiency should not be prioritized on the expence of architectural and design aspects.

	Interessement process: Light is an architectural element, and particularly LED has potential for mediating between building and surroundings, as it holds possibilities for making interactional light due to its potential for dynamic light. Light quality is therefore dependent on its color rendering capability and vividness, which is prioritized over energy reductions. **Goal:** Making good lighting – where light is a result of the intereaction between rules, meanings competences behind designing. This also includes interplay with daylight.
• Environmental psychology researchers such as Associate Professor Thorbjørn Laike	**Obstacle problem:** non-visual effects of lgith influences health and weelbeing – a topic that seems completely ignored in OPP. **Interessment process:** Non-visual effects of lighting are essential aspects of all light sources, be they incandescent, CFL or LED. The spectral distributionhas significance for circadian rhythm. Energy effienciency should not be prioritized over health issues. LED may be a good way to accommodate these considerations though, due to the possibility of designing the spectral distribution. **Goal:** to ensure good lighting which means lighting that is appropriate in relation to the circadian cycle of sleep and wakefulness.
• SYN-TES (Arts, Craft and Design research project)	**Obstacle problem:** Colour is an underestimated subject in much lighting-related research and development (including policymaking). **Interessment process:** Special emphasis is put on the spatial interactionof colour and light in architecture. By seeking to transform the field of colour and light into acoherent field of research, tis allicance seek o emphasize the identifying important problems and the development of theoretical and methodological tools for the transdisciplinary understanding necessary to solving them. **Goal:** Color should have much higheror different priority for research and development of lighting. If so, quality of lighting would increase.
• Residents, here presented as a somewhat unified group, although Part 1 show differences between residential settings. None of the settings seems addressed by other actors though, and they are therefore presented as	**Obstacle problem:** Lighting is facilitating household related activities. Current energy efficient alternatives for lighting do not always 'do' this 'properly' due to certain expectations about the quality of light derived from the way household-related practices are performed. Also,

one group. That said, residents already prone to new technologies due to positive experiences and social processes facilitating the use of the technology may be easiser to enroll.	''energy efficient' light does not always fit the xisting lighting system within the home (technically and aestethiclty). Some routines have developed in terms in relation to the use of CFL, but it seems difficult for residents to getnan understanding of how to use and navigate LED options. **Interessement process**: Lighting is a facilitator of household-related activities, such as dining and cooking. Lighting installed is light that facilitates these activities 'appropriately'. **Goal:** To be able to perform household related activities 'appropriately'. Lighting is a facilitator, not important or meaningful in itself. Interessement devices that focuses on technical aspects providing technically energy efficient light fail to enroll actors such as residents.

The above presentation seeks to draft a picture of the dynamics at play in the current (Danish) socio-technical diagram of lighting. In looking at these dynamics through notions from the sociology of translation, it is not only possible to draft the actor network of the socio-technical diagram of lighting; it also makes it possible to detect where the differences in definitions are, and what they look like. Based on this draft, multiple definitions of what lighting is and should be seem to be at play. However, there also seem to be developing strategies, or alliances, for closing down some of the differences between definitions. For instance, several alliances are made around LED as an intelligent light source, exhibiting LED as something else and something more than 'energy efficient'. As an example, there seem to be a few cases where actors are part of more than one actor group (in the above denoted with a *), which may imply that alliances are 'in the making' across definitions, or that the interessement process of both groups are not entirely convincing, i.e. not closing down alliances with other groups. In other cases, actor groups seems to have been established due to the need for other ways of problematizing 'energy efficient light' to include more and other aspects than mere product substitution. As an example, the EU digital agenda and related strategic projects such as DOLL appear to be an alliance of actors that seems to promote LED as an *intelligent* light source that approaches a solution for other city and municipal issues related to energy consumption. As DOLL is also involved in developing smart lighting solutions for care homes, it may contribute to disrupting some of the above-mentioned obstacle problems put forward by other actor groups, such as environmental psychologists focusing on non-visual effects of light and health-related aspects. Further, actors such as Lyngsaa A/S, Bolius and to some extent Louis Poulsen seem to reach out for alliances with architects and certain kinds of residents interested in trying out new things with light, in trying to bring forth the importance of aesthetics and function that can be reached through the use of LED. *However, issues of normality, routines and habits are not addressed in any obvious ways.*

In general, there do in fact seem to be very few initiatives, or goals, in terms of actively targeting and enrolling residents and residential lighting systems. This is interesting as household-related lighting patterns are deeply entrenched in the history of lighting, which plays an important role in the current 'shape' of the socio-technical diagram of lighting. Further, as established through zooming in on household-related practices, new lighting patterns are established around new kinds of technologies, such as halogen,

which are not necessarily as energy efficient as expected. In order to make current lighting-related changes intelligible for household-related purposes, treating lighting as lighting *patterns* instead of a matter of lighting products therefore seems essential. It therefore seems to be important to establish yet another problematization that challenges the existing OPP, namely one that proposes that:

'lighting is a problem in terms of general energy consumption related to the performance of practices, and this may be approached through facilitating energy efficient lighting patterns that are intelligible in terms of practices'.

In this way, residential lighting may be included in the deliberations, and the interessement processes may become more holistic in including actors across what seems to be dominant demarcations of what is institutional, residential and outdoor-related lighting. Therefore, I established and conducted my own lighting-related workshop, trying to promote residential lighting as well as to demarcate lighting systems a bit differently, namely as something that is developed across existing demarcations, and which are very dependent on practices and derived user patterns, which will be presented and discussed in the following.

8.3.1. Presentation and discussion of the concluding workshop "Lighting in Transition".

As a result of the findings across zooming in and zooming out on lighting-related practices, it seems appropriate to regard lighting as a result of interactions between multiple practices, derived standardized systems and problematization processes. Lighting patterns seem to evolve from these interactions, and essentially it seems that in order to obtain 'energy efficient' light, not only do the lighting products and technical systems need to be efficient, the lighting *patterns* need to be efficient too.

