

Potential and Opportunity for Lighting in the Energy Revolution

Forces of Change Series



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AMERICA'S FINEST NEWS SOURCE

“History has proven that new technological advancements never have any unintended consequences”

Who, What , Where, Why, When & How

- *Who will lead the innovation and opportunities?*
- What opportunities are likely for the lighting community?
- Where will the lighting industry fit in the IoT opportunity?
- Why are these shifts important to you?
- When will these changes occur?
- How can we help to realize the potential?

2013-2017 Progress Report

Submission Breakdown:			
Code	Type	No.	Percent
IS	Inc Sources	0	0.0%
FS	Fluorescent Sources	3	1.3%
MS	Metal Halide Sources	4	1.8%
SS	HPS Sources	1	0.4%
LS	LED Sources	50	22.2%
HB	HID Ballasts	0	0.0%
FB	Fluorescent Ballasts	4	1.8%
LD	LED Drivers	5	2.2%
EM	Emergency	1	0.4%
EL	Emergency LED	0	0.0%
CO	Controls	11	4.9%
AC	Accessory	6	2.7%
FL	Fluorescent Fixtures	0	0.0%
ML	Metal Halide Fixtures	0	0.0%
LL	LED Fixtures	118	52.4%
RE	Research	2	0.9%
PU	Publications	7	3.1%
MA	Materials	2	0.9%
DT	Design Tools	9	4.0%
		223	99.1%

Submission Breakdown:			
Code	Type	No.	Percent
IS	Inc Sources	0	0.0%
FS	Fluorescent Sources	3	1.1%
MS	Metal Halide Sources	0	0.0%
SS	HPS Sources	1	0.4%
LS	LED Sources	35	13.2%
HB	HID Ballasts	1	0.4%
FB	Fluorescent Ballasts	0	0.0%
LD	LED Drivers	9	3.4%
EM	Emergency	1	0.4%
EL	Emergency LED	0	0.0%
CO	Controls	16	6.0%
AC	Accessory	17	6.4%
FL	Fluorescent Fixtures	0	0.0%
ML	Metal Halide Fixtures	0	0.0%
LL	LED Fixtures	162	61.1%
RE	Research	2	0.8%
PU	Publication	8	3.0%
MA	Materials	5	1.9%
DT	Design Tools	4	1.5%
DL	Daylighting	1	0.4%
		265	100.0%

Submission Breakdown:			
Code	Type	No.	Percent
IS	Inc Sources	0	0.0%
FS	Fluorescent Sources	0	0.0%
MS	Metal Halide Sources	0	0.0%
SS	HPS Sources	0	0.0%
LS	LED	48	21.1%
HB	HID Ballasts	0	0.0%
FB	Fluorescent Ballasts	0	0.0%
LD	LED Drivers	6	2.6%
EM	Emergency	4	1.8%
EL	Emergency LED	0	0.0%
CO	Controls	20	8.8%
AC	Accessory	11	4.8%
FL	Fluorescent Fixtures	0	0.0%
ML	Metal Halide Fixtures	0	0.0%
LL	LED Fixtures	130	57.3%
RE	Research	0	0.0%
PU	Publications	5	2.2%
MA	Materials	1	0.4%
DT	Design Tools	2	0.9%
DL	Daylighting	0	0.0%
		227	100.0%

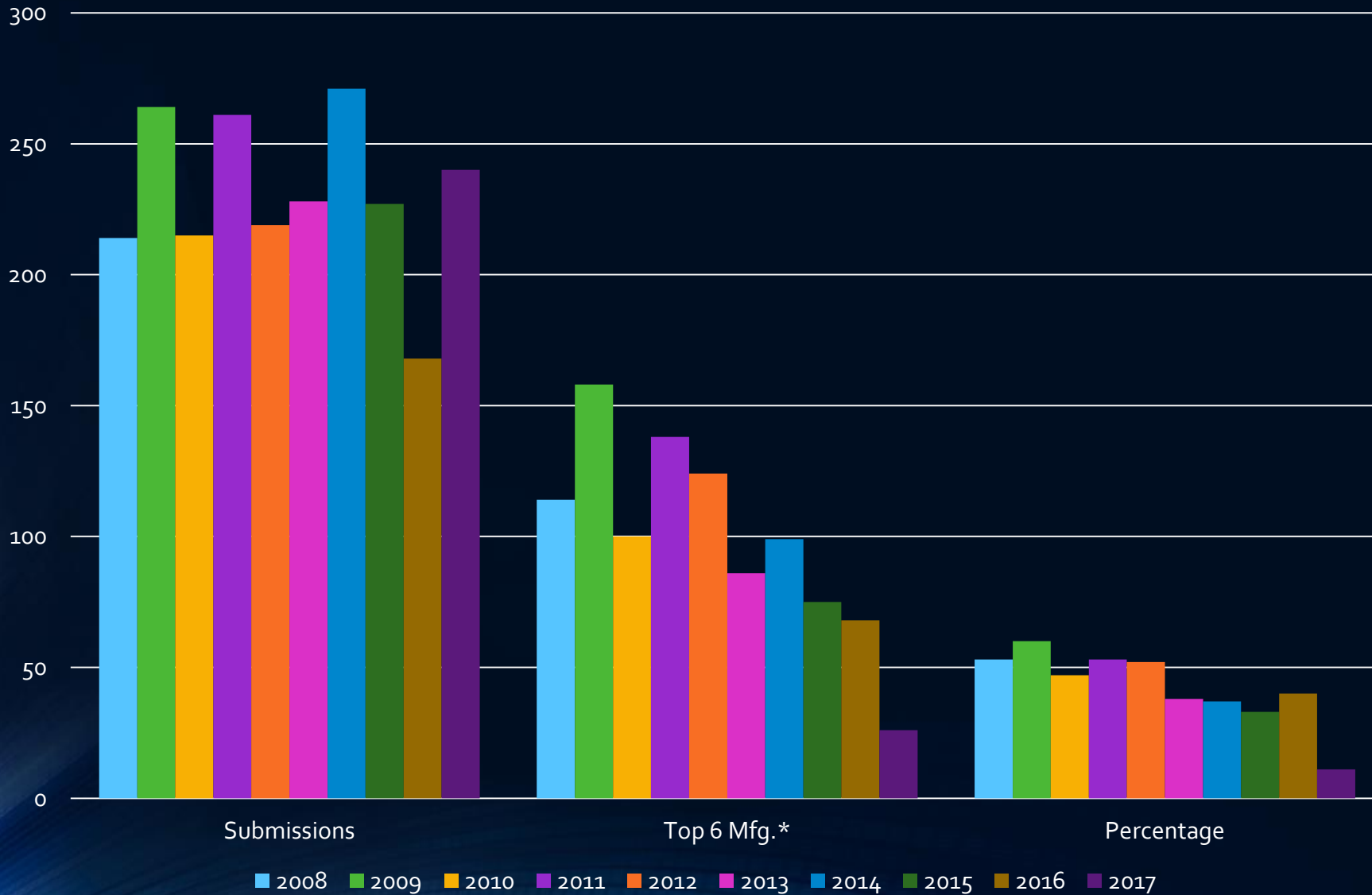
Submission Breakdown:			
Code	Type	No.	Percent
IS	Inc Sources	0	0.0%
FS	Fluorescent Sources	1	0.6%
MS	Metal Halide Sources	0	0.0%
SS	HPS Sources	0	0.0%
LS	LED Sources	26	14.5%
HB	HID Ballasts	0	0.0%
FB	Fluorescent Ballasts	0	0.0%
LD	LED Drivers	0	0.0%
EM	Emergency	4	2.2%
EL	Emergency LED	0	0.0%
CO	Controls	18	10.1%
AC	Accessory	7	3.9%
FL	Fluorescent Fixtures	0	0.0%
ML	Metal Halide Fixtures	0	0.0%
LL	LED Fixtures	101	56.4%
RE	Research	3	1.7%
PU	Publications	3	1.7%
MA	Materials	0	0.0%
DT	Design Tools	3	1.7%
PS	Power Sply	9	5.0%
SY	Lighting System	3	1.7%
DL	Daylighting	0	0.0%
		170	99.4%

