Get Ready for Activity – Ambient Day Scheduling with Dementia

Market Analysis

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Preface

This document forms part of the Research Project "Get Ready for Activity – Ambient Day Scheduling with Dementia (GREAT)" funded by the AAL 2016 "Living well with dementia" funding program as project number AAL-2016-023. The GREAT project will produce the following Deliverables:

D1.1 Medical, psychological, and technological framework

D2.1 Applicable hardware components

D2.2 Applicable software components

D2.3 Field tested hardware components

D2.4 Field tested software components

D3.1 Implementation report

D3.2 Field test report

D4.1 Communication strategy

D4.2 Stakeholder management report

D5.1 Report on market analysis

D5.2 Dissemination plan

D5.3 Final business plan

D5.4 Exploitation plan

The GREAT project and its objectives are documented at the project website http://uct-web.labs.fhv.at. More information on GREAT and its results can also be obtained from the project consortium:

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Executive Summary

The market analysis has been conducted primarily by the industry partners with a view to commercialisation of the GREAT solution. It investigates the economic opportunities in terms of market volume, (potential) customer segments and their respective quantified benefits. It is very much focused on the GREAT luminaire because it has the greatest market potential. Besides, we are not planning to market or sell the other modules (scent and sound) independently but only as part of an integrated solution.

The market potential for AAL solutions in general, and for dementia, in particular, is enormous, given demographic developments. The increasing penetration of technology esp. wearables and smartphones, are further growth drivers. The commercialisation of AAL solutions, however, faces tough challenges such as the fragmentation of the market, a lack of information and transparency, which results in a lack of market intelligence, as well as complex regulatory environments, lack of technical skills as well as privacy and security concerns.

To enter the market successfully, we have moved away from a linear value chain to an umbrella market where different actors work more closely together to develop and market our common solution. Besides, we pursue a solution-oriented selling approach which includes consulting and planning, rather than a straight-forward, product-based business model.

The B2B2C consumer model has emerged as the most suitable model where an intermediary can facilitate access through avenues such as distribution or marketing networks. For example, a nursing home buys the integrated solution that has the backing or has been recommended by a trusted third party such as CURAVIVA, the national organisation of care facilities. In the GREAT project, this translates into a

- Single contact&access point
- Coordinator/Orchestrator

Whereas the contact point should be neutral, non-profit and focus on providing advice and guidance, the role of orchestrator who coordinates the whole value creation network including planning, consulting and post-purchase support, could also be taken on by a private company.

The GREAT system can be sold as an integrated solution (luminaire, scent and sound), which may well be the preferred option for institutional care facilities. As far as mobile installations for private customers are concerned, we consider leasing as the most attractive option given the dynamic progress of the disease. By integrating app control into our installations, use, installation, configuration and updates of the system are independent of time and place.

The GREAT project was launched to improve the quality of life of people with dementia as well as their families and formal and informal caregivers. Whilst these customers segments are still in the centre of our endeavours, we see an even greater opportunity to market the GREAT solution, esp. its lighting component, to additional customer segments in the office and industrial sectors.

1 Introduction

1.1 Objectives and scope

This deliverable is intended to provide an analysis of the markets that are relevant to the GREAT solution and its various components. It investigates the economic opportunities in terms of market size, (potential) customer segments and their respective profitabilities. It also discusses strategies concerning market entry and future prospects. It does not report on academic and non-academic dissemination activities of the results of the project such as conferences, contacts to potential partners, exhibitions, etc. These are discussed in the Deliverable 5.2 Dissemination plan.

The market analysis is very much focused on the GREAT luminaire because it has the greatest market potential. Besides, we are not planning to market or sell the other modules (scent and sound) independently but only as part of an integrated solution.

It is based on the following internal documents:

- GREAT Proposal and the related Description of Work
- A 1-year student project about technological support for people with dementia and their caregivers, which also included looking at possible business models[1]
- A master thesis about technical assistance systems for people with dementia[2]
- A study commissioned by CURAVIVA on the acceptance of AAL solutions by end-users[3]
- A market analysis prepared by Bartenbach concerning the free-standing luminaire

The Market Analysis is furthermore related to the following deliverables:

- D5.2 Dissemination plan
- D5.3 (Intermediate) business plan
- D5.4 Exploitation plan

We have consulted the recent report "AAL Market and Investment Report" prepared by the *Technopolis group* in May 2018[4], as well as specific reports related to the lighting industry, e.g. the White Paper on Human-Centric Lighting[5], the study prepared by A.T.

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[1] Zoller, C., Bögle S. & Chiavi (2016). Technische Unterstützung für Demenzkranke und deren Betreuungspersonen. Unpublished Report, FHS St. Gallen.

[2] Bachofen, S. (2016). Technische Assistenzsysteme für Menschen mit Demenz. Unpublished Master Thesis, FHS St. Gallen.

[3] Technologiekonzept für das Wohn- und Pflegemodell 2030 (2016). Prepared by FZI Forschungszentrum Informatik, Karlsruhe,for CURAVIVA. Unpublished Report.

[4] Varnay et al. (2018). AAL Market and Investment Report. A study prepared for the AAL Programme (Active and Assisted Living) by Technopolis Group, May 2018.

[5] Human Centric Lighting: Going Beyond Energy Efficiency. Report prepared by A.T. Kearney for Lighting Europe and the German Electrical and Electronic Manufacturers' Association (ZVEI), July 2013. https://www.lightingeurope.org/human-centric-lighting.

Kearney for LightingEurope and the German Electrical and Electronic Manufacturers' Association (ZVEI) and the presentations, also prepared by A.T. Kearney, on the quantified benefits of human-centric lighting.[6]

There is some overlap between the deliverables D5.1, D5.3 and D5.4 since all of them deal with the market potential, drivers and barriers for AAL solutions, value chains and business models to some extent. However, the emphasis is different: in the **Market Analysis** we focus on the overall market potential for the GREAT solution, in particular its lighting component, the relevant markets and customer segments and their expected quantified benefits as well as changing value chains and business models.

In **the Intermediate Business Plan** we discuss to what extent the original assumptions have been validated and if we have to revise the original plan as presented in the business model canvas, and if so, why and how.

The **Exploitation Plan** sets up the environment for commercialising the outcomes of the GREAT project. It presents the exploitable outcomes, both products and services, discusses the GREAT value propositions for different customer segments and their respective requirements and settings.

2 General market drivers and barriers

2.1 Introduction

Because of the close link between ageing and dementia, the market we address can be subsumed under the so-called "AAL market", i.e. the technologies, products and services offered in the **ambient or active assisted living** field. The AAL market is driven by demand pull, i.e. the rapidly growing population of the elderly, on the one hand, and technology push, i.e. the development of new ICT solutions, on the other hand. The AAL market has been attracting the interest by the ICT industry, service and care providers and investors in general, largely because it is considered a growth market due to demographic trends.

But most projects have found the AAL market quite challenging and only a few products and services have been successfully commercialised. This may be attributed to a lack of effective user involvement, the fragmentation of the market and the differences, e.g. in language, culture and capabilities.

In the following section we discuss the drivers and barriers in more detail with a view to their implications for the GREAT project.

[6] Quantified benefits of Human Centric Lighting (April 2015). Presentation prepared by A.T. Kearney for LightingEurope and the German Electrical and Electronic Manufacturers' Association (ZVEI), https://www.lightingeurope.org/presentations/180-quantified-benefits-of-human-centric-lighting-april-2015

2.2 Market drivers

According to the Technopolis report (Varnay et al, 2018), the main drivers in the market for AAL solutions are:

1. Demographics
2. Government incentives
3. Consumer behaviour and interest
4. Penetration of technology and technological and data developments

In the following, we discuss the drivers in more detail with a view to their implications for the GREAT project.

