

NanoMarkets Report

Smart Lighting Markets 2014–

Vol. 1 Market Drivers and Forecasts

Nano-713

Smart Lighting Markets–2014 Vol. 1 Market Drivers and Forecasts

SUMMARY

NanoMarkets has been covering the smart lighting market for four years and has acquired an understanding of the key markets, technologies and companies in this rapidly expanding business. This year, NanoMarkets has decided to cover this interesting sector in two volumes. Volume I is devoted to an analysis of smart lighting markets and covering the basic drivers and economics of the smart lighting business. Volume II provides coverage of the leading companies, products and technologies that play in the smart lighting market place.

Together both volumes identify where and how the new business for smart lighting systems will appear over the next eight years as the developed world replaces its lighting infrastructure with solid-state lighting (SSL), especially LEDs.

While many smart lighting systems can control compact fluorescent lights (CFLs), there is little doubt that the smart lighting products of the future will primarily intended for LED control. This is not just because LEDs are the "lighting of the future," but also because they potentially permit very high levels of control compared with previous generations of lighting. With this in mind, this report examines how the latest control and sensor technologies will impact the development of future smart lighting products.

Many existing smart lighting systems are intended primarily to add to LEDs' already impressive energy efficiency. This makes strategic sense given current concerns about rising real energy prices. However, NanoMarkets believes that with the market becoming crowded, suppliers of smart lighting systems will need to find new ways to differentiate themselves in the market, either by (1) exploring new end user markets such as street lighting or auto lighting, or (2) adding new functionality such as health and mood lighting or even visible light communications (VLC). The latest lighting research indicates that smart lighting can also lead to improved health and mood, while newer technology is showing the way to using smart lighting systems for air quality monitoring and even the delivery of information services.

While smart lighting systems have evolved as standalone products, NanoMarkets notes that, in this Internet-of-Things era, the smart lighting business must be seen as part of a bigger picture. In particular, in this report we discuss the opportunities that are expected to emerge as smart lighting systems increasingly interface with building and home automation products.

In this year's reports, we have considerably extended the report coverage to include analysis beyond the energy-saving features of smart lighting to other business opportunities that the arrival of smart lighting is creating. This is – in particular – the focus of Volume I -- But as with NanoMarkets previous report on smart lighting, our 2014 reports show how new value is being created in the lighting market by adding

enhanced electronics and intelligent luminaires and how such product strategies will be able to build on the massive trend towards introducing LED lighting.

Also included in Volume II is an analysis of the smart lighting strategies of the firms that NanoMarkets expects to see as major players in the smart lighting space. We examine what the prospects for start-ups are in this space. And in Volume I there is an eight-year market forecast with breakouts by type of product, end user market segment, and the regions/countries where this report will be sold.

Because of our years of coverage in this field, NanoMarkets believes that our 2014 reports provide the best information and analysis available on the current trends in the smart lighting sector. We include a detailed eight-year forecast with breakouts by functionality and type of end user, as well as analyses of product/market strategies being deployed by leading firms in the smart lighting space. We believe that these reports will prove of value to executives throughout the lighting, semiconductor, sensor and networking industries.

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Chapter One: Introduction

1.1 Background to this Report

NanoMarkets believes that in the past year or so the smart lighting industry has begun to grow up. It has begun to focus on what the opportunities are for its products rather than simply dwelling on technical issues. Our sense of the market is that in the past, next-generation smart lighting firms have been uncourageous about saying how their systems differ from each other and from the previous generation of lighting management systems. We now appear to have reached a stage in the evolution of the smart lighting business, where firms in this space *must* think hard about what they really have to offer.

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Judging from the fact that quite a lot of firms have quit the smart lighting business in the past few years, some smart lighting firms have spent too much money on engineering and not enough on marketing and business development. At the very least some smart lighting companies may not have thought through entirely how their products are going to make money in the coming years.

In this respect, commercial and industrial buildings are a better bet than residential buildings when it comes to selling smart lighting, because the benefits of smart lighting can, for the most part, be easily quantified for business users. This fact of life is reflected in NanoMarkets' most recent forecasts where we show smart lighting for commercial and industrial buildings as generating \$5.1 billion by 2019, but residential smart lighting for the same year with revenues of just \$820 million.

