



LED at the crossroads: Scenic route or expressway?

Although adoption of LED lighting has been slow, roadblocks can be overcome with a comprehensive approach that includes operational improvements, better marketing of products, and other efforts.

**Oliver Vogler,
Dominik Wee, and
Florian Wunderlich**

The advantages of new LED lighting technology are well tested and beyond doubt. Nevertheless, LED lamps have achieved little market penetration and are predicted to make far slower progress than comparable disruptive technologies. Research conducted by McKinsey's LED Competence Center has revealed the underlying reasons for the slow uptake; if manufacturers, retailers, and regulators collaborate to overcome the five major barriers to adoption we have identified, LEDs could dominate the lighting marketplace by 2015.

LED: Environmentally and economically superior

LED is a revolutionary lighting technology. It offers a number of important features, including

many that cannot be matched by existing incandescent, compact fluorescent (CFL), or halogen lights. Among LED's advantages are greater color variability, "instant on" capability, dimming capacity, and freedom in design. The efficiency of LED bulbs makes them significantly superior to CFL today with regard to total cost of ownership. LED bulbs can generate more than 100 lumens per watt of electricity, compared with 60 to 75 for CFLs; they also last three to five times longer. LED's fully loaded costs become lower than those of typical fluorescent lights in roughly six years.

LEDs are also superior from an environmental perspective. They contain no mercury, so their



disposal is significantly less problematic than that of CFL or traditional fluorescent tubes. From a carbon-abatement perspective, LED's energy efficiency offers the potential for substantial savings. Compared with traditional incandescents, LED lamps can reduce energy consumption by more than 80 percent.

LED penetration: The roadblocks and how to overcome them

In spite of LED's advantages, even optimistic market forecasts predict that LED retrofit light-bulbs will not achieve 50 percent household penetration in the United States for 10 years or more. This pace would be slower by half or

more than was achieved by DVDs, broadband Internet, and television.

To understand what is holding LEDs back, McKinsey conducted research involving store visits and a survey of key LED industry players. The results highlighted five key roadblocks, for which we developed solutions based on both existing McKinsey knowledge and new insights derived from proprietary research, including a conjoint analysis of consumer shopping behavior.

1. LED unit costs are too high

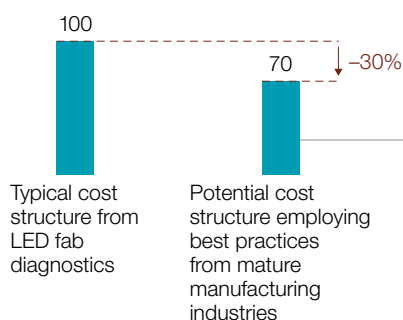
Not surprisingly, our survey shows that industry leaders agree that unit costs are the

Exhibit 1

LED adoption can be accelerated by applying best practices in manufacturing.

Learning from industry best practices...

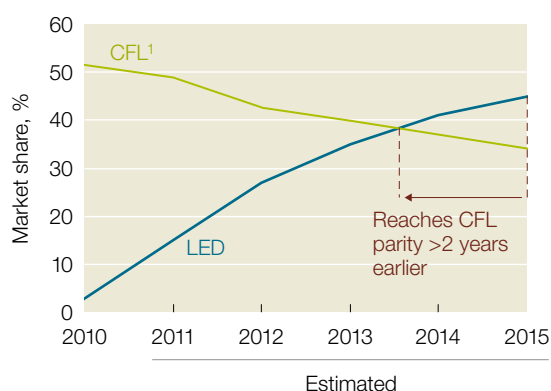
Average LED cost-improvement potential based on McKinsey LED benchmarking



Measures

- Use larger-scale wafers
- Increase automation levels
- Use large-scale fabs
- Employ advanced lean-manufacturing methods such as complexity management

... would accelerate LED market adoption



¹ Compact fluorescent lights.

Source: McKinsey LED benchmarking initiative; KLA-Tencor; McKinsey conjoint model on the lightbulb market

biggest roadblock for LED right now. At €20 to €40, LED is still four times the price of an equivalent CFL in the 40-watt-equivalent product range.

Solution: Reduce costs by applying manufacturing best practices

By employing best practices drawn from mature manufacturing industries (for instance, increasing yield and automation levels), we believe that lowering the cost of LED lamps by as much as 30 percent as a one-time effect could be readily achieved in the short term. The one-time reduction would augment a typical annual cost reduction of around 20 percent, according to most experts (Exhibit 1).

Our analysis indicates that if manufacturers pass on the cost reduction to consumers, LEDs could achieve the same market share as CFLs (about 40 percent) by 2013, two years ahead of current forecasts.

2. Product positioning at retail is weak

Our store visits showed that LED lamp manufacturers are not making sufficient investment in retail presentation. We encountered signage that muddled the distinction between the energy efficiency of LED and CFL bulbs, and 70 percent of the stores we visited had no dedicated section for LED bulbs. More than half the stores in our tour had very limited assortments of LED bulbs, with only typical white bulbs on offer in only the most standard wattages.

Solution: Offer clear and informative consumer guidance

Our analysis reveals that a handful of improvements in merchandising techniques could significantly increase consumer adoption (Exhibit 2).