Demographics

The potential market for AAL solutions is enormous because the ratio of people in the EU that are aged 65 or above compared to the people aged 15-64 is expected to increase from 28% in 2015 to 50% in 2060. A specific challenge to old age is **dementia** and almost 6% of the EU population over 60 years of age suffer from dementia. It is estimated that the number of people with dementia will increase from 10m in 2015 to 13m in 2030 and 19m in 2050[7]. In Switzerland alone about 200'000 individuals are estimated to suffer from dementia. As we know, age is the most important risk factor for dementia. Whilst in the age-group between 65 to 79, less than 2% are affected, this goes up to about 13% in the age-group of 80 – 84. About two thirds of those who suffer from dementia are over 80 years old, and in Switzerland, the population of 80+ is predicted to grow 2.5 times by 2045.[8]

Depending on the severity of people's symptoms, they need varying levels of support. Besides, it is not only persons living with this disease, but also their formal and informal care-givers who are affected by the disease and require support.

We can therefore conclude that the GREAT solution has considerable market potential and that its most relevant customer segments, i.e. People with dementia and their caregivers, are set to grow.

Government incentives

Although there is growing political awareness that healthcare systems and long-term care for the elderly, in particular, could benefit from the integration of digital solutions, there are few government incentives to support this, at least in the countries participating in GREAT. In some countries such as the UK or Sweden, reimbursement schemes for assistive technologies do exist, but in Switzerland, Austria and Italy the market is largely driven by private investment.

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[7] Prince, M., Wimo, A., Guerchet, M., Ali, G. C., Wu, Y. T., & Prina, M. (2015). The global impact of dementia. *World Alzheimer Report*, 1-82.

[8] http://www.bfs.admin.ch/bfs/portal/de/index/themen/01/03/blank/key/ind_erw.html

BFS - Zukünftige Bevölkerungsentwicklung – Daten, Indikatoren - Schweiz Szenarien

This is why we are **not looking for reimbursement from insurers** or health authorities, but focus on creating value propositions that help relieve customers' pain points and respond to their needs so customers are willing to pay, esp. since we intend to offer flexible payment models including leasing. In the field trials we hope to demonstrate measurable impacts on the quality of life of both People with dementia and their formal and informal care-givers to strengthen our value proposition.

Consumer behaviour and interest

The increasing availability of medical **sensors** integrated in consumer devices accompanied by declining costs, has made them accessible to large consumer segments. The so-called *Quantified Self movement*, which involves measuring individual vital data using everyday devices such as smartphones, has furthermore raised consumer awareness about the importance of healthy lifestyles.

However, it has been shown that many stop using them after a couple of months and that they only seem to reach a small percentage of those who might actually benefit from engaging in more exercise or adopting healthier lifestyles.

Besides, the medical professions including nurses have (so far) demonstrated **limited enthusiasm in promoting or endorsing digital solutions**. In our interviews it has been shown time and again that care-givers tend to be sceptical about such devices. To overcome such scepticism, we require clear evidence with regard to the benefits to increase acceptance and actual use of our solution.

Penetration of technology and technological and data developments

We can observe an increasing use of ICT in people's private lives, at work and in the health and care field. **Internet and smartphone usage** is wide-spread even among the elderly, and is likely to grow. The decreasing costs of such technologies have also been driving their adoption.

However, penetration of the healthcare sector, e.g. in the form of telecare services including remote monitoring of patients, is still limited. This may be due to a lack of interoperability, complex regulatory environments as well as privacy concerns (see 2.3 Market barriers). The Technopolis report points out that the lack of platforms based on open standards also hampers the take-up of new technological developments.

Another issue that has frequently popped up in our interviews is the fear that digital solutions might lead to a decrease in face-to-face interaction and that they might require additional time and effort, at least in the beginning. Therefore, support has to be automated – as is the case in the GREAT solution -, be highly situational and take the specific conditions of the setting into consideration.

Our system offers **automated settings** for lighting scenes to activate at certain times depending on one's needs. It also allows individual and easy-to-use control from different user interfaces e.g. smart phone, tablet or laptop.

2.3 Market barriers

Despite the enormous market potential, the solutions developed in a large number of AAL projects have not really been taken up by the market. Apart from the already mentioned fragmentation of the market, this may also be due to a lack of information and transparency, which results in a lack of market intelligence as pointed out in the final evaluation of the AAL Programme from 2008-2013.

The final evaluation also stated that aspects such as interoperability, standardisation, harmonisation and transnational transfers should be given more attention to intensify the market orientation and make results sustainable and achieve impact. Finally, the Technopolis report also mentions complex regulatory environments, lack of technical skills as well as privacy and security concerns as major barriers (Varnay et al., 2018).

In the following section, we discuss these barriers and their implications for the GREAT solution in more detail:

Complex regulatory environments

Regulations concerning the provision of health and care services tend to fall under national jurisdictions. As far as telemedicine and telecare are concerned, very few countries actually have specific legal instruments which causes uncertainty on the part of investors. Besides, different national regulations may require that an AAL solution or medical device will have to be certified per country. Recent initiatives at EU level such as the General Data Protection Regulation or the Medical Device Directive should help harmonise the law and ease the circulation of such devices.

As we have seen in our project, there still exist considerable differences between European countries, e.g. with regard to the use and acceptance of electronic health records. Whereas Austria has introduced the nation-wide ELGA system, in Switzerland keeping electronic patient records is only compulsory for hospitals, but still optional when it comes to GP surgeries. And so far, there are no reimbursement schemes for telecare assistance or digital care solutions in any of the participating countries.

Market fragmentation

Barriers include naturally occurring obstacles such as cultural diversity, language, market size and geographic location. Therefore it is difficult to develop an AAL solution which is applicable to all areas of the EU, impacting marketability and investment prospects. Most experts suggest that an effective way to overcome such barriers is through partnerships formed across borders, be it with distributors or other intermediary organisations.

In the GREAT project, the **cross-border cooperation** with partners from three different European countries offers substantial added value, esp. because of the complementarity of the respective activities and channels to reach their customers. At the same time, the marketing of the GREAT solution will be adapted to the specific national markets, which opens up opportunities for small companies such as emt ag who are well connected with relevant stakeholders and influencers such as Curaviva and other relevant organisations.

Interoperability and standardisation

As mentioned before, the lack of platforms based on open standards can be considered as one of the most significant market barriers within the ICT industry. This hinders the scaling up of AAL solutions both nationally and across Europe. With a view to commercialisation particular attention therefore must be paid to the compatibility of the individual systems when selecting the various software components to guarantee communication and thus data exchange between the systems.

We achieve interoperability by means of easy **integration with current bus systems** like EIB/KNX, LM, DALI, EnOcean, BACnet, MODBUS, Beckhoff ADS and EtherCAT and allowing different communication technologies like Ethernet, ZigBee, Bluetooth, WLAN. For the field tests, an easy to use end user interface for controlling the system has been developed based on standard technologies like HTML/JavaScript/CSS.

Technical skills

According to Varnay et al. (2018) more than half of all individuals across the EU had basic or above basic digital skills in 2016. Still, in the interviews conducted for the study commissioned by Curaviva as well as in the course of the master thesis, it became clear that both formal and informal carers of People with dementia needed help with integrating new technologies into their daily routines. Various approaches have been put forward by the interviewees:

- Basic training: When a new system is installed, care should first of all be taken to provide them with a comprehensive introduction to the technologies used in their homes and other areas and not simply to leave them alone with the technologies.