It is also apparent that smart lighting firms will now have to work to get their products into profitable channels. For the giant lighting firms—the GEs and Osrams of this world—this is not an issue. However, for the many smaller firms in this business what this will mean is slogging away trying to build arrangements with local and regional building product and electrical supply outlets/installers. This takes time. Selling smart lighting through major national chains is another option—and to some extent a quick fix—but it is not easy to get one's products into such retailers and may not be optimal given the retail-orientation of many of these outlets.

Beyond this, NanoMarkets believes that there are some trends that have not been recognized widely yet by the smart lighting community, but which will be important going forward. One of these is the necessity for smart lighting suppliers to push their marketing stories well beyond the energy efficiency meme. Another is the degree to which there are opportunities for smart lighting in markets other than buildings.

As NanoMarkets noted in its 2013 smart lighting report, firms that fail to find effective ways to differentiate themselves in what is already becoming a crowded smart lighting marketplace, will quickly see their business slip away from them. In our 2012 smart lighting report we specifically noted that many of the smart lighting systems from firms that were *purportedly* innovative start-ups, actually had a certain sameness to them. They seemed to be offering features and benefits that just weren't that special and we questioned whether these would be enough to build a sustainable business for smart lighting firms.

Yet in a recent interview with a smart lighting firm, NanoMarkets was told that it was hard enough to design a smart lighting product for energy efficiency without having to worry about functionality beyond energy efficiency. However, we think that increasingly such comments are going to seem beside the point.

1.1.1 Beyond Efficiency: Why Smart Mood Lighting is the Next Big Thing

Possibly, the necessary market differentiation for smart lighting can be achieved simply by offering higher levels of performance; such as quicker response times for lighting systems. But it seems to us that more will be needed in the era of the Internet-of-Things (IoT), when customers are going to be looking for more than just an extra percentage point on energy efficiency.

IoT raises the stakes. As a result, we think that manufacturers of smart lighting will switch to a bigger story; one that encompasses “mood lighting” as well as energy efficiency. For our purposes, mood lighting in this context includes lighting designed to influence, not just immediate mood, but long-term health and work performance. According to NanoMarkets’ forecasts, smart lighting with mood enhancement capability will generate \$2.9 billion by 2019.

It has been well understood since the days of the first incandescent light that changes in light can affect health, mood, and human performance. However, given the nature of lighting technology, there has until recently been a limited amount that could be done to take advantage of what was known about light and human behavior. With the new solid-state lighting systems—those based on LEDs—a lot more can be done. These systems intrinsically allow for more control, partly precisely because they are based on chips not tubes and bulbs.

As NanoMarkets sees things, there is enough potential in the smart mood lighting concept to allow for substantial differentiation in smart lighting products and systems for most of the eight-year period that is covered in this report. And when the mood lighting idea begins to run out of steam, smart lighting can tap into smart lighting based visible light communications (VLC). However, we also expect that

smart mood lighting will increasingly be challenged by professional medical opinion which is already saying that the health benefits of lighting are not all that they are cracked up to be.

1.1.2 Thinking Outside of the Building

The other profitable new direction that NanoMarkets sees for smart lighting is in markets outside of traditional building usages. Non-building sectors in which smart lighting could be deployed include transportation, street lighting and other outdoor lighting. Together, we see these applications for smart lighting as accounting for \$4.6 billion in revenues; that is 42 percent of all smart lighting revenues. These applications will account for just 12 percent of smart lighting in 2014.

What is creating this opportunity for smart lighting *outside* of buildings is the same factor that is creating opportunities for lighting applications *inside* buildings; the growing role of LEDs. LEDs are a key enabler for smart lighting systems because they are chips and therefore inherently more controllable than the types of lighting that went before it. So with LEDs, smart lighting systems are more of an obvious play than they were with earlier generations of lighting.