Submission Breakdown:			
Code	Type	No.	Percent
IS	Inc Sources	0	0.0%
FS	Fluorescent Sources	0	0.0%
MS	Metal Halide Sources	0	0.0%
SS	HPS Sources	0	0.0%
LS	LED Sources	22	9.2%
HB	HID Ballasts	0	0.0%
FB	Fluorescent Ballasts	0	0.0%
SO	Solar	2	0.8%
EM	Life Safety	2	0.8%
DL	Daylighting	1	0.4%
CO	Controls	20	8.3%
AC	Accessory	10	4.2%
FL	Fluorescent Fixtures	0	0.0%
ML	Metal Halide Fixtures	1	0.4%
LL	LED Fixtures	155	64.6%
RE	Research	1	0.4%
PU	Publications	4	1.7%
MA	Materials	1	0.4%
DT	Design Tools	6	2.5%
PS	Power Sply	13	5.4%
SY	Lighting System	2	0.8%
		240	100.0%

No Progress on Traditional Fixtures and Sources



Revealed in Progress Report 2017

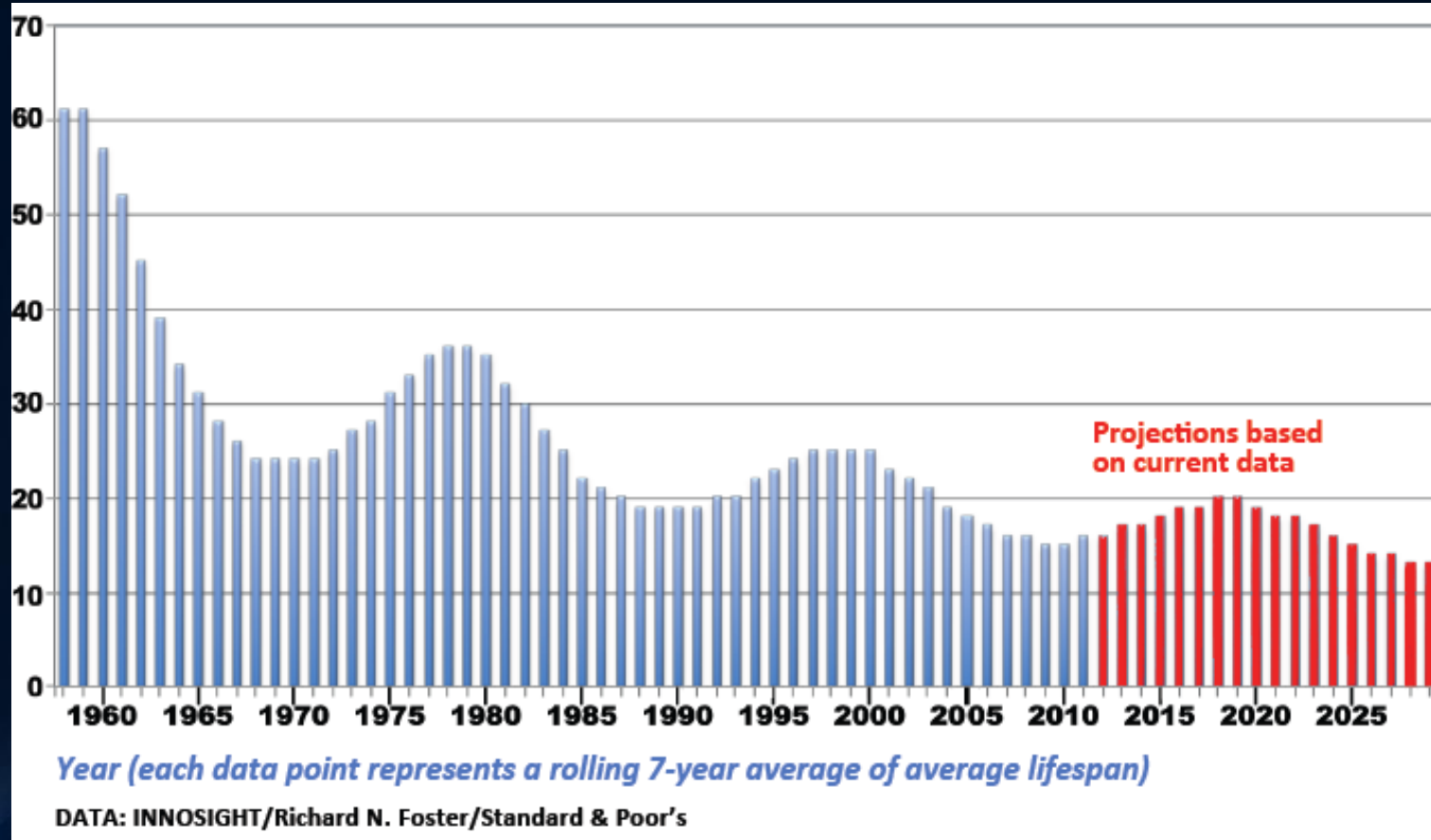


	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Submissions	214	264	215	261	219	228	271	227	168	240
Top 6 Mfg.*	114	158	100	138	124	86	99	75	68	26
Percentage	53	60	47	53	52	38	37	33	40	11

Lifespan of firms in the S&P 500

Hello...

e-bay
NETFLIX
Whole Foods
Amazon
Google
Comcast
E*Trade
etc.