- Technology pilots: This could be implemented in the form of a central contact person for technology-related questions in the neighbourhood/region of customers. On request, a brief introduction to individual technologies could be provided, queries about use could be answered, support with personalisation, e.g. of SmartHome configurations, or rapid help could be provided in the event of problems with the technologies.

- Instruction leaflets: Explain the technologies used in the nursing homes or private households, either in detailed written form with a series of explanatory pictures of the individual steps or also in animated form via video, comparable for example to the safety instructions in airplanes.

- Peer group training: It is conceivable that technology-savvy customers might offer introductory courses in individual technologies for other customers. This could also promote social interaction.

- App-based training: Another possibility is training in the use of technologies directly via specially installed applications.

The possibilities described are not mutually exclusive, but can be combined to ensure optimum support for customers in their use of the available technologies. In the GREAT project, we have so far implemented the **Basic Training** approach when installing the

GREAT system in the nursing homes. We have also prepared various **Instruction Leaflets** for handling the different components (only available in German for the time being).

However, it is not only the carers who may lack certain skills. On the supply side, too, there is also a **lack of employees with cross-functional qualifications** in areas such as chronobiology, lighting, electronics and computer science which will have to be resolved. Knowledge gaps may actually defer market penetration especially of human centric lighting systems such as the GREAT system.

Privacy and security

Privacy and security concerns are key issues in institutional and private settings. In the interviews carried out by our master student (Bachofen, 2016) both family care-givers and experts voiced reservations about the ethics of continuous monitoring or surveillance of people with dementia. In the opinion of most interviewees monitoring should happen in a non-obtrusive "passive" way and come with clear benefits to be justified.

Privacy, security and data protection also played a major role when applying for permission from the ethics committees in the countries where the field trials are conducted. In our applications we set out clearly and in detail how we would ensure at all times that the principle of **confidentiality and protection of personal rights** would be respected.

For example, **all data material concerning the field trials is encoded or anonymised**. The raw data (transcripts, observation protocols, assessment documents, nursing progress documentation, field notes) and the code lists are managed and stored on separate password-protected data memories. The audio files, digitized transcripts, documents and field notes and all other encoded data are archived by the project manager and not accessible to third parties.

3 Market opportunities

3.1 Introduction

Despite the above-mentioned barriers, market and investment experts do see economic opportunities in the AAL sector. **Opportunity areas** that are frequently mentioned include smart emergency calling systems, personal assistants (at home and outside), intelligent monitoring systems, simple communication services, information platforms that make information and elderly care-services easily available for informal carers and gives them the support to organise themselves, platforms that help building up and supporting caring communities.

The authors of the Technopolis study (Varnay et al., 2018) see opportunities in the AAL market primarily in combining different types of technologies into new and innovative solutions that support independent living of older people. Moreover, they note that there is increased interest in **solutions that keep people active and healthy**, rather than solutions that focus on treatment. AAL solutions that integrate simpler sensors, e.g.

wristbands, and data processing technologies, and artificial intelligence are more likely to have market potential.

In the GREAT project we are very much in line with these trends:

- We have integrated a **non-obtrusive upper-arm sensor** for capturing vital data such as heart-rate variability – a well-known indicator for stress – from nurses in the participating nursing homes and the special-care unit at the clinic so as to investigate and hopefully demonstrate the soothing impact of the GREAT solution on caregivers.
- We **process the HRV data** and compare them with the observational data obtained as a result of dementia care mapping and the log data from the system. The results will provide valuable insights in the effects of light, sound and scent on people's mood. We expect these insights to help develop future products which integrate adaptive, self-learning software that automatically generates suggestions for calming or activating people with dementia.
- We will strengthen our conclusions and suggestions for designing future **self-learning software** by cooperating closely with the EU project ***Repro-Light***, which is coordinated by Bartenbach. Repro-Light wants to respond to the increasing need for customised luminaires that are adapted to individual preferences. The project aims to create the first solution on the market to synchronise human-centric lighting to people's individual chronotypes and therefore achieve a much higher impact on their health than conventional HCL products.

The **unique selling points** of the **GREAT solution** can be summarised as follows:

- Positive effects on the wellbeing of people with dementia enabling meaningful activities (as specified by end-users) via three senses (seeing, hearing, smelling) simultaneously to create an ambient effect
- Enhanced quality of life of formal and informal carers, e.g. by reducing agitation
- Room ambience system fitted to individual requirements and/or systematically controlled in line with therapy plans
- Valuable information about the patients for caretakers and physicians based on data collected by sensors as well as observation (dementia care mapping)
- A modular and extensible system – modules (light, sound, scent) can be easily added or removed without incurring any additional installation effort
- A single point of contact for (potential) customers ranging from advice, configuration, installation to support and maintenance for both technical and disease-specific issues
- Scalable and flexible solutions that adapt to changing user needs in line with the progress of the disease,
- Solutions that are adapted to different requirements and settings (low-level, low-cost and mobile for private households vs. high-end and stationary for nursing homes or specialised care units), and
- Easy handling of system with just 2 buttons (activation vs. relaxation)

3.2 Market opportunities in the lighting industry

As mentioned before, the market analysis is focused on the lighting component of the GREAT solution because it has the largest market potential. Besides, we are not planning to sell the sound and scent modules independently but only as part of an integrated solution. For this reason, we have included a separate section on market opportunities in the lighting industry with a focus on human-centric lighting (HCL) since the GREAT luminaire falls into this category.

Human-centric lighting enables consumers, retailers and utility management teams to help create the desired ambiance in adapting to a user's mood – almost instantly, while maximizing energy efficiency. It includes automated controls to simplify the environmental settings for places such as highly efficient commercial facilities, based on minute-to-minute levels of occupancy, and desired amounts of sunlight. HCL can be applied to any space that uses a lighting system, including homes, offices, retail outlets and even municipal infrastructure.