Automotive: NanoMarkets believes that by 2015 we are going to see significant revenues generated by smart lighting systems in the automotive sector. This may not be all that obvious though, because the impetus for smart lighting in cars and trucks is coming not from the smart lighting community itself, but rather from the automobile firms and it is not always tagged as being “smart” lighting, although this is exactly what it is. Among the firms that have indicated publicly that they are involved with developing smart lighting are Audi, BMW, Opel and Mercedes-Benz. (All German car firms, by the way, and more or less the same group that are working with smart *windows* in their cars.)

One aspect of smart lighting in the automotive segment that interests us especially is that it is another example of smart lighting moving beyond energy efficiency. Thus, Audi’s Matrix LED headlamps are said to provide more precise lighting for the driver and less blinding light that dazzles drivers in oncoming cars. BMW is working on “laser headlamps” that offer white lighting that can be intelligently modulated.

The general objective of these developments seems to be to provide improved control of the outside lighting on cars for greater safety. But as NanoMarkets sees things, “smarts” could also be deployed inside a vehicle. Smart mood lighting seems to be especially appropriate in this context; to provide passengers and drivers with greater comfort. This makes sense in cars and internal lighting has



also been a specific focus of Boeing and (presumably) other firms that make airliners.

One ongoing advantage to the transportation sector from the perspective of the lighting industry is that once a particular smart lighting product is designed into a popular vehicle, this can guarantee that tens of thousands of lights will be sold. The flip side of this is that design-in times (i.e., lead times) can be very long. In the auto industry three years is typical. In aerospace, it can be seven years.

Street lighting and other outdoor lighting: Outdoor lighting is in just as much need of energy efficiency as in-building lights; arguably more. Therefore, we see emerging a significant market for smart outdoor lighting, which can potentially be quite elaborate. A recent project at the University of California illustrates this well. The University has built a \$1-million network of outdoor smart lighting that "talk to each other and adapt to their environment." According to press reports, the new outdoor lights promise to save the university \$100,000 on electricity and make it a safer place after dark.

This University of California smart lighting system can be scheduled and adjusted for increased or decreased levels of activity, such as during sporting events, or to guide pedestrians along preferred routes. The system senses occupants, whether on foot, bicycle or automobile, predicts their direction of travel, and lights the path ahead. The smart network also senses when areas are vacant, then dims lights enough to save energy and reduce light pollution, without compromising safety.

Street lighting is also gradually using more LEDs and consequently is a likely target for smart lighting in the future. Large individual orders are possible as they are in the transportation sector—street light installations can involve thousands of lights. But lead times can be a lot more attractive for novel lighting designs than in the transportation sector. However, smart lighting faces a serious challenge in the street lighting sector—the problem of glare. The HID lighting that is currently used in street lighting is good on glare, but not easy to make smart.

The converse is apparently true for LED lighting and NanoMarkets believes that this fact may again drive smartness for lighting away from being a pure energy efficiency play. Although we are not entirely clear how this can be done, some form of intelligence might be used to reduce glare. Meanwhile, we note that Philips is teaming up with Ericsson on a connected street lighting project. It combines LED lighting from Philips with Ericsson's telecommunications equipment and uses VLC to make street lights into hot spots for mobile devices.



Yet again, this indicates just how far smart lighting can potentially reach beyond the energy efficient lighting label.

1.2 Objective of this Report

The objective of this report is to analyze and forecast the opportunities for smart lighting—especially LED-based smart lighting—in the key market sectors in which it can be sold. Volume II of this report examines the key enabling technologies for smart lighting and the strategies of the firms that are especially active in this space. NanoMarkets has been covering the smart lighting business for five years, but we now believe that the market has become large enough to give it this two-volume approach.

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Our focus here is on the leading edge of smart lighting, rather than on products and markets that might be considered to be part of "smart lighting" but which are largely mature or about to be superseded technologically. As per the "essay" at the beginning of this chapter, we are particularly interested in this year's reports in the ways that profitable opportunities are stretching the concept of smart lighting well beyond its origins as a form of hyper-efficient lighting technology.

We do not give as much attention to mature "smart lighting" products, which are often better known as lighting management products. These would include, for example, room lighting attached to a simple motion sensor, or the niche market for "home controllers;" which blossomed for a while in the 1980s, but never quite took off; although such things still exist today. Such markets may actually be larger than the markets that we actually do focus on in this report. But they are not really "opportunities" in the sense of being a source of significant profits at the present time and certainly not in the future.