'Lighting pattern' is arguably a somewhat ambiguous term. However, in being ambiguous it opens up opportunities for including several of the obstacle problems that seem to exist for several of the identified groups of actors. 'Lighting patterns' may indeed include everything from a 'nice lighting experience' through 'healthy light' and 'intelligent and energy efficient light' to 'light that facilitates vividness and brightness in terms of colours'.

In order to open up a discussion on *lighting patterns*, I thus invited a number of people identified as key actors or representing key issues in the socio-technical lighting diagram (please see table 7) to discuss and share experiences and primarily to debate a topic that so far seems underprioritized:

"How should we understand good and efficient residential lighting – and how do we obtain it?"

The intention with the workshop was therefore both to create a forum where different expectations and different approaches to light could be discussed and related to a resientia setting, and to create a forum for discussing patterns across the socio-technical diagram of lighting. Bearing in mind that actors are operating within different institutionalized systems (as discussed in paper 4), actors operate within different object worlds (eg. Bucciarelli, 2002) that establish how a certain object is defined and what aspects of this definition are *taken for granted* and thus implicitly dealt with. Therefore, one of the intentions with the workshop was to *explore (some of) these object worlds as well as creating a forum for them to meet*. For instance, an actor defining lighting in terms of intelligent systems may take things for granted that actors more focused on non-visual effects of light would not necessarily know of, and vice versa.

Therefore, through exemplifying my explorations of the current configurations of the socio-technical diagram of lighting I asked the participants of the workshop to discuss challenges as well as possibilities with LED as a lighting source for general residential use, based on their experiences (e.g. revisit the programme in appendix 4). During the workshop, I introduced some aspects to inspire the discussions, based on my explorations of the current configuration of the socio-technical diagram of lighting, in order to create a common ground for the discussion to unfold by. The aspects I drew out can be seen in figure 6.

Essentially, figure 6 visualizes some of the aspects I have uncovered throughout papers 1 to 4 as well as in my investigation of the current socio-technical diagram of lighting. With a focus on the residential setting, hence the sketched-out floor plan, I attempted to bring some of the seemingly parallel discussions of lighting in terms of health and smart city structures I have identidied into a residential discussion. Through the figure, I aimed to get the workshop particpants to think about the following questions: What will residential lighting patterns imply for smart city planning and vice versa? How can discussions about light and health in schools and care homes be brought into a discussion of the residential setting and should it? How does healthy light become 'normal' if healthy light is not an essential part of daily life within the home, and what does it imply for 'comfort' notions connected to residential light, as I have uncovered in papers 1 and 2? What does dynamic light mean for residential lighting patterns, and should/will dynamic light be facilitated through building design?

Based on some of the deliberations behind these questions, the intention of the workshop was to articulate what it seems to take to 'make LED work' in a residential sense. Who is doing what and how and why? As my studies show that no one really incorporates practice considerations in the development of (residential) lighting and that the residential scene is not really included in spite of it being subjected to significant changes in terms of lighting, this was my attempt to bring my findings into play and hopefully shape a new interessement process, problematizing lighting and related energy consumption in a way that is intelligible for the residential setting.

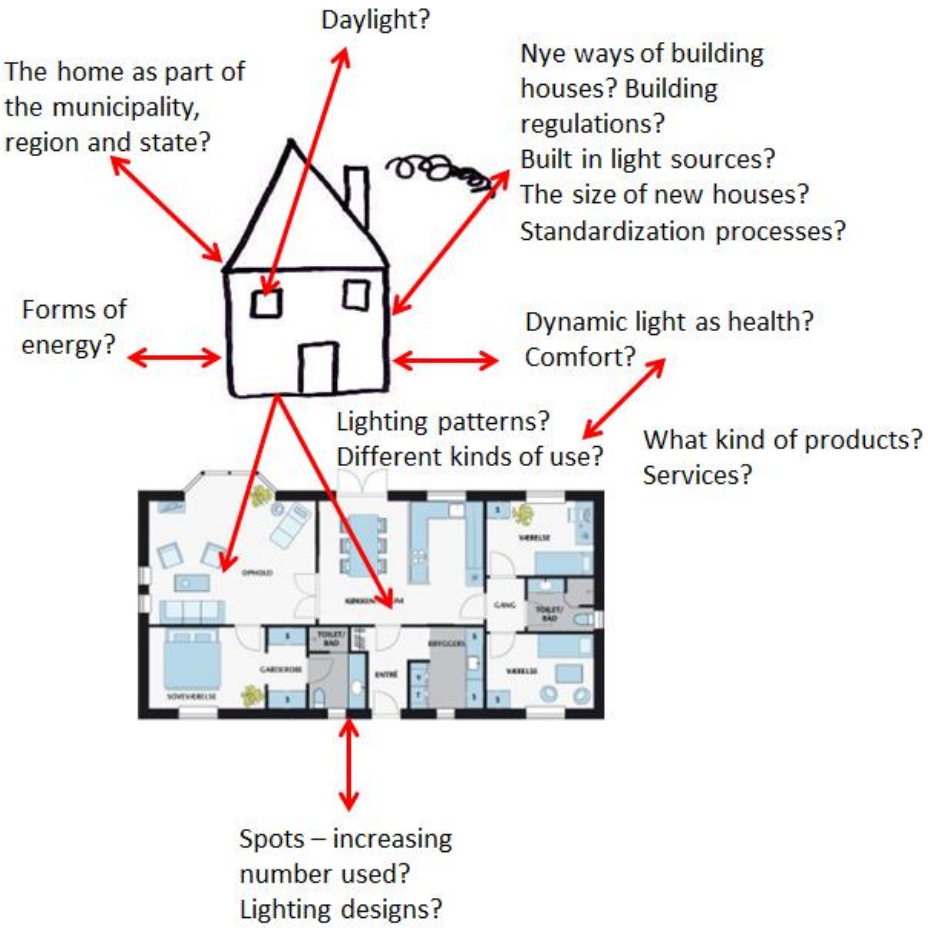

Figure 6: Aspects covered at the workshop regarding the problematization process of redefining how good energy efficent lighting for the home should be understood – and approached.