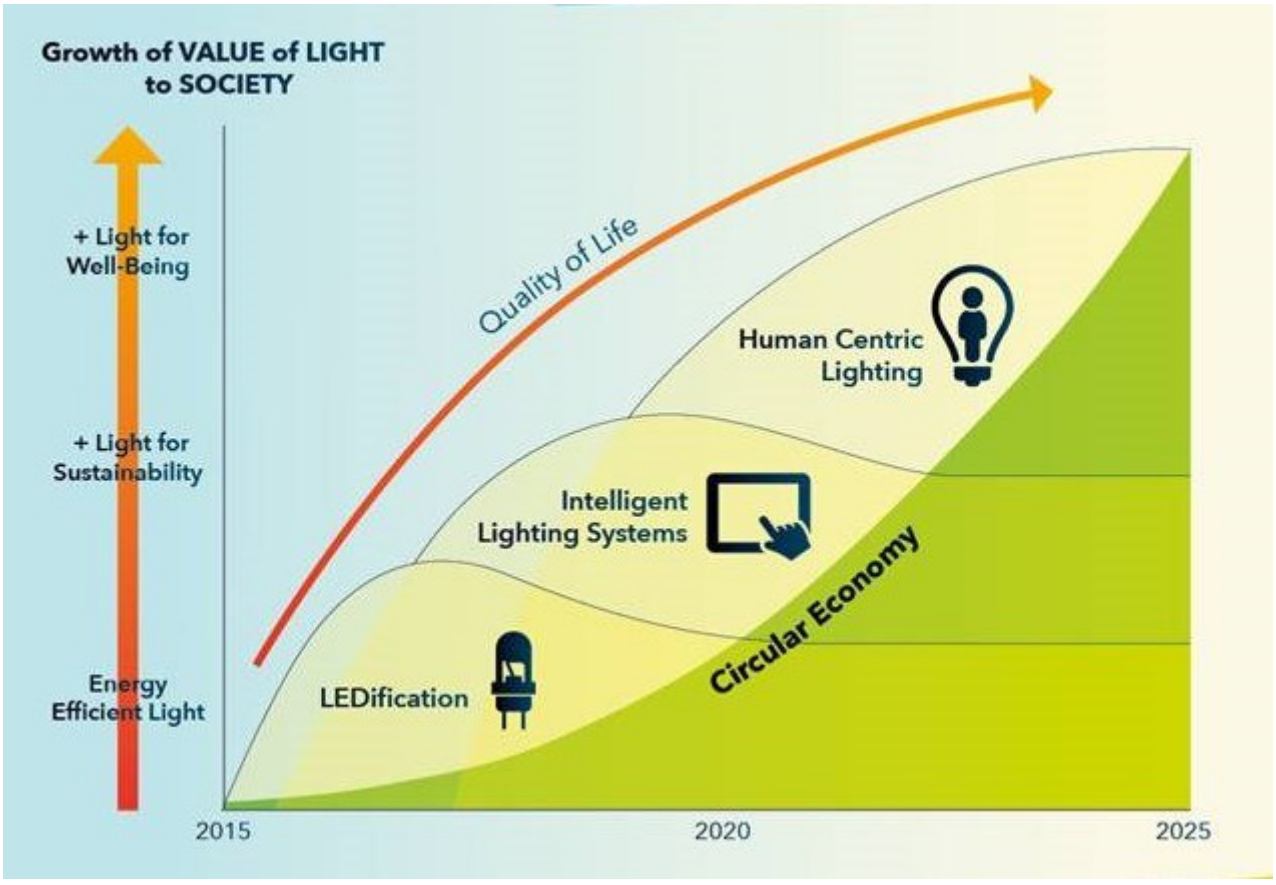

Figure 1: Growth drivers in the European lighting market

In the Strategic Roadmap 2025 launched by Lighting Europe, the industry association that represents more than 1000 lighting companies, the market for **human centric lighting (HCL)** is expected to become a multibillion-euro business. [9]

[9] Study prepared by A.T. Kearney with Lighting Europe and the German Electrical and Electronic Manufacturers' Association (ZVEI) in 2013.

Figure 1 shows that better quality of lighting through LEDification, intelligent lighting systems and human centric lighting based on a circular economy are considered as the main growth drivers for the European lighting market.

The study (A.T. Kearney, 2013) derives the market volume from segment- and region-specific estimates of relevant floor space, penetration rates and prices. To determine the business potential of HCL, the model has analysed **three different scenarios**: conservative, optimistic and pessimistic. The conservative scenario is considered the most probable and assumes selective government support, joint industry initiatives and considerable marketing investments.

Figures 2 and 3 show the market volume and penetration rates by scenario and by application, respectively:

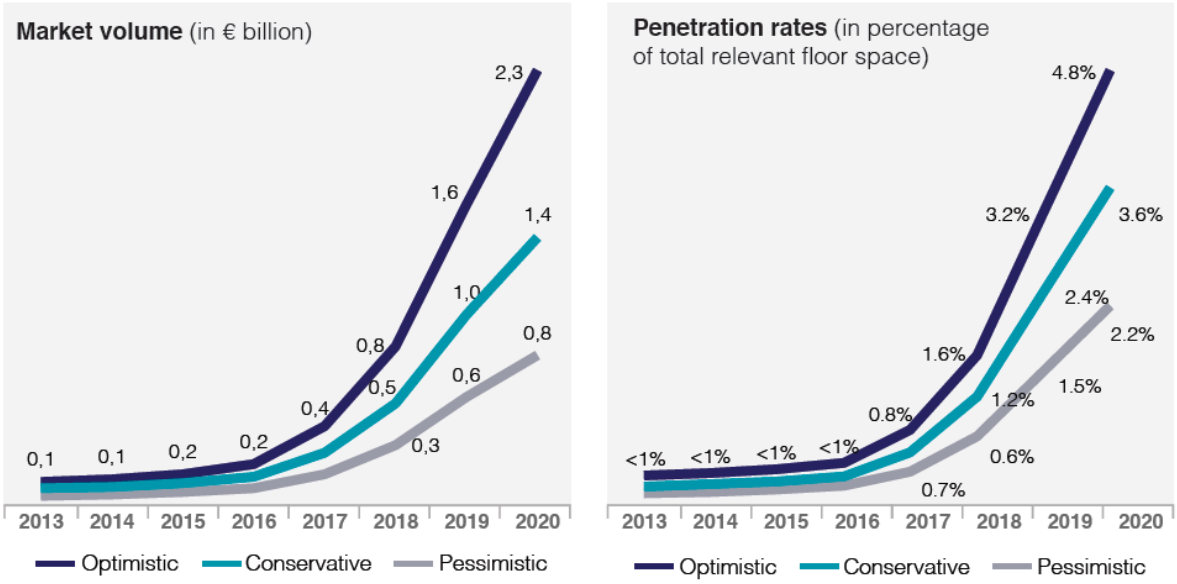

Figure 2: European human centric lighting market (by scenario)

Source: A.T. Kearney Human Centric Lighting market model

As shown in Figure 2, the HCL market volume would amount to €1.4 billion in 2020 for the conservative scenario. Figure 2 also shows that around 4 percent of new installations and renovations in 2020 will include HCL solutions. Within the HCL market, biologically effective lighting - as is the case in the GREAT solution – is estimated to represent the major share with 65 percent market share (A.T. Kearney, 2013).

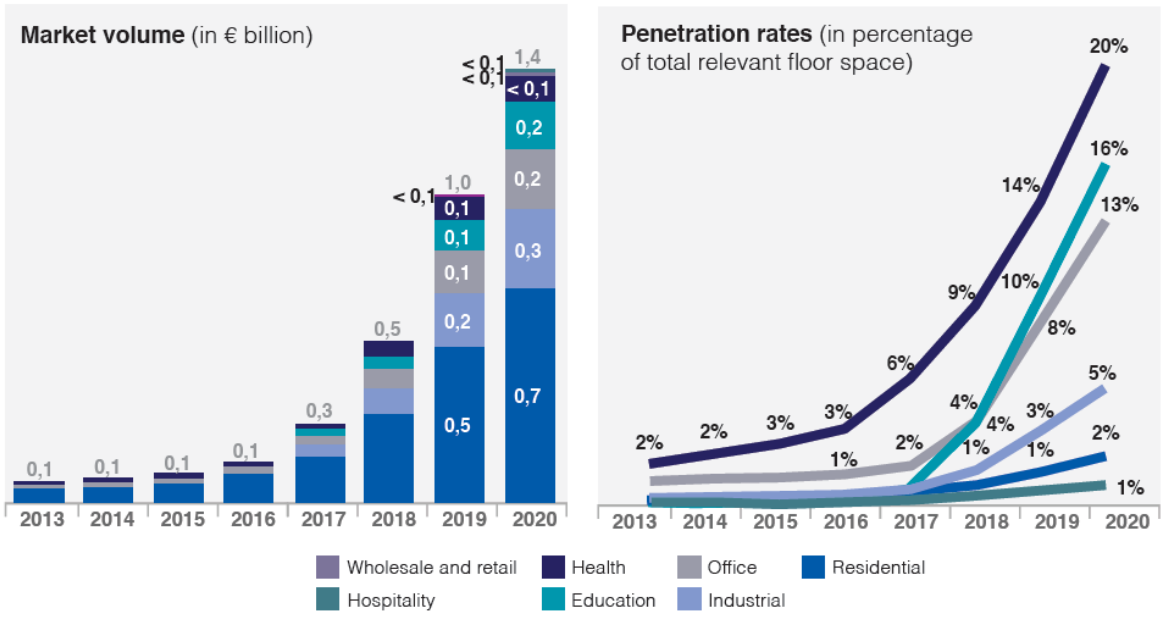

Figure 3: European human centric lighting market (by application)

With regard to different applications or market segments, market penetration is expected to be high in office, health and education segments (see Figure 3). In the case of the **health sector**, however, this is not reflected in the market volume due to the small relevant floor space, which is much bigger in the residential segment even though it has a relatively small penetration rate.