1.3 Scope of this Report

Instead, most of the focus of this report is on where we think profits are available to smart lighting firms of all kinds (manufacturers, distributors and retailers) in the near to medium term. In the analysis in this report, we are focus on what we see as the five key markets for smart lighting: residential buildings, commercial and industrial buildings, government and public buildings, streetlights and other outdoor lighting, and transportation (especially automotive).

Within these application sectors, we have quantified the markets for four kinds of smart lighting systems. One type of system is the traditional lighting management system mentioned above, which is still very much with us, although we think they will disappear over the period of time considered in this report. Second, we cover—and with a great deal more interest—the next-generation of smart lighting systems.

These are designed with the latest capabilities of microelectronics taken into consideration and are increasingly designed with the IoT concept in mind. But their functionality is still very much focused on energy efficiency.

The other two smart lighting products categories that we analyze and forecast in this report are (1) smart lighting systems that provide a significant amount of mood enhancement capability and (2) smart lighting with visible light communications capability. For all of these markets and products, we break out system components shipments/revenues in the form of local intelligence, central controller, and smart switches and dimmers. All the forecasts in this report cover an eight-year period and are in volume and value terms

Finally, this report—and the forecasts in the report—are intended to be international in scope, although we do comment at various points in the report on which countries and regions are most likely to be open to the penetration of smart lighting technology. And we also include an eight-year forecast of smart lighting sales revenues by region and country.

1.4 Methodology of this Report

This report was compiled based on a general approach that NanoMarkets has used in most of its other published reports. More specifically, we have synthesized data from a wide variety of sources to paint a picture of what is going on in the smart lighting sector and have then identified and analyzed the trends in the industry with the goal of showing where the main opportunities going forward will be found.

Data sources that have been used include other NanoMarkets reports that cover related areas such as OLED lighting and photovoltaics. In addition, we have based our opinions expressed in this report on discussions with firms and individuals that are shaping the future of smart lighting. We have more to say about data sources used here later in this section.

There appears to be no definitive figure for the overall size of the worldwide lighting market. However, figures in the literature suggest that anything from \$60 billion to \$100 billion is reasonable as an assessment of aggregate lighting market size. In aggregate the market is not growing very fast, since lighting fixtures aren't replaced very often and the construction industry (for new installations) never grows fast in real terms. So the forecasts that we derive in this report seem to imply that smart lighting will account for some 20 percent or so of the entire market by the end of the forecast period, which seems plausible to us.

As we stress throughout this report, most of this value is created through the sales of luminaires and electronics, not bulbs. And in any case, the volume sales of bulbs will most certainly decline in the next decade as luminescent bulbs go away and are replaced by CFLs and LEDs.

1.4.1 Forecasting Methodology

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The forecasting methodology used here is to determine the size and growth of the underlying addressable markets, assess what the penetration of smart lighting systems will be during the period under consideration, and by combining these estimates come up with a shipment forecast for these systems. By adding our estimates of pricing for these systems, it then becomes possible to produce revenue forecasts for smart lighting systems.

As we have already indicated the addressable markets for the products covered in this report are hard to quantify and for each forecast provided here, we provided a justification for the numbers that we have used in this context. In each case, we are able to establish that the addressable market is large and that relatively small penetrations of smart lighting can yield sizeable business opportunities.

This is good news for the makers of smart lighting systems, many of whom lack the resources to create a huge marketing campaign for smart lighting systems. Better news still; the fact that there is now a huge transition away from lighting that has been traditional technology for years to SSL, means that the markets described below are very open to new energy saving technology.

While the above describes the basic forecasting methodology used in all the forecasts presented in this report, the individual forecast contain much more elaborate breakouts by product and component type and these “sub-forecasts” are explained in much more detail in the chapters on the individual markets for smart lighting.

The general approach to forecasting used in this report is quite similar to that used in the previous report published by NanoMarkets in the smart lighting space. In particular, we have used more or less the same addressable market numbers as in the previous report.