Presenting aspects for discussion in this way allows for an opening up of a discussion on lighting patterns and what these patterns are comprised of. Notably, the household has a central role in this presentation, which it does not necessarily need to have for discussing all aspects of lighting patterns. This was, however, an attempt to include households and residential lighting in the discussions, as this seems to lack significance in ongoing developments. Essentially, in this way I attempted to utilize the workshop as an interessement device in order to enrol actors in my problematization of 'energy efficient light'. Various interesting aspects related to lighting patterns were discussed, such as how to design lighting atmospheres, as presented by Lone Stidsen, and though this was something that most of the participants found interesting and relevant, it is difficult to say whether the workshop worked the way I intended; It seemed like most of the partipants left the workshop bearing in mind that thinking across areas such as legislation, use and design is essential. As I received very little feedback on the workshop other than that the particpants found it interesting and worthwhile due to the 'new angle on already debated issues', I presume that the workshop worked as 'food for thought'. Our aim to get the particpants to think about and propose 'next steps' however did not go entirely as planned, as no one gave any precise and binding promises to take anything further. Yet, one of the participants were willing to participate in making and publishing a practice-oriented user manual through his lighting company, and to facilitate public events about it, which is therefore, in the moment of writing, a pending activity resulting from the workshop.

CONCLUSIONS

It can be concluded that lighting is important in relation to energy consumption as well as environmental and climate issues. In acknowledging that, the EU commission is seeking to find ways to reduce the energy consumption from lighting, within the residential sector among others. In this process past forms of regulation of lighting have primarily focused on substituting light sources with more energy efficient types of light sources.

Part 1 shows that this kind of regulation is not particularly effective, partly due to a rebound effect, partly due to the way that lighting is used and perceived. Part 1 concludes that lighting should be considered in relation to the practices in which it is used, and it also shows that social processes play an important role in incorporating new light sources. Targeting lighting patterns instead of just lighting products therefore seems essential. The question is how to include this knowledge in a policy perspective. In order to look into this, Part 2 opens up for a broader focus on how technology, regulation and different kinds of practices evolves and interacts in relation to development and distribution of lighting technologies. Through analyses of the historical as well as the contemporary development of (electrical) lighting, Part 2 shows that processes involving lighting are highly shaped by and influencing practices that exist, disrupt or develop. This makes it important to understand not only the household related practices that are involved, but also the planning and designing strategies that are involved in the development of lighting, as an important part of legitimatizing and perhaps creating certain ways of illuminating which then again requires and acquires certain levels of energy consumption. Part 2 concludes that there are several obstacle problems at play in the process of developing and marketing new, efficient lighting technologies. The differences challenges the validity of what seems to be the currently dominating problematization of lighting that treats lighting (merely) as an energy issue, that can be solved through substitution. Various actors seem to be defining lighting differently, and the process of establishing the LED as a new lighting source is thus challenged by different and sometimes conflicting interessement processes. Creating forums for actors that define lighting - and what lighting 'should be' - differently, could be a way of supporting a transition towards energy efficient lighting systems and lighting patterns. A number of suggestions for facilitating a transition towards energy efficient lighting patterns can be given, based on the assessment of the current socio-technical diagram of lighting and in correspondence to the theoretical frameworks applied for the research

For one, (re-)focusing on design and innovation processes, both in terms of lighting products and lighting systems, seems beneficial, in order to include knowledge about practices. Where do we need to optimize, and how, and in what ways do energy efficient light become meaningful and thus a 'configuration that works'? Paying attention to finding ways to focus on lighting patterns in stead of looking only on individual lighting products may be a way to approach the design and innovation processes. One way to do this could be to focus on designing lighting atmospheres, which was one of the aspects presented by one of the participants at my workshop "Lighting in Transition". Based on the results of the assessment of the socio-technical diagram of lighting as well as the studies of how people use and interact with lighting within the home, it could be beneficial to launch lighting experiments, such as show-rooms and real-sized arrangements of alternative ways of illuminating the home. In this way, it would be possible to assess what kind of lighting patterns would evolve from the arrangements, if people were to live with them for a while, and trying them out. This seems to be included in some of the ongoing projects for 'future lighting' that

focuses on developing intelligent lighting, also in relation to health aspects. However, there is room for including everyday life and practice considerations in these projects.

For all intents and purposes, gathering existing experiences seems essential as well as to establishing partnerships; as it has been recognized, a lot of projects with different kinds of problematization as well as interessement processes are currently developing, however it is difficult to see whether any one is making assessments *across* the projects, which would be beneficial in terms of obtaining cohesive developments. Gathering up the threads across the projects, experiments and discussion may help a more cohesive standardization process as well. One of the conclusions from my research seems to point in the direction that silo-based developments within product design, Eco-design directives, and measuring procedures in terms of colour-rendering capabilities are causing some troubles for the standardization processes. Further, with the emerging new schemes for smart houses and smart cities, even more areas that are subject to policy-based regulations (building construction, roads etc) will be determining for the shaping of lighting (smart lighting). Thus, the thesis suggests including the above mentioned deliberations going *across* sectors, in relation to EU regulations and other kinds of policy initiatives in order to obtain lower energy consumption from lighting.

Summing up, my main contributions with this thesis are:

Empirically:

What others have shown in other areas related to energy consumption, such as heat and comfort related practices, I have shown in relation to lighting-related practices and corresponding energy consumption issues. I have therefore contributed to the collection of studies of energy consumption and practices with a new empirical focus, establishing that practices, rather than pure technological developments, are essential in aiming for energy savings. Further, I have shown empirical examples of how practices seem to be influenced, re-configured and re-established through social processes, such as in the case of Munksøgaard. I have made an empirical contribution in terms of trying out the zooming in and zooming out toolkit that Nicolini (2012) suggests, and therefore contributed empirically to the discussion of how to utilize a practice theoretical approach together with socio-material frameworks such as ANT. Lastly, I have experimented with enrolling myself as an engaged actor in the field that I am researching, trying to establish an interessement process corresponding to what I have learned across the lighting projects, discussions, topics and practices I have studied.