But given the fact that the majority of elderly care applications will fall into this category, the study predicts that **residential will become the largest market segment in absolute terms, accounting for 45 percent of the market in 2020!** These estimates are very encouraging for the GREAT solution, which apart from care facilities also targets private households!

3.3 Market and competition analysis for the GREAT luminaire

Bartenbach carried out a detailed market analysis to estimate the market potential for the GREAT floor/ free-standing luminaire (see Figure 4). The focus on free-standing luminaires is due to the fact that contrary to wall-mounted and pendular luminaires, they are very flexible and can be easily moved from one room to another. Besides, the market for wall-mounted and pendular lighting is enormous and highly competitive, which is why we do not regard entering this market as a priority.

The GREAT luminaire fulfils the following criteria:

Visual criteria:

- asymmetrical light distributions provide illumination of large room areas (up to 16 m²) → no additional lighting needed
- adjustable luminaire head (swiveling, tiltable) for optimal line up in relation to table position or positioning of the luminaire within the room

- indirect up-light creates a uniform ceiling → homogeneity reduces glare and creates a comfortable room atmosphere
- floor lamp with integrated spot allows part area lighting with up to 1000 lx > lighting can be adapted to a person's individual visual requirements and preferences)
  > lighting can be adapted to higher visual requirements and tasks that need higher light levels
- > balanced brightness distributions ensure stable perception (task luminance is always brighter or equal than ambient luminance)
- luminance levels in the range of vision < 1000 cd/m² → no glare

Human centric lighting (HCL) criteria:

- „Melatonin" or circadian light(CCT about 2200K) with high CRI (colour rendering index) to stabilize and improve circadian rhythms during the late evening and during the night
- high vertical illuminance levels without glare for activation/light therapy
- luminaire meets the standard requirements of DIN EN 12464-1 and furthermore, provides light therapy and creates an improved light environment for elderly persons

Figure 4: Free-standing luminaire developed in the GREAT project

The market analysis evaluated 9 luminaires including the GREAT luminaire according to a pre-defined set of criteria (see Table 1).

Table 1: Competition analysis of luminaires

Criteria	GREAT	Regent Light Pad	Kiteo Virtus	Tobias Grau XT-s Floor	Waldmann Lavigo	Novus Attenzia	Esylux Prana	Trilux Bicult LED	Grimmeisen Onyxx
visual									
meets norm DIN EN 12464-1			?	?		?			
E_H ≥1000 lx		?	?	?	?	?	?	?	?
L_{max}≤ 1000 cd/m²		-	?	?	-	?	?	?	?
biological									
$E_{vertical}$ ≥ 300-1000 lx/h		?	?	?	?	?	?	?	?
Individual light curve				-	-	?	-	-	
Melatonin - light				-	-	-	-	-	-

The market analysis showed that not enough technical information was available for the luminaires currently on the market to really make a serious assessment of their potential visual and biological effectiveness.

Only the luminaire of **Regent („Light Pad“)** shows some similarities with the GREAT standing luminaire with regard to light distribution and light scenes. However, Regent‘s Light Pad comes without an additional spot for task illumination of specific areas with increased visual requirements. The Light Pad is moreover rigid and therefore not adaptable to different room dimensions and user scenarios.

We can therefore conclude that some of the available standing luminaires do not even meet the current standards for indoor office lighting DIN EN12464-1 (with 500 lx horizontally at the table). Due to the absence of melatonin light (2200K) and the lack of high intensities most of the evaluated luminaires do not pose any serious competition because they cannot achieve biological effects.

We therefore expect the GREAT luminaire to have **high market potential due to the following features:**

- high light intensities,
- high light quality – colour rendering index,
- illumination of the entire room via indirect illumination of the ceiling with a beautiful light sky,
- luminaire (or parts of the luminaire) very flexible and adjustable to fit different room dimensions,
- additional adjustable spotlight,
- tilt and swivel function to change the light beam direction.

The GREAT luminaire can fill the gap in the market for an adaptable and biologically effective luminaire.

4 Value chains and business models

4.1 Introduction

Earlier AAL solutions tended to have **linear value chains**, moving from research and design, to the development of a platform or solution, to the development of services, installation and maintenance and finally to commercialisation. The authors of the Technopolis study expect the AAL market to move away from a linear value chain to an umbrella market represented by a **value network** where different actors work more closely together to develop a common solution (see Varnay et al., 2018).

We find similar observations in the study about the market potential of human-centric lighting (A.T. Kearney, 2013). The authors deplore **the fragmented value chain structure** which leads to insufficient collaboration among manufacturers including electronics, smart home and software engineering. Furthermore, due to their complex nature, HCL systems require a solution-oriented selling approach rather than a straight-forward, product-based business model. As a result, A.T. Kearney expect an increased demand for consulting and planning activities.

The Technopolis study also points out that it may be difficult to sell solutions directly to end-users and therefore suggest a B2B2C consumer model where an intermediary can facilitate access through avenues such as distribution or marketing networks (Varnay et al, 2018).

The B2B2C model is one of the avenues which we are pursuing in GREAT, especially with regard to integrated solutions for nursing homes, assisted living facilities or special-care units. It implies that the customer buys an integrated solution that has the backing or has been recommended by a trusted third party such as the national umbrella organisation of care facilities or an association of health professionals.

The following section discusses the business models that we consider most appropriate for our solution.

4.2 B2B2C – the ideal business model for the GREAT solution

We looked at different models in the digital health and/or AAL sectors such as the one proposed by Peters, Blohm, & Leimeister, (2015) for complex services including the health sector, as well as the one presented by Osl, Sassen & Oesterle (2008) on *Collaborative Business Models in the Field of Ambient Assisted Living*. It was, above all, the business models proposed by Gersch and Hewing (2012) which proved to be the most inspiring.

Figure 5 shows the different business models in the AAL sector as defined by Gersch & Hewing (2012).[10]

"Orchestrator" (coordinates value creation networks)	**Integrated health care / disease management programme**	**Community** (creates and coordinates homogenous groups both demand and supply)
Insurance companies (risk sharing, may be private or public)	**Supplier of Specialised Services** (medical, technical…)	…
Supplier of Single Components (autonomous / neworked)	**Provider of Infrastructure** (platforms, bandwidth, interfaces…)	**Supplier of Commercial Services** (information broker, Quality&Security, Advice/Consulting…)

Figure 5: Business models in the AAL sector based on Gersch & Hewing

[10] See Gersch, M., & Hewing, M. (2012). AAL-Geschäftsmodelle im Gesundheitswesen-Eine empirisch gestützte Typologie relevanter Grundtypen ökonomischer Aktivitäten zur Nutzung von Ambient Assisted Living in sich verändernden Wertschöpfungsketten. In AAL-und E-Health-Geschäftsmodelle (pp. 3-26). Gabler Verlag.