1.4.2 Matters of Definition

As we discuss throughout this report, smart lighting is not yet a well-defined market and by adopting one definition or another we can significantly change how the forecasts turn out in terms of market size. Indeed, we ourselves have decided to

include smart automotive lighting, although the term “smart” is not frequently used when auto lighting is discussed.

Conversely, if one counts all the building automation systems that control lighting, the market can be said to be quite large already and we have specifically decided not to do this. Building automation systems are systems that encompass HVAC and are aimed at the largest users. These characteristics are the very opposite of what is intended by many of today's smart lighting systems.

1.4.3 Data Sources and Assumptions about Market Size and Penetration

Quantifying the underlying markets for smart lighting is not easy either; while some countries publish very detailed statistics on housing stocks and other information relevant to understanding the size of available markets others do not. However, we have been able to piece together what we believe are some reasonably useful data on the addressable markets for smart lighting from information provided by governments and from non-copyright information available on the Web.

Along the way, we have made a number of simplifying assumptions. We have tacitly assumed that all the sensors for a lighting system are sold within one year of the initial purchase of this system. This is probably not actually likely to be the case, but seems a reasonable approximation to the truth at this early stage of this market's development. Meanwhile, the rate at which smart lighting is likely to penetrate the available markets is subject to a number of different scenarios and ultimately depends on the reception that consumers give to the features that the smart lighting systems provide. This is mostly a matter of subjective judgment.

As we indicate throughout the report, there appear to be some major driving forces for smart lighting systems that suggest that there is a real opportunity in smart lighting. On the other hand we are not aware of any major signs that this sector is capturing a mass market as of yet. So in our projections we have been cautious in our modeling of smart lighting systems' market penetration, noting also that most of the firms active in this space do not yet have a power business development program.

1.4.4 Systems Components Forecasting Assumptions

For each of the addressable market sectors, we not only break out the market by smart lighting systems type, but also by the components (really subsystems) that go to make up those systems. In this and earlier NanoMarkets reports in the smart lighting space, we have forecast based on three kinds of components: "local intelligence," central controllers and "intelligent switches."



Local intelligence: By local intelligence, we mean the intelligence that is "local" to the lighting itself. That is to say that it is in the luminaire or the ballast in some cases. For the most part, this local intelligence is going to be connected to some kind of central controller, although this is not necessarily the case.

Central controllers: This category of product appears to be self-explanatory. However, the degree of functionality/intelligence that they contain is still open and undecided. It seems likely that these central controllers may connect to a gateway that provides connectivity to the Internet or to a building automation system of some kind.

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We have, however, not included the gateway in our forecasts. One reason for this is that this gateway may have functionality that extends well beyond smart lighting of any kind. However, some central controllers (especially those designed for the residential market) may include energy management and other functionality that offers a bit more than lighting control.

Standalone intelligent switches and dimmers: These are devices that control otherwise "dumb" lighting systems through some kind of clocking or sensing mechanism. These products should certainly be characterized as smart lighting systems, we think, but should probably be considered interim products. The future of smart lighting systems is most likely to be highly distributed.

1.5 Plan of this Report

In Chapter Two of this report, we discuss how the markets for smart lighting are evolving for business establishments including an account of how worldwide construction trends are impacting this segment of the smart lighting business. We include a broad breakout of smart lighting markets for commercial and industrial buildings, as well as breakouts by specific kinds of business/industrial facility with consideration of the drivers of smart lighting markets in each of these areas.

Chapter Three repeats the efforts of Chapter Two, but this time for the residential sector. This time, the final market breakout is by single-family and multi-tenant buildings, the latter having requirements that are similar in some ways to commercial buildings.

In Chapter Four of this report we examine and forecast the markets for smart lighting in non-building markets, especially street lighting and other outdoor lighting as well as auto lighting. We also have something to say about the use of smart lighting in urban farms and horticulture.



Chapter Five provides our analysis of the smart lighting market from the perspective of national markets. While the key drivers for smart lighting in all national markets are more or less the same, there are important variances from one to another because of local conditions, regulation and industrial policy.

Finally, in Chapter Six of this report, we provide a full summary of the forecasts and discuss the major trends that exist throughout the entire smart lighting market.