Applying their trade-spend budgets as necessary, manufacturers should encourage

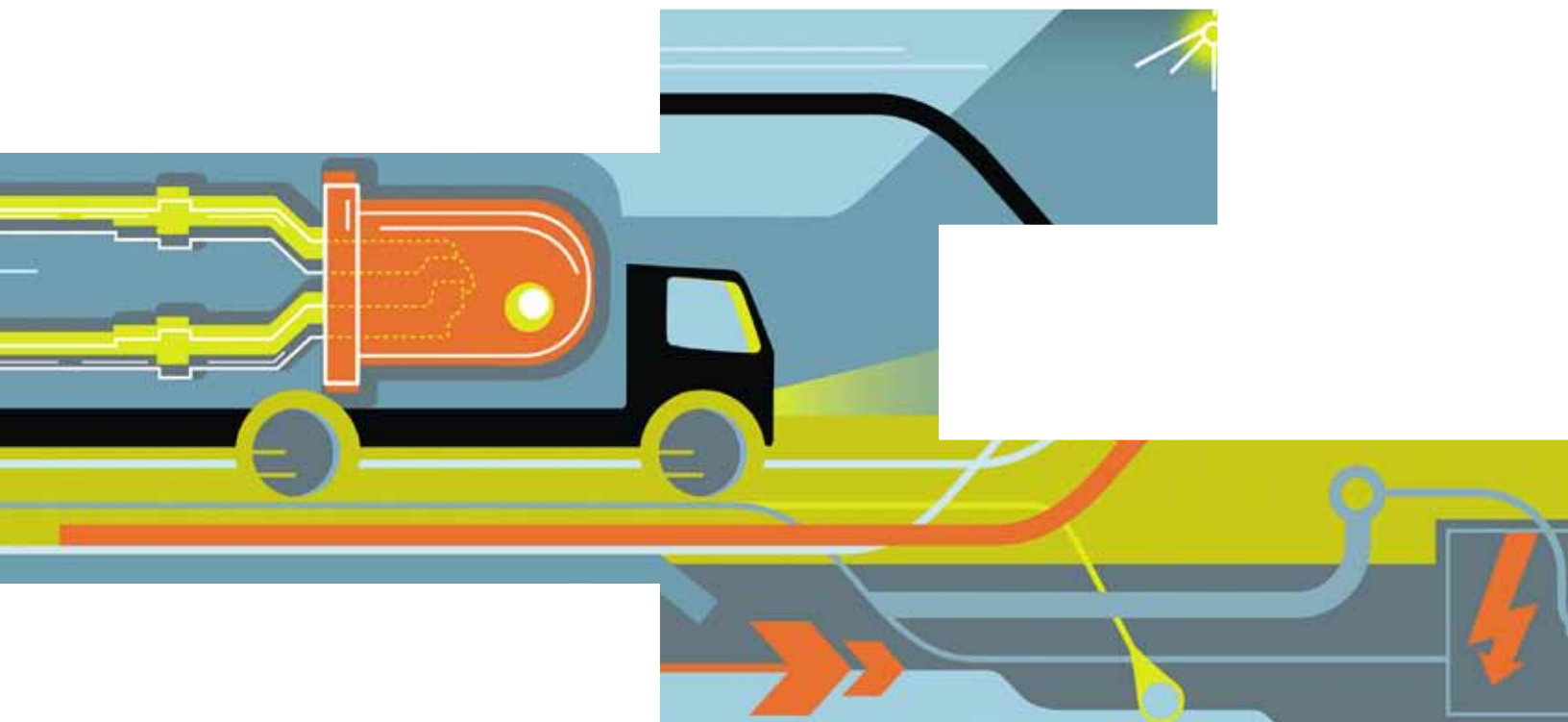
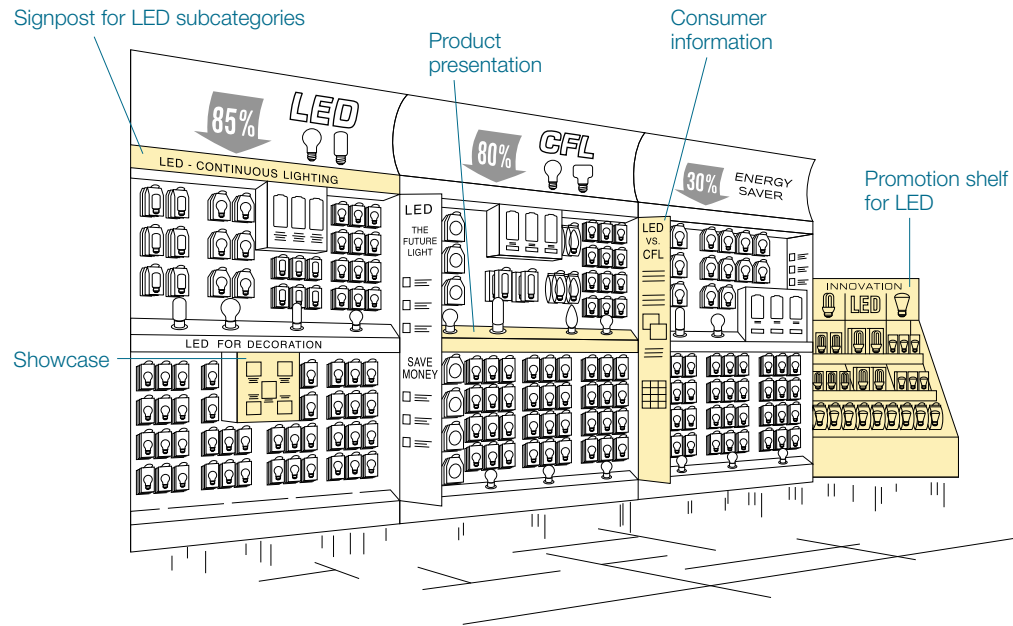