For most AAL solutions, more than one model may apply or several models may be combined depending on the local or regional context. In the study conducted by Zoller, Bögle & Chiavi (2016), the authors conclude that the models of Orchestrator, Supplier of Components as well as of Specialised Services are most appropriate and promising. We have slightly adapted the models suggested by Gersch & Hewing (2012) to the special scenarios related to people with dementia and their caregivers.

The following discussion is limited to the two models which correspond best to the B2B2C model:

4.2.1 Single Contact & Access Point for Dementia

This model to a large extent corresponds to the category *Supplier of Specialised Services*. For our main customer segments, i.e. people with dementia and their caregivers both in institutional and private settings, we envisage a neutral and non-profit office/institution that provides information, advice and guidance.

The single point of contact&access should consolidate decision-relevant information to create transparency in complex subject areas. For this purpose, data is collected, evaluated and structured systematically and oriented towards special needs such as those of people with dementia and their caregivers. Preferably this role is taken by an organisation that represents end-users.

4.2.2 Coordinator/Orchestrator

Orchestrators coordinate **value creation networks** by bringing together suppliers of components and services to create integrated solutions. New and innovative solutions are created by combining existing value-added modules from and, in some cases supplemented by new components, which can be combined with each other. The focus of the company's own business activities is on coordination along the value chain.

Although the information and advice services may well be provided by organisations such as Curaviva, support and coordination services could be delivered by companies such as Belvita (www.belvita.ch) or Nestor (www.nestor-swiss-ch) both of which offer integrated solutions to private customers or neighbourhoods.

These companies could take on the **Orchestrator** function using different payment models such as charging by time unit, pay per use, or levy fees from advertisers and/or single component suppliers on their respective platforms.

For information on how we are planning to implement the business models in the different participating countries, please consult Deliverable 5.4, Exploitation Plan.

5 Market segmentation

In the GREAT project, we distinguish between the following market segments:

1. Medical
2. Residential care (institutional setting)
3. Residential care (private setting)

The following discussion of the potential profitability of the different market segments is focused on the GREAT lighting. A recent market study[11] on human centric lighting (which includes the GREAT luminaire) simulates segment-specific economic benefits on micro and macro level using the following **input parameters**: Energize, Alertness, Cognitive performance, Circadian stability, Sleep quality, Mood and Relaxation (non-visual or biological benefits). Other parameters taken into account are Labour cost, Typical error rates and Investment needs.

The Calculation model distinguishes between the **micro-level** (perspective of individual investors, e.g. facility owners) and the **macro-level** (perspective of the general public, e.g. health insurances). For GREAT, the most relevant segment are Medical as well as Residential, both institutional settings (e.g. retirement/nursing homes) and private settings.

The quantified benefits expected for these segments, are discussed in the following section.

5.1 Quantified benefits in the medical market segment

The medical segment includes:

- hospitals, in particular corridors, recreation and ward rooms
- Focus on patients (and medical staff)

The estimates are based on the following use cases and assumptions:

- Hospital with a capacity of 1,000 beds and 1,500 employees
- 100k m² floor space, 48k m² relevant for Human Centric Lighting
- Capacity utilisation of 75%
- Average stay of 7 days per patient, i.e. ca. 39,000 patients per year
- Average diagnostic related flat rate: €3,000
- Average sick days per employee: 11.7
- Share of medication cost of "diagnostic related flat rate" and of total average health care costs: 20%

At the micro-level the following effects are expected, but – so the authors admit - not well researched yet.

[11] A.T. Kearney (2015) Human Centric Lighting: Going beyond energy efficiency. Presentation prepared for ZVEI and Lighting Europe.

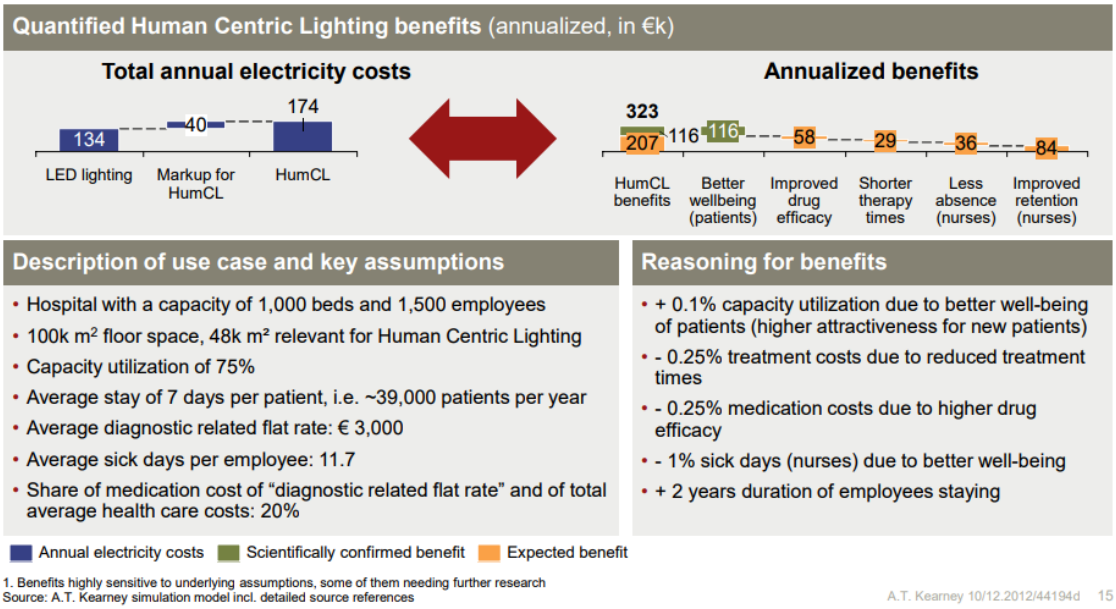

Figure 6. Micro-level effects in the medical segment

5.2 Quantified benefits in the institutional care segment

This market segment includes:

- Care homes for elderlies with and without physical constraints
- Focus on elderlies (and staff)

In the case of residential care in nursing homes, the authors specify the following use cases and assumptions:

- Retirement home with 100 beds, 90 inhabitants and 63 employees, which implies an intensive care setting
- 3,000 m² floor space, 2,010 m² relevant for Human Centric Lighting
- Fee per patient per year: € 30,000
- Capacity utilization of 90%
- Gross contribution margin of 45%
- € 2,568 monthly labour cost per employee
- 0.15 falls per bed per year

For retirement or nursing homes A.T. Kearney reckon that capacity utilization can significantly improve due to better well-being of residents at the micro level.