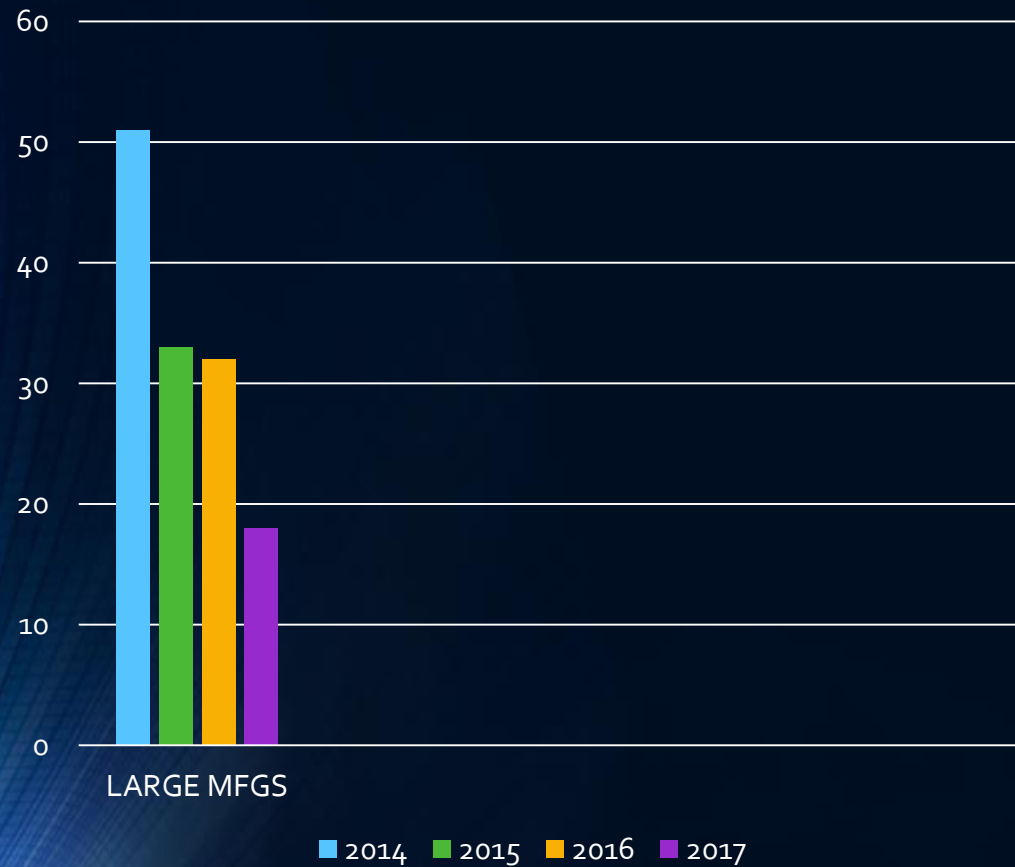


Goodbye...

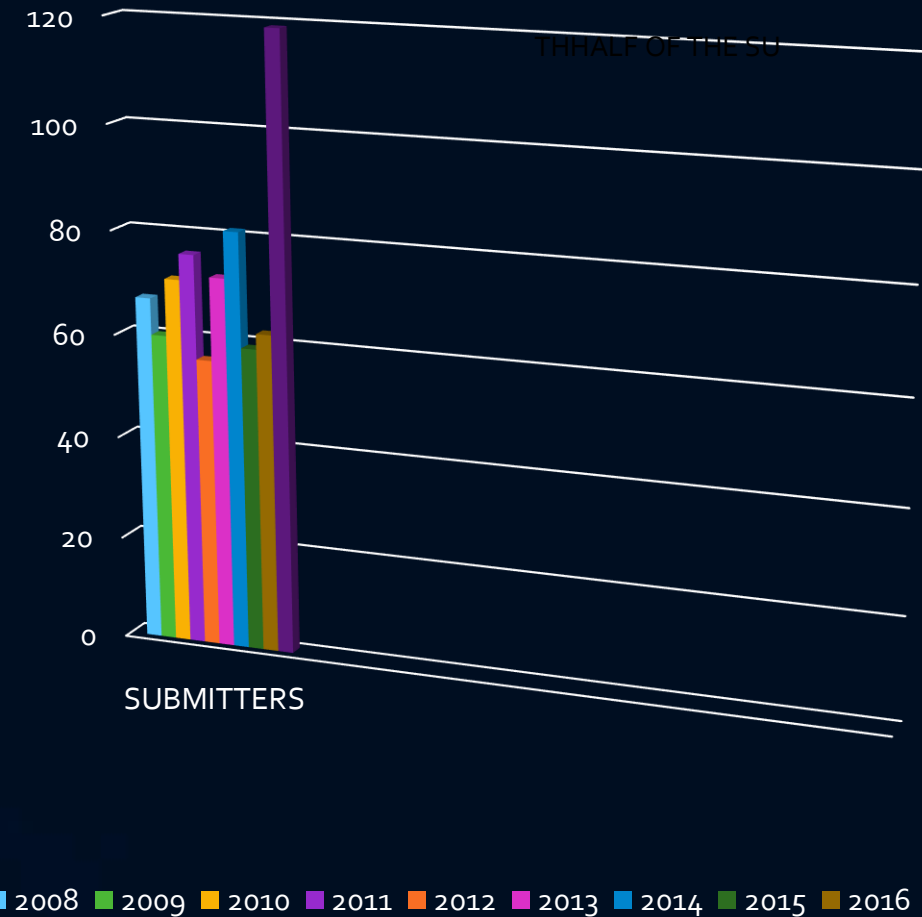
Eastman Kodak
Palm
New York Times
Sears
Comp USA
Circuit City
Radio Shack
etc.

Babson School of business projects that 10 years from now 40% of today's S&P 500 will not exist. By 2020 more than 100 will be companies that we have not heard of yet.

LED SOURCES



QUANTITY OF SUBMITTERS



In 2017 there were 119 companies submitting out of 240 submittals averaging 2 each

New Submitters in 2017

- Kobi
- PhosphorTech
- Contrast
- Zotia
- Vode
- Invisia
- Vibia
- Coronet
- Luceco
- Holm
- Structura
- Zaniboni
- Deako
- Sielo
- Above All Lighting
- QSSI
- Flex
- Ligman Lighting
- CoeLux
- Volt
- LaraLee Optical
- OLED Devices
- LF Illumination
- Luxxbox
- Chrome –Q
- i2Systems

Local players dominate LED lighting fixtures market

June 2, 2017: The growth of the global lighting fixtures market, revenue-wise, is estimated to touch US\$215.29 billion by 2021 end. The market will grow at a CAGR of 6.9% till 2021, according to a Transparency Market Research (TMR) study.

North America will claim the largest revenue from lighting fixtures, which is expected to reach US\$64.10 billion by 2021. The lighting fixtures revenue of the Asia-Pacific region will touch US\$82.26 billion by 2021, due to its highly-populated countries and rapid industrialization. On the other hand, China's revenue in the lighting fixtures market will reach US\$45.47 billion by 2021.

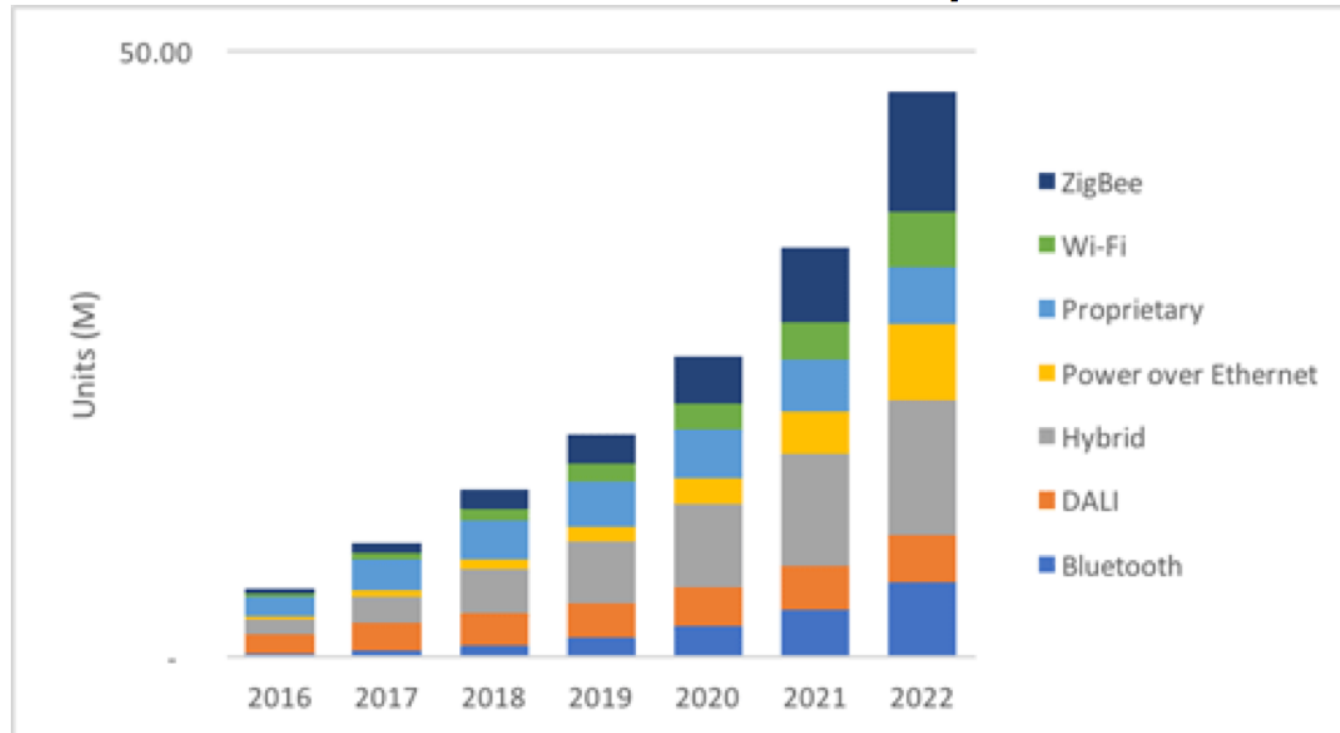
However, the trend shows that nearly 90% of the lighting fixtures market is in the hands of the regional players, with the top four global lighting fixtures companies held a only 10.2% of the global market value in 2014, which shows that the market is extremely fragmented.