Theoretically:

I have theoretically contributed to the discussion of how to combine practice theoretical frameworks with frameworks within ANT and more system-focused frameworks such as the MLP. Through the discussion and exercising of combining aspects within the various frameworks, I have added to the discussion of how to point towards new, alternative ways of including practice theoretical considerations in policy making. I have contributed to the discussion of how to theoretically (re)think what a transitions entails and how it should be approached empirically, by asking what different theories call a transition, and how one can empirically approach these different definitions.

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APPENDICES

Appendix 1 – Details on EU regulations of lighting

In the 1990ies, the EU introduced an Integrative Product Policy (IPP) framework as a reaction to the increasing quantity, variety and complexity of products with new types of products regularly being introduced to the market with an increasing level of global trade. The IPP aims to promote measures to reduce the environmental impact of products in an as effective way as possible (DEA, 2012). The IPP includes both voluntary initiatives and regulations. Lighting products are subject to legislation tools implemented through the IPP framework, such as the Eco-Design Directive, the Energy-labelling Scheme, and the Eco-labelling Scheme. The Eco-design Directive is a mandatory regulation that enforces certain minimum requirements for energy consuming products, banning the production and distribution of products that do not live up to the requirements. The Energy Labelling Scheme is, much like the Eco-Labelling scheme, meant to stimulate both supply and demand of products with reduced environmental impacts (Jørgensen and Jensen, 2012). Further, they are information-providing frameworks that are meant to help the consumer to choose the most efficient product. Both schemes vere originally based on voluntary engagement; however the Energy-Label became mandatory for all energy consuming products in 2011.

The following subsections will describe the details of each of the frameworks, as a supplement to the section about lighting as a legislative matter presented in the Introduction.

Detals on Lighting and the Eco-design directive

The Eco-design Directive is implemented nationally through framework laws, and each product group is regulated through specific national acts. In Denmark, the national compliance of the Eco-design Directive is implemented through the framework law 308 - 30/04/2008.

The efficiency targets for light sources as put forward by the Eco-Design Directive have been implemented in three acts. Two of them became effective from September 2009. One of them; EC no 245/2009 (EC, 2009a) is focused on certain types of fluorescent light sources as well as high intensity discharge lamps. This act is mainly directed at street lamps and lighting for the service sector. The other one; EC no 244/2009 (EC, 2009) is focused on residential light sources and covers *non-directional light sources for residential use.* The third one; EC no 1194/2012 (EC, 2012) covers *directional light sources, and all LED-light sources (directional and non-directional) for residential use,* which becomes effective from March 2014, and therefore is not enforced yet. This means that non-directional LEDs that are already covered in the 244/2009 will be subject to new requirements before long.

Lighting in the EU energy- and eco-labelling scheme

The Energy labelling scheme and the Eco-labelling scheme both set out criteria that goes beyond minimum requirements and is thereby meant to create incentives for so-called front-runners. In other words, the eco-design directive ensures that certain minimum requirements are met, whereas the Energy labelling scheme gives the producers the possibility to show that their products are more efficient and the consumer the possibility to choose the product that is most efficient during the consumption phase. The Eco-labelling scheme allows the producer to show that they have taken other environmental aspects into consideration than what is established as the minimum requirements, and allows the consumer to choose the product with a lower environmental impact in varies parts of the products lifecycle.

The Energy- as well as the Eco-Label is therefore meant to help the consumer to buy energy efficient or environmentally friendly products, by focusing on the lifecycle of the product in stead of merely the moment of purchase, and that it pays off to 'invest' in a energy efficient or enviontally friendly product. The details of both schemes in terms of lighting, is presented below.

Details on Lighting in the EU Energy-Label

The energy label is supposed to help the consumer to acknowledge these benefits of purchasing the energy efficient light sources. To enable consumers to buy more energy efficient bulbs, the European Commission developed Directive EC 11/1998 that set mandatory energy labelling requirements for household bulbs (with the exclusion of directional lamps) under Framework Directive EEC 75/1992 concerning the energy labelling of household appliances. The EEC 75/1992 has recently been replaced by the EC 30/2010, and EC 874/2012 is a delegated act under EC 30/2010 that replaces EC 11/1998, as products have become too efficient to be appropriately covered by the previouse act, but also to meet the requirements of covering the Enery Related Products (ErP) as introduced by the Eco-design Directive update from 2009 (EU 30/2010). The new energy label thus also covers the luminaires not just the bulbs (EC 2012) . A new scale for the Energy Label has subsequently been introduced. From 1st of September 2013, all subsequently produced light bulbs must carry the new Energy Label in order to be allowed on the market[9].

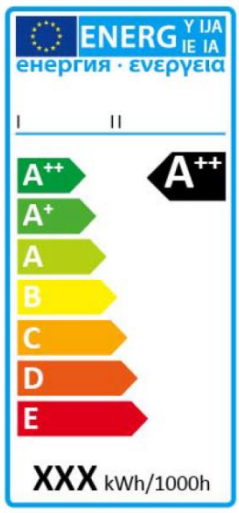


Figure 7 EU energy label for household lamps (bulbs)

Not only does the light product carry a label like the one presented in figure 7, the luminares that are produced after September 2012 also need to carry a label. This is due a recent change in the Eco-Design Directive, that does no longer only apply for energy using products (EUPs) but energy related products (ERP). Although this change is positive in terms of incorporating products that could be considered energy consuming, but was not covered by the Eco-Design Directive focusing on EUPs, this does complicate the way consumers should navigate the market of energy consuming products.

[9] Source: http://lednet.dk/artikler/lovlige-led-lyskilder/

The luminaire can either have a built in light solution or the luminaire can be compatible with certain light products, or the luminare can have both built in LEDs and be compatible with other types of light products. Henceforward, the consumer can meet several versions of the general label, as can be seen in figure 8.