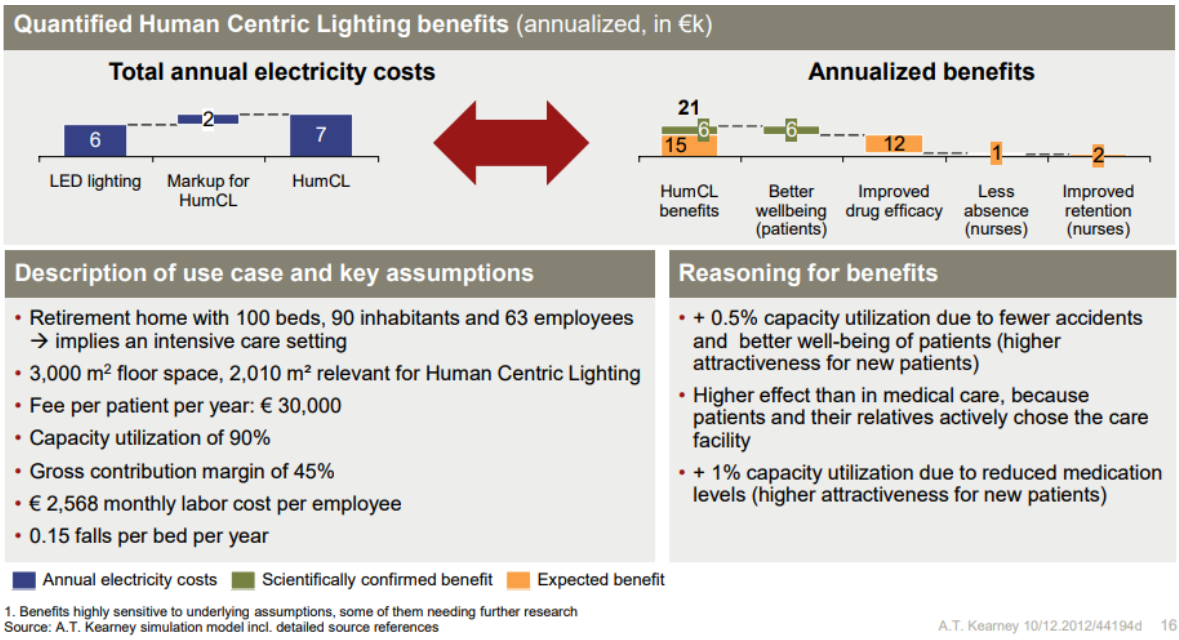

Figure 7: Micro-level effects in the institutional care segment

At the macro level, they expect significant additional benefits for the public healthcare system.

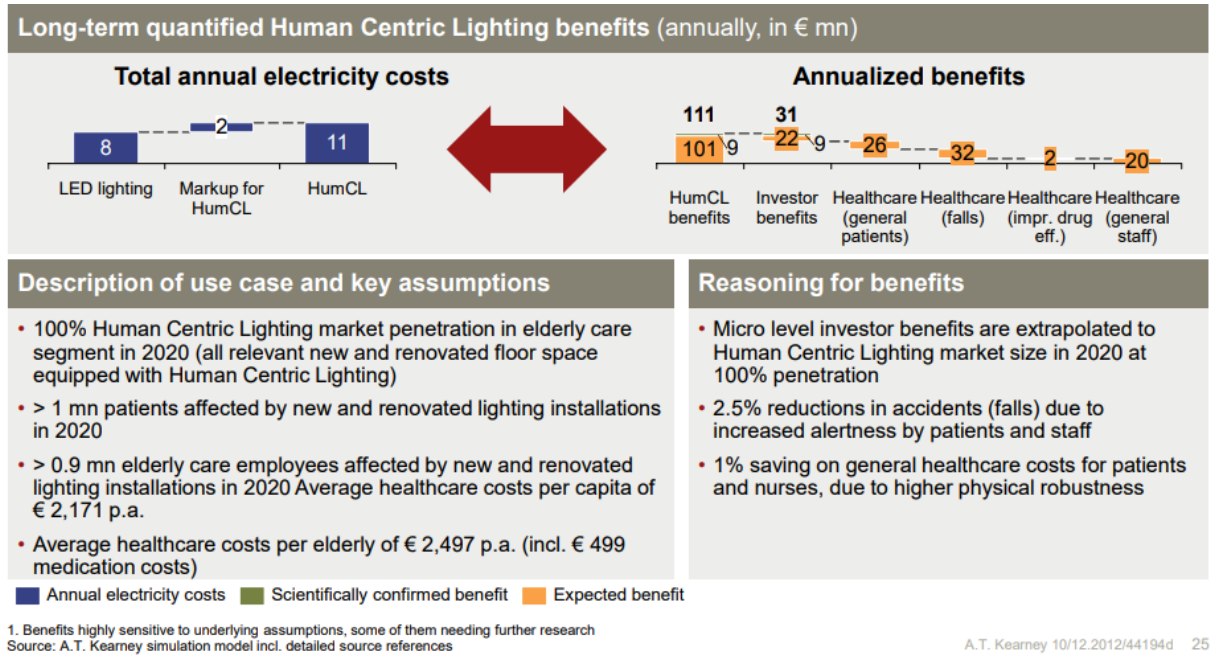

Figure 8: Macro-level effects in the institutional care segment

5.3 Quantified benefits in the private care segment

This market segment includes:

- Both own and rented flats and houses
- All income segments
- Including home offices

In the private setting of residential care, benefits are mainly **driven by the deferred need for institutional care** (see below).

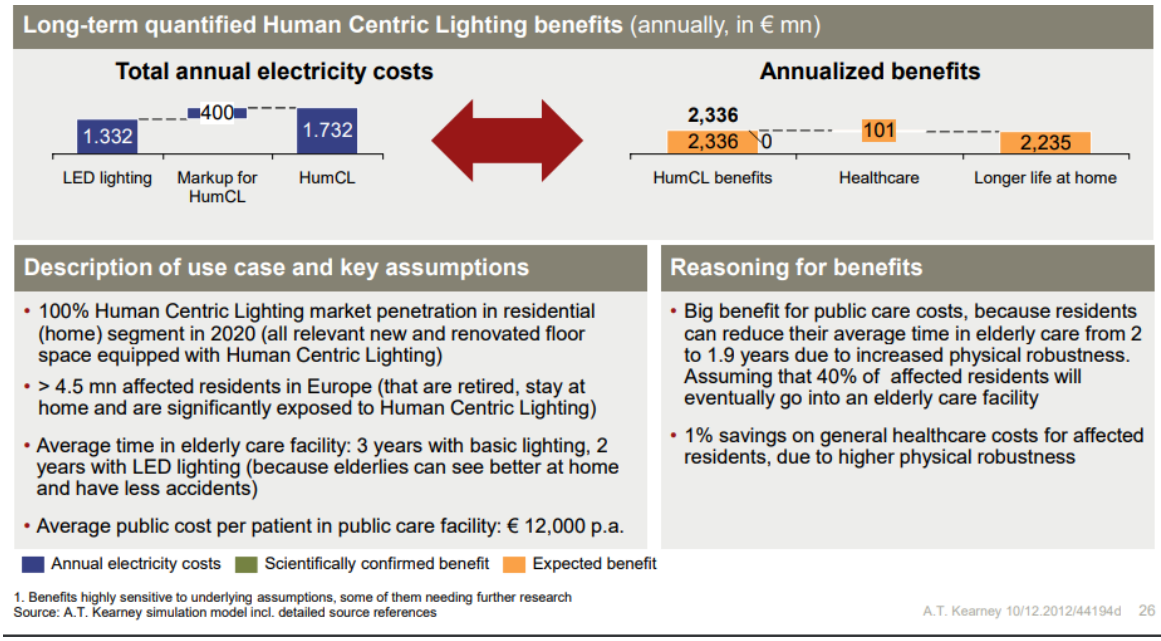

Figure 9: Macro-level effects in the private care segment

According to the authors, the medical and elderly care segments show less attractive quantified benefits, as most savings cannot be realized by the investor, but by other stakeholders, e.g. insurance companies. They emphasize that in all cases benefits are highly sensitive to underlying assumptions, some of them needing further research.