As a result, the top global players like Philips, Acuity Brands, Hubbell Lighting, and Cooper Lighting, are facing extreme competition, and to beat this competition, they are adding innovative products into the market, and are focusing on increasing their geographical reach.

Global Luminaires Market Analysis and Forecast 2017

Pennwell - June 2017

Total Connected LED Luminaire Unit Shipment Forecast



Included with report: Interactive PDF, two hours of analyst time, Excel spreadsheet with data

This report analyzes the market for the top indoor luminaire form factors used in the world today and provides a detailed forecast of installed base, unit shipments and revenues from 2016 through 2022.

Who, What , Where, Why, When & How

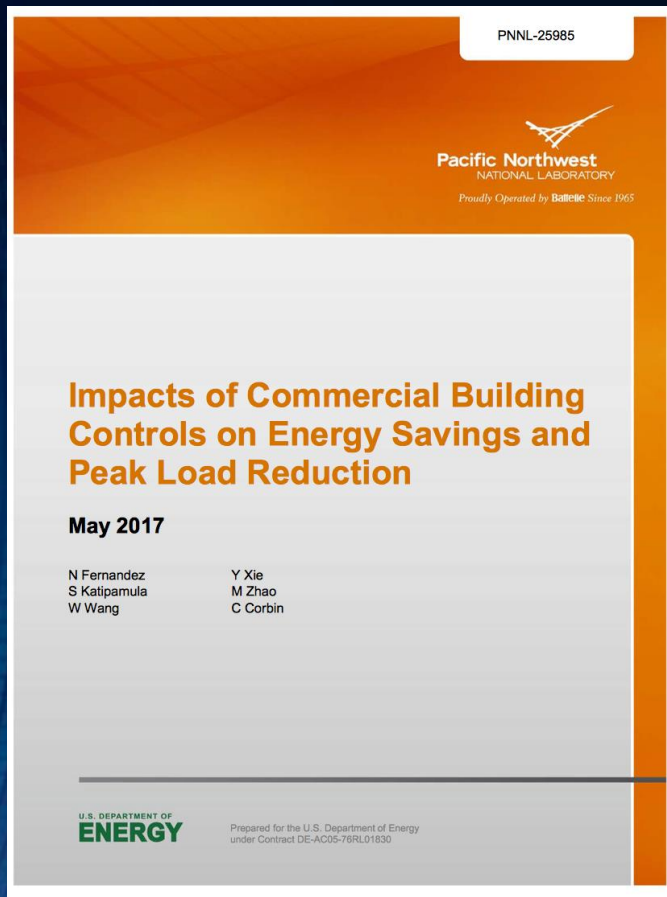
- Who will lead the innovation and opportunities?
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Four Concurrent Revolutions