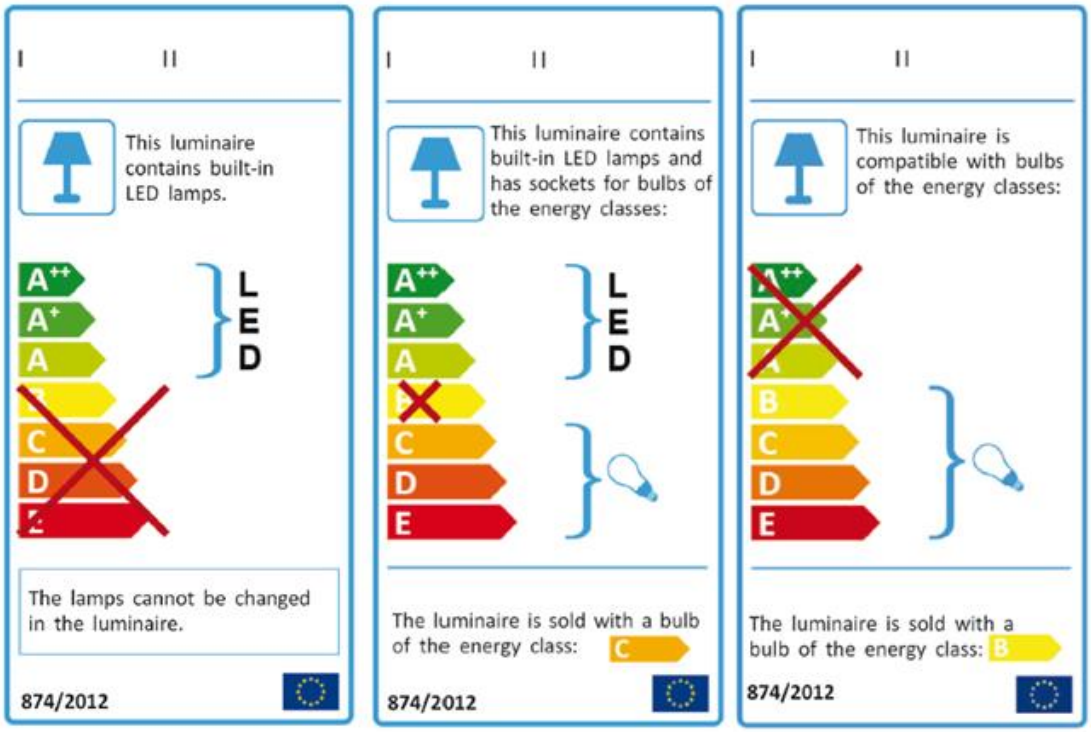


Figure 8 examples of energy labels on luminaires (from EC, 2012)

Where as the Energy Label informs the consumer about energy consumption tied to the consumption phase of the products lifecycle, the Eco-label set out criteria across the entire lifecycle, and therefore includes environmental impacts in production and disposal phases. In the following the Eco-Label criteria will be elaborated on.

Details on Lighting in the EU Eco-labelling scheme

The EU 331/2011 (EC, 2011) establishes the ecological criteria for a light source for it to be awarded the EU Eco Label. This is in oppostition to the Energy Label and the Eco-Design Directive a voluntary scheme, . To acquire the EU Eco-Label, the light source has to comply with 11 critieria, as specified in figure 9

EU Eco-Label Criteria

1. Energy efficiency, lifetime, lumen maintenance and mercury contents
2. Switch on/off
3. Colour rendering index
4. Colour consistency
5. Hazardous substances and mixtures
6. Substances listed in REACH
7. Plastic parts
8. Packaging
9. User instructions
10. Social accountability
11. Information appearing on the EU Ecolabel

Figure 9 EU Eco-Label Criteria (based on EC 2011)

The intension of the EU ecolabel criteria isparticularly to reduce environmental impacts from lighting, but also to *"encourage the implementation of best practice (optimal environmental use) and enhance consumers´ environmental awareness*" (EC, 2011 p. 15). The Eco-Label scheme is therefore meant to comprise even further incentives for the 'environmentally aware' consumer. For instance, the energy efficiency criterion is 10 % higher than the lumen/watt value for energy class A (corresponding to the previous Energy label from 1998 which has just been replaced.)

With criterion 9 and 11, the label provide information that is aimed at the consumers with the purpose of raising their environmental awareness and implement optimal environmental use. Apart from information based on other criteria, the ninth criterion (User instructions) includes information on energy and money savings when attention is given to turning off the light when not used. Criterion 11 encompasses the information to be applied on the packaging. These following bullet is to be applied to the product:

- High energy efficiency – *saves money*
- Long life time,
- Performance tested.
  (EC, 2011 p. 19, emphasis added)

Appendix 2 – Example of interview guide for residential case studies - in Danish and English translation.

Danish version of the interview guide:

Interview guide – Munksøgård

"Mit projekt handler som sagt om at finde ud af, hvordan mennesker bruger og forholder sig til kunstig belysning – hvad der er vigtigt, når man køber pærer, lamper, og hvordan lys indgår i forskellige dagligdags situationer. Interviewet er fastlagt til at tage lidt over en time, og størstedelen af tiden vil vi være i de forskellige rum, ved jeres lamper. Vi ser, om vi kan nå alle sammen.

Jeg vil meget gerne have lov at optage interviewet, hvis du tillader det. Jeres fulde navne bliver ikke gengivet i mit arbejde med jeres interviews, men det vi gennemgår her i dag, vil indgå i forskellige analyser jeg laver, i forbindelse med mit projekt.

Kan vi gå en tur rundt i dit/jeres hus/lejlighed, så jeg kan se jeres lamper?"

Start med:

- Hvilken lampe har du senest købt? (alternativt, den lampe du bedst kan lide)
- Hvornår?
- Hvor?
- Hvilke overvejelser?

Ved gennemgang pr lampe/pr rum:

Lamper:

- Hvornår bruger du denne lampe?
- Er der situationer, hvor du ikke ville bruge lampen?
- Hvordan vil du beskrive lyset du har her?
    - Er du tilfreds med lyset?
    - kan du give mig eksempler på hvad der er 'god/dårlig lys' (omvendt af hvad der er blevet talt om i spørgsmålet oven over…)?
    - er der andre aspekter der indgår i 'dårligt lys'? 'Godt lys'?
- Hvem købte lampen?