5.4 Quantified benefits in other markets

According to the authors **the most significant quantified benefits are realized in industrial segments due to the dominant impact of productivity increases** (micro-level, i.e. individual investors). Relevant applications in industry are repetitive, manual tasks as well as advanced manual work with little to some automation, e.g. tool making. In the office segment, increased productivity can result in significant labour cost savings due to higher productivity, fewer sick days and less fluctuation of staff.

On the macro level (perspective of the general public, e.g. health insurances), simulations yield Human Centric Lighting effects for Europe in 2020 of up to € 0.87 bn assuming a realistic market penetration (see Figure 2).

In offices, they expect significant additional benefits to be realized for the public healthcare system:

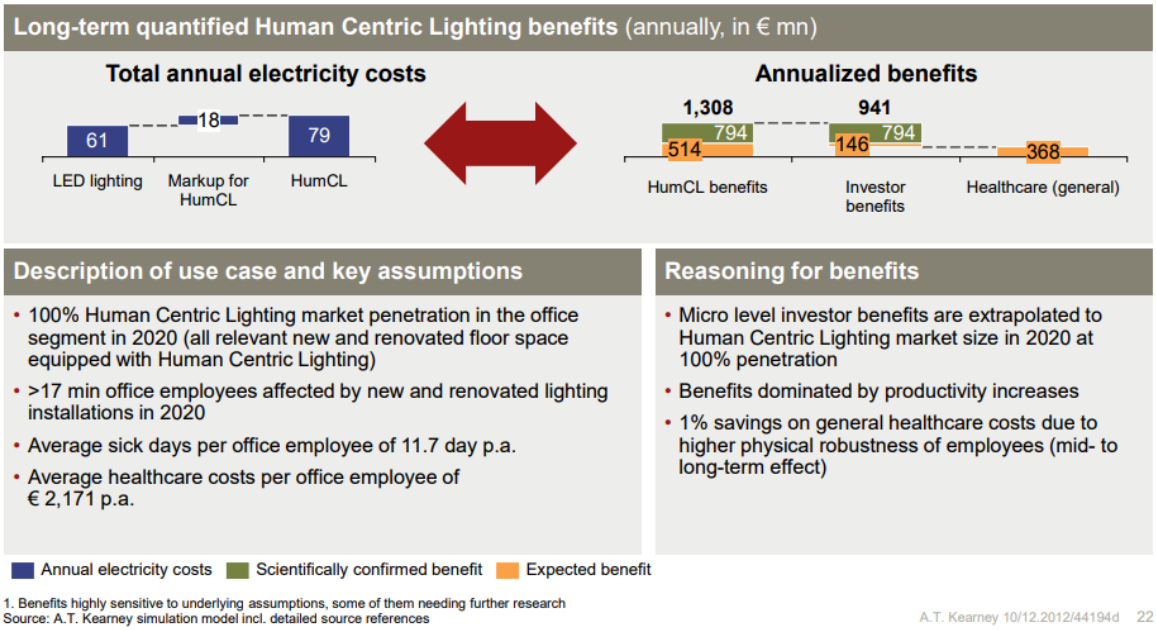

Figure 10: Macro-level effects of the office segment in the public health sector

The authors conclude that in most segments, benefits for owners and investors dominate. However, additional social and public benefits may also justify Human Centric Lighting mark-ups.

In the case of GREAT, we expect both benefits for individual investors and social and public benefits.

6 Market entry strategies

For the purpose of market entry, the marketing efforts will focus on three main target groups:

1) technically open-minded family/informal caregivers, who want to relieve the stress involved in taking care of persons with (early stage) dementia

2) care facilities (stationary and ambulatory) who want to improve their quality of service and reduce stress and burden for their personnel,

3) People with early stage dementia who want to maintain their autonomy and independent life as long as possible.

We expect that our proposed persuasive ambiences will reach the market in about one year after project completion. This will allow us to incorporate the feedback of users participating in the field trials. The relatively short time-span is feasible because we can build on well-proven and tested technologies and already existing home automation components as well as functioning light ambience algorithms and solutions from previous AAL projects.

The **strategies for market entry** can be summarised as follows:

- Provide a highly interoperable, modular and flexible system we will:

- combine peer-to-peer network with server-based network to form a strong efficient portable and compatible network architecture
- allow easy integration with current bus systems like EIB/KNX, LM, DALI, EnOcean, BACnet, MODBUS, Beckhoff ADS and EtherCAT
- take care of hardware heterogeneity and allow different communication technologies like Ethernet, ZigBee, Bluetooth, WLAN
- implement a multilayered, modular software architecture to ensure effective configuring, scaling, and servicing
- use an open and documented plug-in-interface to give third-party developers the opportunity to create own applications for the modular system
- integrate app control

By integrating app control into our installations, the use, installation, configuration and update independent of time and place. Setup is faster and easier. Non-invasive maintenance is more efficient, meaning happier customers and less time spent on callouts.

With multiple intelligent control features that ensure the settings for the different modules is perfect for the current use of the room, app control gives users an easy way to control their comfort. It allows to manage preferences without needing to access a maintenance panel or central control, for example, easily set lighting scenes to activate at certain times and on certain days, depending on one's needs. Users can configure the app's functions and override automated settings to suit one's preferences.

As a result, we are confident that we can overcome existing market entry barriers by offering a reliable, easy to use solution, that has been validated by end-users, and which is broadly available and affordable.

7 Conclusions and future prospects

Based on the discussions in the previous sections we can conclude that the GREAT solution has great market potential because it fulfils all the prerequisites for successful commercialisation, namely:

- A proven demand in the marketplace
- Attractive value propositions and benefits for key stakeholders
- Trusted 3rd parties for customer access
- Focus on consumers' pain points
- No stigmatization thanks to highly attractive design
- The product is commercially viable (based on current cost estimates)[12]

The industry partners are furthermore convinced of the market opportunities for the GREAT solution and committed to its commercialisation because it is aligned with their

[12] For more information on the last three points, please consult the Intermediate Business Plan.

companies' goals and strategies. In GREAT, all industry partners are highly motivated and capable of commercialising the developed solution. Each of them has a clear business case.

As far as future developments are concerned, it is above all **the self-learning aspect** that we shall pursue. In the field trials we process the HRV data and compare them with the observational data obtained as a result of dementia care mapping and the log data from the system. The results will provide valuable insights in the effects of light, sound and scent on people's mood. We expect these insights to help develop future products which integrate adaptive, self-learning software that automatically generates suggestions for calming or activating people with dementia.

By cooperating closely with the EU project ***Repro-Light***, which is coordinated by Bartenbach and has just started, we will strengthen our conclusions and suggestions for designing future self-learning software. Repro-Light wants to respond to the increasing need for customised luminaires that are adapted to individual preferences. The project aims to create the first solution on the market to synchronise human-centric lighting to people's individual chronotypes and therefore achieve a much higher impact on their health than conventional HCL products.

Whilst the main target group remains people with dementia living in their own houses or in nursing homes, the project partners are aiming for a much larger market. The GREAT solution and the luminaire, in particular, is also relevant to settings and scenarios that demand a high degree of attention regardless the time of day, e.g. people engaged in shift or night work in hospitals, or people engaged in visually demanding tasks in offices.

According to the HCL study, the most significant quantified benefits are actually realized in industrial segments due to the dominant impact of productivity increases. However, the study also predicts that residential will become the largest market segment in absolute terms. accounting for 45 percent of the market in 2020! These estimates are very encouraging for the GREAT solution.

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