- Solid State Lighting / Energy
- Internet of Things
- Trust
- Lighting & Health

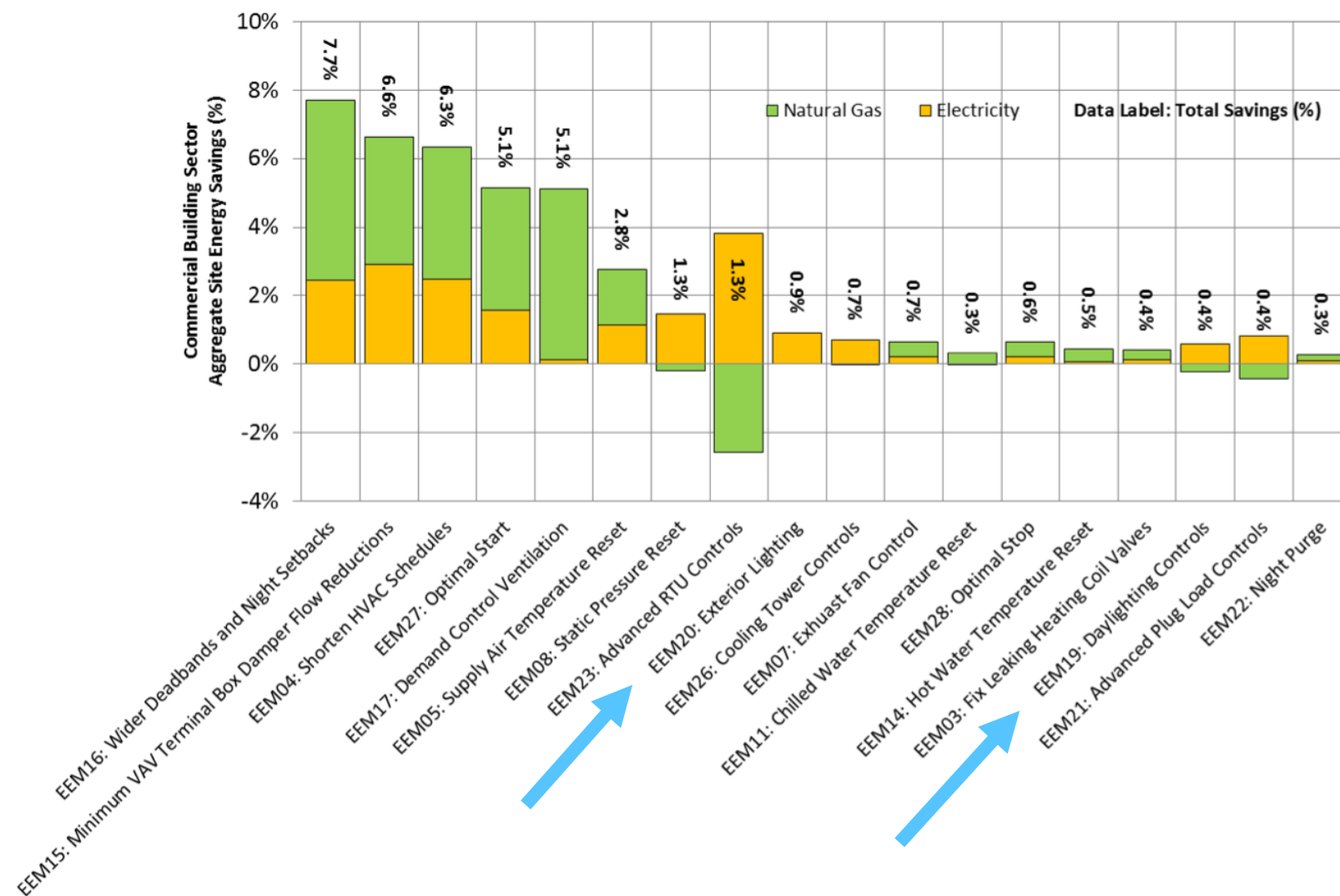
The Trust Revolution

- Our ability to trust products and services affects their growth and impact
- Technology, individuals and companies are developing new ways to trust
- We have stopped trusting institutions and started trusting strangers
- Trust enables change and innovation
- Trust underlies our disruption(sales, cybersecurity, data collection&analysis, etc)
- Rachel Botsman defines trust as “a confident relationship with the unknown”



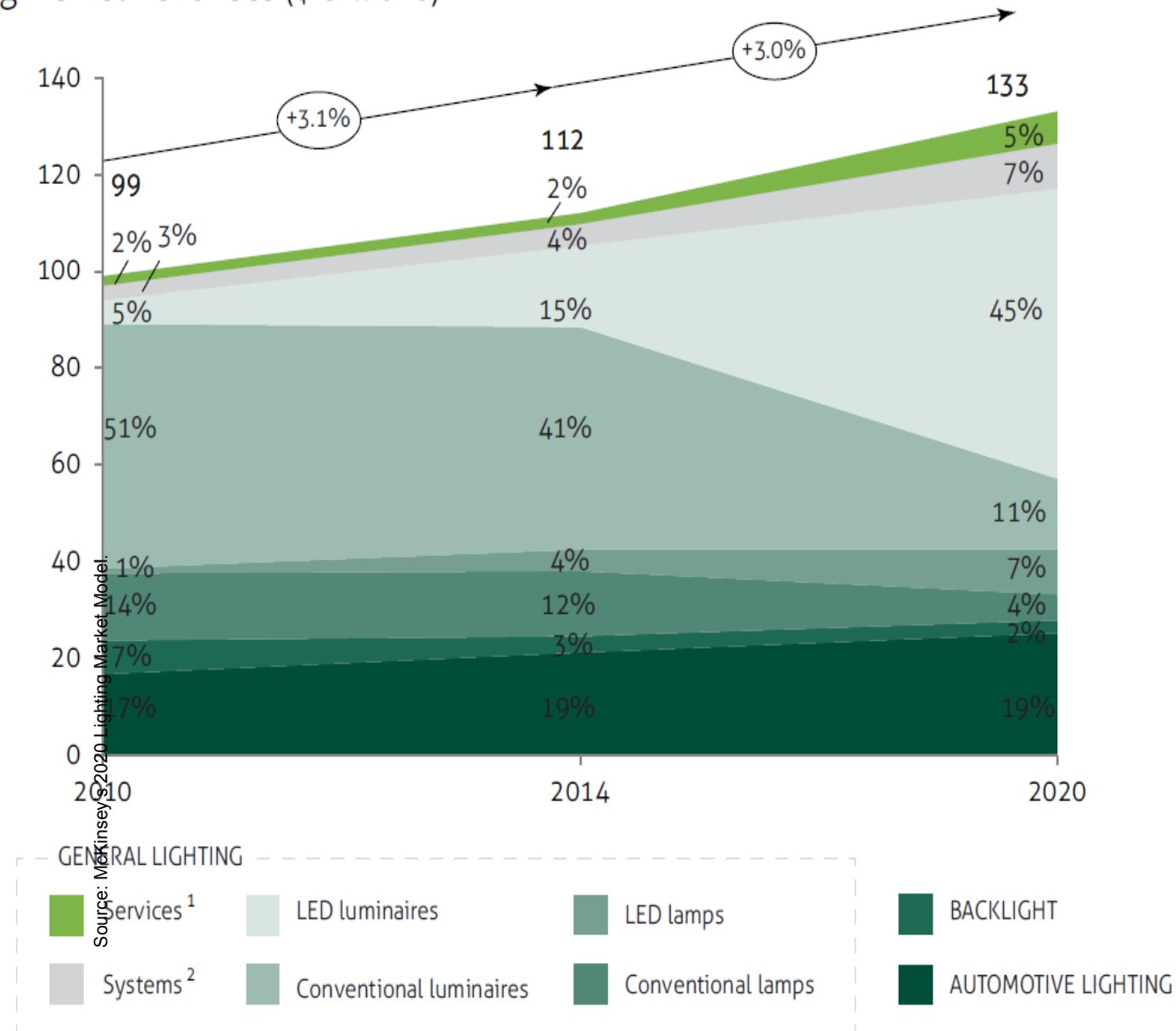
7.3 Energy Savings from Individual Measures Aggregated Across All Building Types and All Climate Locations

Of the 34 measures simulated, 6 measures, when simulated individually and weighted according to the expected prevalence of opportunity for their implementation, showed the potential for over 2% of the total site energy savings, nationally. These measures are the first six, ranked by impact, in Figure 7.1.



The Changing Composition of the Lighting Market

Worldwide Lighting Market Revenues (\$ billions)



Lighting as a service

From Wikipedia, the free encyclopedia

Lighting as a Service

(LaaS) is a service delivery model in which light service is charged on a subscription basis rather than via a one-time payment. This business model has become more common in commercial and citywide installations of [LED lights](#), specifically in retrofitting buildings and outdoor facilities, with the aim of reducing installation costs. Light vendors have used an LaaS strategy in selling value-added services, such as Internet-connected lighting and energy management.^[1]

Controls - Hi Alexa...



Lighting in new DC area homes will feature Amazon voice controls

Published on: January 4, 2017

By Mark Halper

Contributing Editor, LEDs Magazine, and Business/Energy/Technology Journalist

The IoT rises as the Alexa system will also let people verbally boss around thermostats, window blinds, door locks, and all sorts.



In another example of the property business pushing into smart lighting, home construction company Brookfield Residential said it is building smart homes in the Washington, DC area featuring voice control of lights and other things using the Alexa system from Amazon.

Works with Alexa | Lighting

Welcome to the Alexa Smart Home Store for Lighting, where you'll find great prices on a wide range of light bulbs, dimmers and switches that you can control with your voice through Alexa.

Shop by
Solution

Shop by Brand



Lighting



Outlets



Starter kits



Thermostats



Door locks



Cameras



Other solutions



Alexa Smart
Home



Alexa things to
try

<http://www.ledsmagazine.com/articles/2017/01/lighting-in-new-dc-area-homes-will-feature-amazon-voice-controls.html>

• [TECH/ARTIFICIAL INTELLIGENCE](#)

Lyrebird claims it can recreate any voice using just one minute of sample audio

The results aren't 100 percent convincing, but it's a sign of things to come

by [James Vincent@jjvincent](#) Apr 24, 2017, 12:04pm EDT

What it is: Lyrebird, a Canadian startup, has unveiled a set of AI algorithms capable of recreating a person's voice after just a single minute of sample audio. This is an order of magnitude improvement over other synthesized voice projects like Google's Wavenet and Adobe's VoCo, which are closer to the 20-minute mark. Lyrebird has incorporated emotional flexibility into its algorithms, allowing customers to create voices that are angry, stressed or sympathetic. Creating an initial voice-print requires considerable computing power, but voice creation is trivial -- 6,000 sentences in less than half a second.