Pærer:

- Hvilken pære sidder der i denne lampe?
- Hvornår købte du pæren?
- Hvor købte du den?
- Hvem købte den?
- Hvilke overvejelser gjorde du dig, da du købte denne pærer? (kan du huske det?)

- Er der andre lampekøb, hvor overvejelserne bag adskiller sig fra overvejelserne omkring dette køb?
    - Hvis ja, går vi til den lampe.

Mere generelt:

- Er der nogen af lamperne der var her, da du flyttede ind?
    - Hvad synes du om den?
- Er der en eller flere af lamperne der er et arvestykke/en gave?
    - Kan du fortælle mig om den?

- Er der nogen lamper/pærer der har fået dig til at tænke over de omkringværende møbler eller vægges farver?

Her til slut:

- Hvornår og hvorfor flyttede du til Munksøgård?
    - Hvilke overvejelser lå der bag?
- Hvad er et økologisk bofælleskab for dig?
- Hvad har gjort at du gerne vil deltage i denne undersøgelse?
- Hvilken uddannelsesmæssig baggrund har du, og hvad arbejder du med?
- Kan jeg eventuelt bede dig om at tilsende mig et print af dit gennemsnitlige el-forbrug fra sidste år? Der behøver ikke være personlige data på.

English translation of the interview guide:

Interview guide – Munksøgård

"As I have mentioned, my project is about finding out how people use and relate to artificial lighting - what is important when buying bulbs, lamps, and in what way light is part of different everyday situations. The interview is set to take a little over an hour, and it is the intention to visit your lighting installations in the various rooms in your househ/apartment, to talk about the light 'on site'. We shall see if we get to all of them.
I hope you will allow me to record the interview. Your full name will not appear in my work, but what we talk about today during the interview, will be included in the analyses I make for my research.

Will it be okay to start the tour around your house/apartment, so that you can show me your lamps?"

Begin with:

- What is your last lamp purchase? (alternatively, which lamp dp you like the most?)
- When
- Where?
- What considerations?

In assessing each lamp/room:

Lamps:

- When do you uset this lamp?
- Are there any situations, for which you would not use this lamp?
- How will you describe this light?
    - Are you satisfied with this light?
    - Can you give me any examples of good/bad light? (empasise the reverse of what was mentioned in the question above)?
    - Are there any other aspects of good light/bad light?
- Who purhased the lamp?

bulbs:

- What kind of light bulb is in this lamp?
- When did you buy the bulb?
- Where didi you buy it?
- Who bought it?
- What considerations did you make when purchasing this bulb? (do you remember?)
- Are there any lamp-purchases that differs from the purchase of this lamp?
    - If yes, then we will explore that lamp

Generally:

- Were any of the lmaps here, when you moved in?
    - What do you think of it?
- Are there one or more of the lamps that were a gift to you, or a family heirloom?
    - Can you tell me about it?

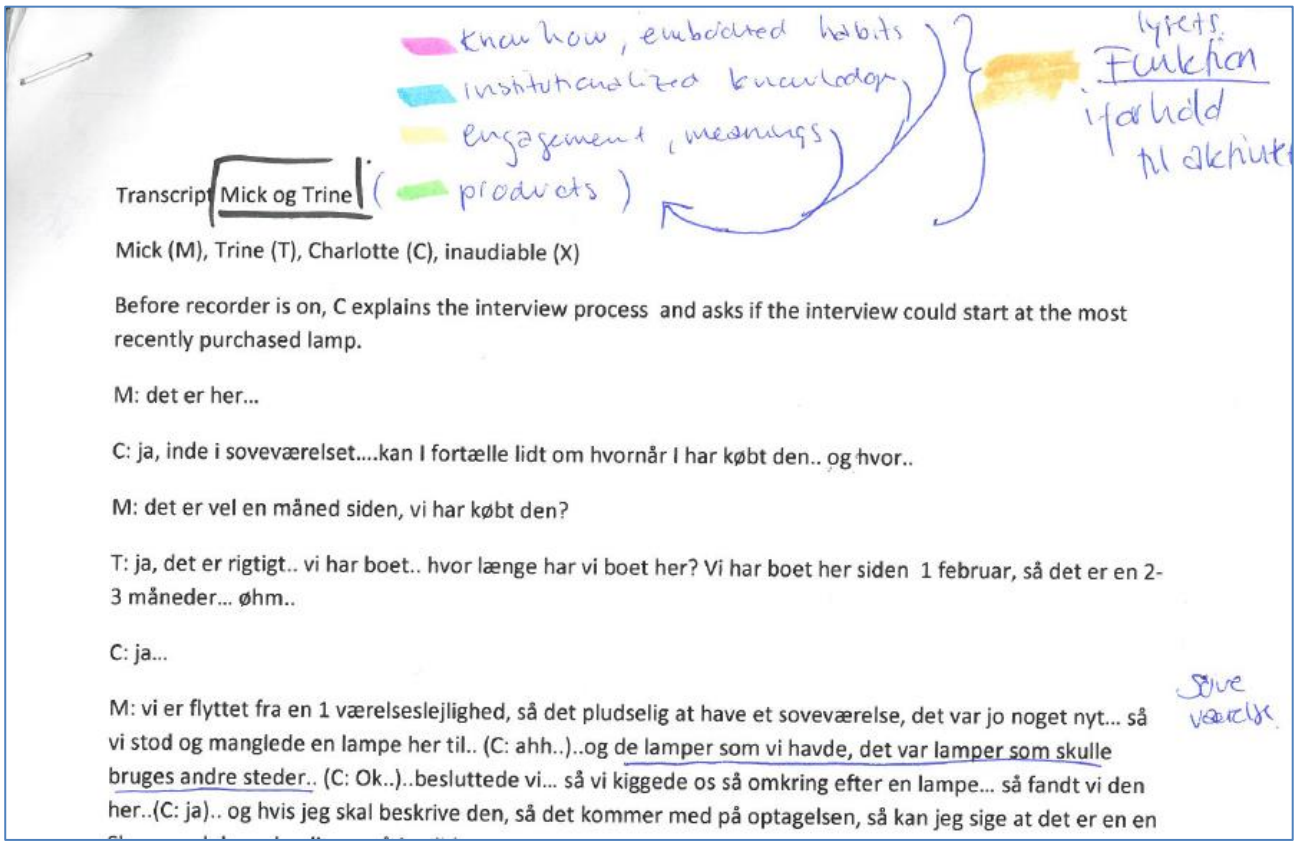
- Have anye of the lamps or bulbs made you think about the colors of nearby furniture and walls?