Why it's important: We're approaching a time when we can edit and recreate voice just as we now do with images, enabling an explosion in our ability to develop conversational interfaces, lifelike AI's in virtual reality, and more emotionally present robotics. As more signals are digitized, we'll be able to apply machine learning principles to just about *anything* to generate new insights.

www.3ders.org
3D printer and 3D printing news

Home Price Compare Videos Stats 3D Printing Basics Forums

Rohinni produces the 'world's thinnest' LED lights using 3D printing, and it adds light anywhere

3D Printing OLED Light Fixtures – Do it Yourself!

Try designing your own light with [3D printing](#) and an OLED light DIY Kit. OLED Task Lamp made with one 100x100mm [LG Chem OLED](#) module and a driver included in a LG Chem OLED light DIY kit.

For more information, visit <http://www.facebook.com/lgoledlight>

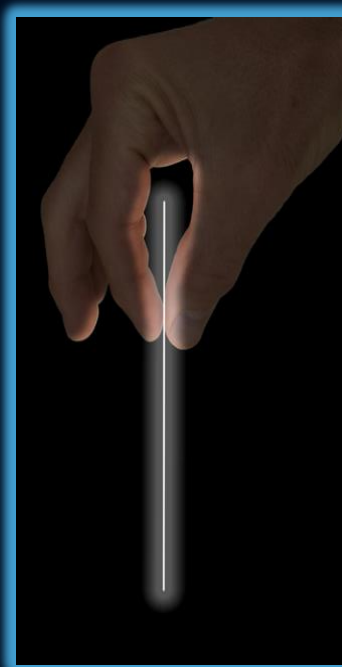
3D Printing OLED Light Fixtures

By Illumarco · Nov 14, 2015 · 0



DIY: 3D Printing OLED Light Fixtures for Designers

OLED, one of the most advanced technologies in today's lighting world meets the most innovative technology in printing. Still, the most important thing in a lighting fixture would be the light source itself. However, [3D printing technologies](#) bring new and enhanced design possibilities closer to light design and engineering studios and help them create new and designful products. Here's a nice example from LG Chem about 3D Printing OLED Light Fixtures.



XYZprinting
XYZprinting da Vinci Jr. 1.0 3D Printer - 5.9" x 5.9" x 5.9" Built Volume (Includes: 300g PLA Filament, USB Cable & Power Adapter, Cleaning & Maintenance Tools, Print Bed Tape, Print Removal Scraper)
★★★★☆ 326 customer reviews | 177 answered questions

Price: **\$199.99** Prime

In Stock.
Want it Sunday, May 14? Order within **2 hrs 22 mins** and choose **Standard Shipping** at checkout. [Details](#)
Ships from and sold by Amazon.com. Gift-wrap available.

Color: **Orange**

	from \$303.00		\$449.95 Prime		\$199.99 Prime
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Roll over image to zoom in

amazon Prime

- Free XYZmaker 3D design software, Free XYZware 3D printing software, Free XYZprinting STEAM 3D printing curriculum.
- Easy Z-offset calibration, adjust your print bed with ease on the LCD screen. No time consuming 3 knob calibration needed.
- Supports XYZprinting non-toxic PLA plastic filament, which is DEHP-free and Heavy metal-free
- Build size of 5.9" x 5.9" x 5.9"
- Print Speed Upgrade: Max print speed up to 100mm/second. (XYZware software must be version V2.1.12.1 or above)

Graphene 3D Lab Files Patent for Graphene 3D Printed LED Light Source and Multi-Function 3D Printer

by Scott J Grunewald | Dec 4, 2015 | 3D Printers, 3D Printing, 3D Printing Materials, Business |

The World's Leading 3D Printing Service & Marketplace

Shapeways Enables Everyone to Bring Their Ideas to Life



Upload Your 3D Design to Order Instantly

UPLOAD NOW



Learn how to turn your idea into reality with Shapeways

LEARN MORE



Discover Gifts and Products Designed by Our Community

SHOP NOW

POPULAR CATEGORY

3D Printed Optics

3D Printed Lampshades

3D Printed Luminaires

3D Printing Eleven

3D Printing Software

3D Printing Education

3D Printing Chandeliers



The Strategic Roadmap of LightingEurope demonstrates the increasing growth in the value of light to society.

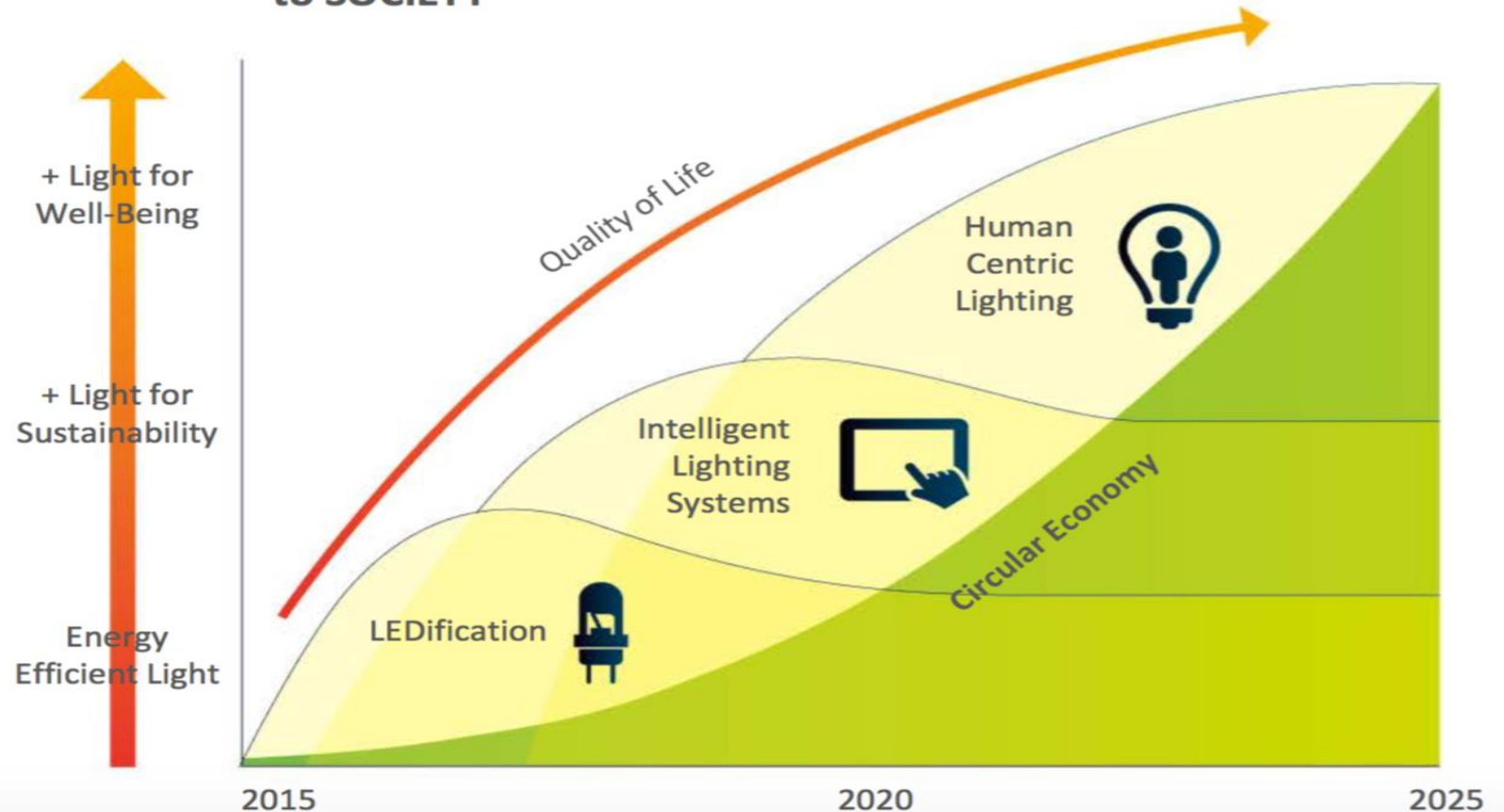
In this process, **energy efficiency** is supplemented **with light for sustainability** and with **light for well-being**.

The European lighting industry is aiming together with European Regulators for the **growth of the European lighting market** by more intelligent lighting, increased renovation rates, Human Centric Lighting and by circular economy thinking.

A result will be an increased number of jobs in Europe.

Value of light to society

Growth of VALUE of LIGHT to SOCIETY



Wild Nights: How Taming Sleep Created Our Restless World Kindle Edition

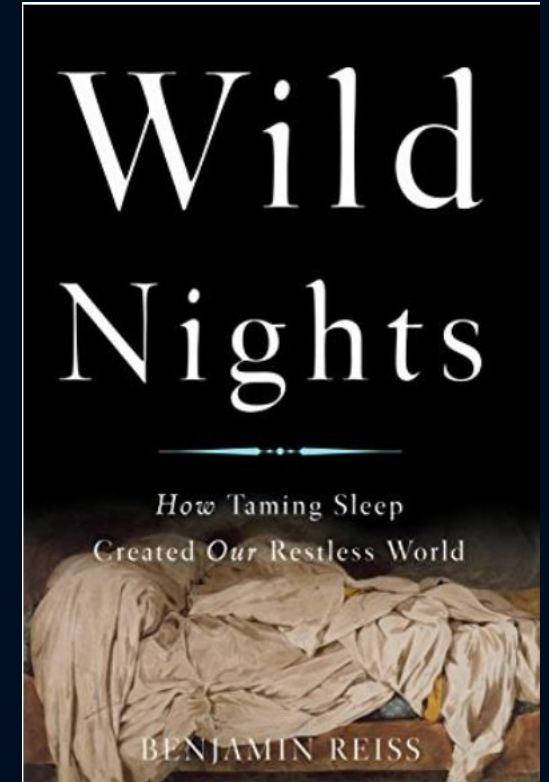
by [Benjamin Reiss](#) ▾ (Author)



[8 customer reviews](#)

Why is sleep frustrating for so many people? Why do we spend so much time and money managing and medicating it, and training ourselves and our children to do it correctly? In *Wild Nights*, Benjamin Reiss finds answers in sleep's hidden history--one that leads to our present, sleep-obsessed society, its tacitly accepted rules, and their troubling consequences.

Today we define a good night's sleep very narrowly: eight hours in one shot, sealed off in private bedrooms, children apart from parents. But for most of human history, practically no one slept this way.



Li-Fi crucial to the future of lighting, says LED inventor

Shuji Nakamura, the man who won the Nobel Prize for inventing the blue LED, has named Li-Fi as crucial to the future of lighting technology.

Speaking at Academia Sinica, in Taipei, Dr. Nakamura stated that LED has now reached a 'stage of maturity' and manufacturers are seeking out new markets where they can thrive into the future.

Nakamura named Li-Fi and laser lighting as two crucial areas the LED industry needs to concentrate on in order to further their businesses successfully.



Shuji Nakamura is talking up the future Li-Fi. Photo by Russell Abraham for Sora.

http://luxreview.com/article/2017/02/li-fi-crucial-to-the-future-of-lighting-says-led-inventor?cmpid=enl_lux_latestlightingnews_2017-02-23

Who, What , Where, Why, When & How

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CABA Impact of IoT Report - 2017

Theme 1 - Realizing the value of IoT

Summary of key message: As technology developments throughout the IoT Ecosystem have come to fruition and continual innovation drives solutions, adoption of IoT solutions in intelligent buildings remains dependent on proving the value of IoT. **Although the ecosystem interviews gave perspective on what the suppliers to the industry believed would be of value, the decision-maker survey illustrated this was not always in line with what the customer was actually looking for.**

“Most attractive advantages that IoT in building automation can bring”
- #1 Reduce Energy Consumption

Roundup Of Internet Of Things Forecasts And Market Estimates, 2016

- Bain predicts that by 2020 annual revenues could exceed \$470B for the IoT vendors selling the hardware, software and comprehensive solutions. 
- McKinsey estimates the total IoT market size in 2015 was up to \$900M, growing to \$3.7B in 2020 attaining a 32.6% CAGR. 
- General Electric predicts investment in the Industrial Internet of Things (IIoT) is expected to top \$60 trillion during the next 15 years. 
- IHS forecasts that the IoT market will grow from an installed base of 15.4 billion devices in 2015 to 30.7 billion devices in 2020 and 75.4 billion in 2025

<http://www.forbes.com/sites/louiscolombus/2016/11/27/roundup-of-internet-of-things-forecasts-and-market-estimates-2016/#2f1192554ba5>



ANSI C137 Reveals Fundamental Need for New Definitions

Coexistence – the ability of systems or system components to operate together without having harmful or undesirable effects on each other

Compatibility— the ability of a system or system components to have coexistence, interoperability, and/or interchangeability with other systems or systems components, depending on the context

Note: Because the terms “compatible” and “compatibility” are ambiguous, their use is not recommended when other terms are more specific. See definitions of coexistence, interoperability, and interchangeability to determine which are most appropriate.

Functional Interchangeability—the ability of a system component to perform in an equivalent manner as another system component Note: The system component may not be physically interchangeable.

System Input Power— total electrical power consumed by the system, including the operation of all electrical components necessary for its intended functioning

Interchangeability—the ability of system component to replace the form and fit of another system component and perform in an equivalent way Note: See definitions of functional interchangeability and physical interchangeability.

Interoperability—the ability of systems or systems components to transmit, receive, interpret, and/or react to data and/or power and function in a defined manner



ANSI C137 Reveals Fundamental Need for New Definitions

Lighting System—a collection of functionally related components that can include, but is not limited to, luminaires, sensors, controllers, software, firmware, windows or skylights, installed in an application to provide illumination

Notes:

1. lighting systems may be networked to provide central or remote control and monitoring functions.
2. lighting systems may be connected to or integrated with other systems or devices.
3. energy use, light quality, light level, human comfort, visibility, safety and security, the physical environment, system operation and maintenance, and daylight integration are considerations addressed by lighting systems.

Physical Interchangeability—the ability of a system component to replace the form and fit of another system component Note: The system component may not perform in an equivalent way.