Finally:

- When and why did you move to Munksøgård?
    - What considerations did you make?
- What is an ecological community to you?
- Why did you volunteer to partake in this interview?
- What is your educational backgground and what do you work with?
- Can I ask you to send me a copy of your electricity consumption from last year? You can delete all personal information of course.

Appendix 3 – an example of the coding process for interviews exploring household practices

Below is shown two examples of the coding process for the interviews conducted in the two household case studies. The transcripts are available in printed format, if so needed for the official assessment.



Transcript Mick og Trine

Mick (M), Trine (T), Charlotte (C), inaudiable (X)

Before recorder is on, C explains the interview process and asks if the interview could start at the most recently purchased lamp.

M: det er her...

C: ja, inde i soveværelset....kan I fortælle lidt om hvornår I har købt den.. og hvor..

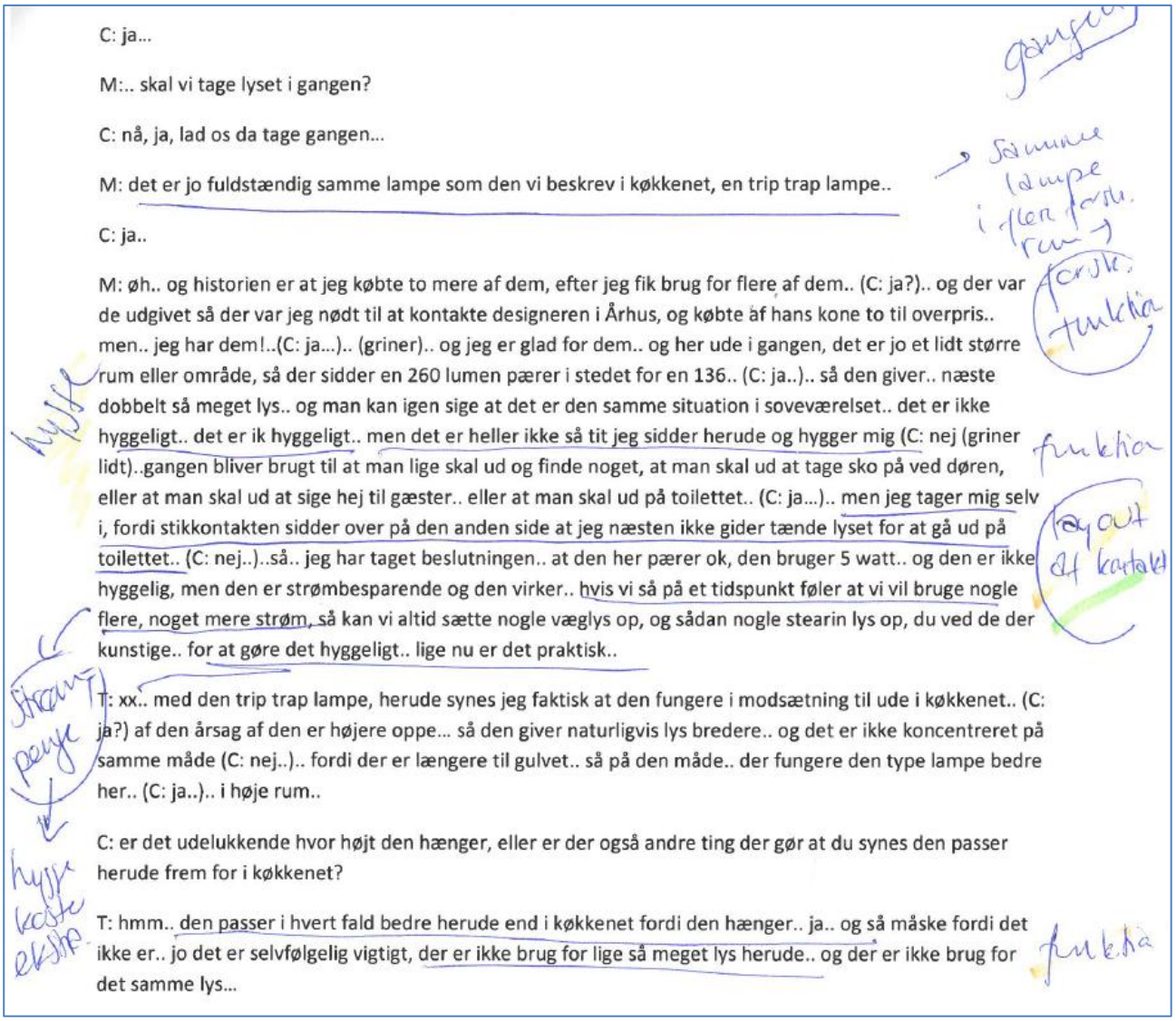
M: det er vel en måned siden, vi har købt den?

T: ja, det er rigtigt.. vi har boet.. hvor længe har vi boet her? Vi har boet her siden 1 februar, så det er en 2-3 måneder... øhm..

C: ja...

M: vi er flyttet fra en 1 værelseslejlighed, så det pludselig at have et soveværelse, det var jo noget nyt... så vi stod og manglede en lampe her til.. (C: ahh..)..og de lamper som vi havde, det var lamper som skulle bruges andre steder.. (C: Ok..)..besluttede vi... så vi kiggede os så omkring efter en lampe... så fandt vi den her..(C: ja).. og hvis jeg skal beskrive den, så det kommer med på optagelsen, så kan jeg sige at det er en en

Figure 10 example of coding process



C: ja...