Smart, IoT & Connected Lighting

- Smart products and sensors slowly penetrating market (period of “deception” prior to accelerating to exponential growth).
- Exterior lighting precedes interior due to ROI, product availability and potential benefits to municipalities, the public and manufacturers
- Smart cities are driving connectivity (using lighting as the lynchpin to connect the various elements of a complicated structure together)
- Standards are under development

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All Skill Sets are Affected and Respond Differently



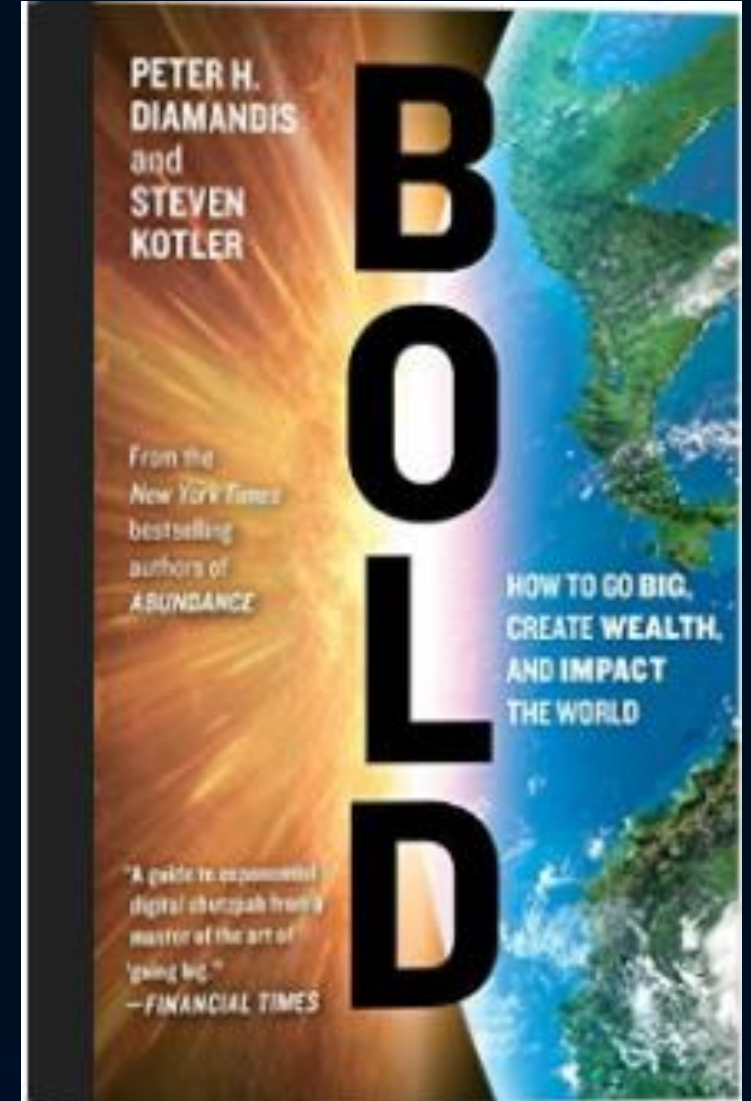
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The 6 D's

Hallmarks of Exponential Growth

1. Digitalization
2. Deception
3. Disruption
4. Demonetization
5. Dematerialization
6. Democratization



“An expert might be reasonably good at predicting the growth of a single exponential technology (e.g. the Internet of Things), but try to predict the future when the following eight technologies are all doubling, morphing and recombining... You have a very exciting (read: unpredictable) future”

1. Computation

2. Internet of Things (Sensors & Networks)

3. Robotics/Drones

4. Artificial Intelligence

5. 3D Printing

6. Materials Science

7. Virtual/Augmented Reality

8. Synthetic Biology

1. Emergence of Continuous Low-Power Always-On Sensors

One of the major advances from the past three years has been the proliferation of "always on" sensors.

2. Smartphones Drives Sensor Volume at Low Cost

The number of sensors in your smartphone today have exploded. Raj continues, "We are now seeing 10, 20 and even 30 sensors embedded in our smartphones.

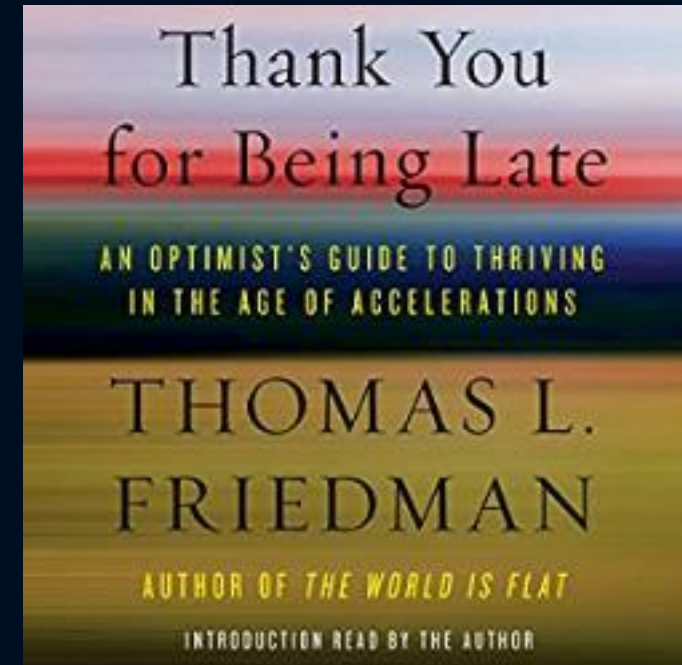
A billion phones means 20 billion+ sensors – and we are headed towards a trillion sensor economy.

3. "Systems" Fuse Continuous Sensor Data & Cloud Processing

Seamless integration of processing is happening in the cloud and on your device. Raj explains, "When you say, 'Okay, Google,' a part of what happens next is on the phone and a part is on the cloud. You don't really know where the processing is being done, on your device or on the cloud, the handoff is seamless."

Simultaneous Accelerations

- Technology Changes
 - Exponential Growth Patterns (Moore's Law, etc)
- Market Changes
 - Globalization
 - Connectivity
- Mother Nature
 - Climate Change
 - Biodiversity Loss
 - Population Growth and Shifts



From Book: Thank You for Being Late by Thomas L. Friedman

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What will
ultimately make
the difference in
how relevant our
industry,
organizations and
standards are is...

YOU

Get Involved



Unfinished Business-Barriers to Opportunity

- Cybersecurity for Lighting Products/Systems
- Flicker Metric
- Effect of Light on Human Metabolism (melanopic lux, circadian stimulus, etc)
Both Metric & Health Recommendations
- Redefine the Lumen for Perceived Brightness
- Glare Metric
- Increased Broadband Access and Speed
- International Metrics for Color Quality of Light Sources Related to Perception & Preference
- Energy Monitoring

Scarcity or Abundance Mentality?

The same transformation from scarcity to abundance, from expensive to demonetized, is happening across a wide range of products and services:

- *Information* has become abundant and free through Google
- *Knowledge* has become abundant and free through Wikipedia
- *Energy* is becoming abundant through wind and solar
- *Communications* has become abundant through mobile networks
- *Entertainment* has become abundant through YouTube (more than 1 billion hours of free videos were served in 2016)
- *Transportation* is demonetizing 10x because of electric autonomous cars

This is an important lesson for entrepreneurs. What product or service will you dematerialize and demonetize and transform to abundance?

Potential and Opportunity for Lighting in the Energy Revolution

Forces of Change Series



Mark Lien LC, HBDP, CLEP, CLMC, LEED AP BD&C
Illuminating Engineering Society
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