M:.. skal vi tage lyset i gangen?

C: nå, ja, lad os da tage gangen...

M: det er jo fuldstændig samme lampe som den vi beskrev i køkkenet, en trip trap lampe..

C: ja..

M: øh.. og historien er at jeg købte to mere af dem, efter jeg fik brug for flere af dem.. (C: ja?).. og der var de udgivet så der var jeg nødt til at kontakte designeren i Århus, og købte af hans kone to til overpris.. men.. jeg har dem!..(C: ja...).. (griner).. og jeg er glad for dem.. og her ude i gangen, det er jo et lidt større rum eller område, så der sidder en 260 lumen pærer i stedet for en 136.. (C: ja..).. så den giver.. næste dobbelt så meget lys.. og man kan igen sige at det er den samme situation i soveværelset.. det er ikke hyggeligt.. det er ik hyggeligt.. men det er heller ikke så tit jeg sidder herude og hygger mig (C: nej (griner lidt)..gangen bliver brugt til at man lige skal ud og finde noget, at man skal ud at tage sko på ved døren, eller at man skal ud at sige hej til gæster.. eller at man skal ud på toilettet.. (C: ja...).. men jeg tager mig selv i, fordi stikkontakten sidder over på den anden side at jeg næsten ikke gider tænde lyset for at gå ud på toilettet.. (C: nej..)..så.. jeg har taget beslutningen.. at den her pærer ok, den bruger 5 watt.. og den er ikke hyggelig, men den er strømbesparende og den virker.. hvis vi så på et tidspunkt føler at vi vil bruge nogle flere, noget mere strøm, så kan vi altid sætte nogle væglys op, og sådan nogle stearin lys op, du ved de der kunstige.. for at gøre det hyggeligt.. lige nu er det praktisk..

T: xx.. med den trip trap lampe, herude synes jeg faktisk at den fungere i modsætning til ude i køkkenet.. (C: ja?) af den årsag af den er højere oppe... så den giver naturligvis lys bredere.. og det er ikke koncentreret på samme måde (C: nej..).. fordi der er længere til gulvet.. så på den måde.. der fungere den type lampe bedre her.. (C: ja..).. i høje rum..

C: er det udelukkende hvor højt den hænger, eller er der også andre ting der gør at du synes den passer herude frem for i køkkenet?

T: hmm.. den passer i hvert fald bedre herude end i køkkenet fordi den hænger.. ja.. og så måske fordi det ikke er.. jo det er selvfølgelig vigtigt, der er ikke brug for lige så meget lys herude.. og der er ikke brug for det samme lys...

Figure 11 example of coding process

Appendix 4 – Workshop program (English translation)

Invitation to SusTrans-workshop:

”Lighting in Transition”

Thursday, November 7, 2013,

Aalborg University Copenhagen

A. C. Meyers Vænge 15 room 4.058,

2450 KBH SV,

9.00-17:00.

The many new players in the lighting field, the new opportunities in terms of lighting, design and future housing construction, the numerous assumptions and uncertainties associated with new forms of lighting (both producers and consumers side), not to forget the assumptions from which people choose light, form a complex web of issues, all of which are important in the formation of certain kinds of lighting patterns as well as the defection of others. With the need for lighting patterns to become more energy efficient and the total energy consumption for lighting to be reduced as part of achieving an environmental and resource more sustainable future, it is time to ask the question:

“How should we understand good and efficient residential lighting
– and how do we obtain it?”

This workshop will deal with this issue. As the Sustrans project that organizes this workshop deals with sustainable transition in focusing on practices and actor-network, it is essential to look at the professions that work with lighting and identify what 'good lighting' is for these professionals, and through which practices this is intended achieved. It is also important to map energy saving potentials and whether the LED is 'the way forward', as many reports suggest. Further, it is important to discuss what could be any next steps in the development towards better and more energy efficient residential lighting.

PROGRAM:

9:00-9:30: Coffee

Artificial lighting – what is it and what does it mean for us as human beings?

9:30-10:00: Welcome and introduction (Charlotte Louise Jensen)

10:00-10:30: Anne Bay, President DCL**; Lighting right now** (15 min presentation and 15 min for questions).

10:30-11:00: Lone Stidsen, Post Doc AAU: **Lighting atmospheres: what does light mean for our well-being? Potentials and challenges in designing lighting atmospheres.** (15 min presentation and 15 min for questions).

11:00-11:30: Malene Lytken, PhD candidate at the royal Danish academy of fine arts: **The history of the lamp shade: why do we illuminate our homes the way we do today?** (15 min presentation and 15 min for questions).

11:30-12:00: Ellen Kathrine Hansen, architect and external lecture at AAU: **Lighting in development - the new lighting education at AAU.** (15 min presentation and 15 min for questions).

12:00-13:00: Lunch

Specifically looking at LED.

13:00-13:30: Rune Larsen, CEO Normasym og author of "LED-bogen": **LED: potentials and challenges** (15 min presentation and 15 min for questions).

13:30-14:00: Kenneth Munck, ÅF Lighting, Chairman of Danish Standards S-61 board for artificial lighting: **Standardizations in terms of lighting, as well as systemic and technical challenges with the LED as a new light source.** (15 min presentation and 15 min for questions).

14:00-14:30: Flemming Madsen DLIN: Municipal and regional challenges with energy consumption and lighting – provisional initiatives and how these are thought to have influence on private (residential) lighting. (15 min presentation and 15 min for questions).

14:30-15:00: Henrik Bendz og Christian Krause, COROS: **Design possibilities with LED- opportunities and challenges?** (15 min presentation and 15 min for questions).

15:00-15:15 Coffee and cake.

15:15-17:00: Who is doing what now? Opportunities and barriers to better and more energy efficient lighting in homes: What could be the next steps in the design, innovation, experimentation, experiences, governmental regulation, private-public partnerships, etc.?

- "I have heard this and this today, how can I go on with this?"
- Suggestions for new fora?

PAPERS 1, 2, 3 and 4