Exhibit 2

Clear and informative guidance for consumers is essential when marketing LED products.



Source: Store visits (n = 12, July 2010, Munich)

Illustration by Lloyd Miller

retailers to do a number of things: segment lighting technologies for display, feature LED products on special promotional shelves and on the ends of aisles, and deploy showcases enabling comparisons of brightness, color, and temperature from technology to technology. Manufacturers should also be sure that consumer-information literature is displayed beside the segmented LED products.

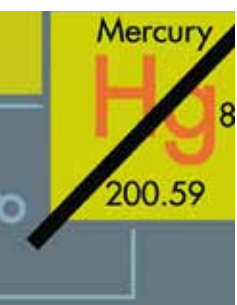
3. Principal-agent conflicts abound

In most commercial lighting situations (for example, corporate offices or building lobbies), builders make the majority of lighting decisions based on initial cost rather than longer-term benefits. On the other side of the ledger,

the tenants pay the operating cost, meaning that they would likely prefer LED, if they were in a position to make the decision.

Solution: Create third-party lighting service providers

These interests, now in conflict, create an opportunity for the introduction of a new business model to satisfy both sides: lighting service provision by a manufacturer, a utility, a facility-management company, or a third party. A business of this type would sign contracts to provide not only the up-front investments, perhaps with financial participation from an investor, to enable LED lamp installation, but would also provide



Switching from incandescents to LED can actually yield a profit from CO₂ abatement of approximately €140 per ton of CO₂ abated, due to the energy-saving potential of LED

the maintenance and upkeep of the LED fixtures and charge occupants an hourly rate for light. By removing the purchasing decision from the builders, such a provider could price its services to begin delivering on the total-cost-of-ownership promise of LED to customers from the very first day, while also earning a decent margin for its services.

We calculated, for example, that by supplying and maintaining street lights for a city of one million people, an LED provider could generate energy savings on the order of 22 percent. At average rates, this model would save the municipality roughly €2.3 million per year, mainly through electricity savings.

Corporate customers could also benefit from such an arrangement. Their lighting costs would be reduced due to lower energy consumption, and the corporations themselves would bear none of the up-front investment costs. In addition, the maintenance burden associated with lighting would be reduced and completely outsourced.

4. Direct regulatory support is lacking

Despite bans of incandescents in more and more countries, LED adoption has little direct government support in the consumer sphere against competing traditional lighting

alternatives like CFLs. In contrast, other energy-saving technologies enjoy more support: Germany, for example, provides €2.4 billion in solar-panel subsidies per year (paid by consumers), while the European Union is considering strong regulations to reduce CO₂ output from automobiles and other medium-size vehicles from 3.5 to 16 tons. Analysis shows that solar subsidies achieve CO₂ abatement at a cost of €80 per ton, and emission reduction in cars achieves this at a cost of roughly €190 per ton.

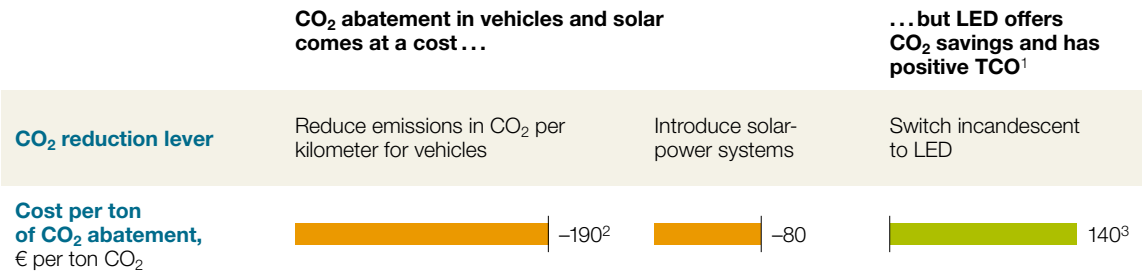
Solution: Publicize the remarkable environmental and cost advantages of LED

Our analysis reveals that switching from incandescents to LED can actually yield a profit from CO₂ abatement of approximately €140 per ton of CO₂ abated, due to the energy-saving potential of LED (Exhibit 3).

LED manufacturers have an irresistible case for their technology, which must be presented to regulators. A basic calculation shows that by funding LED retrofits at the same level as solar subsidies (€2.4 billion), Germany could abate 50 megatons of CO₂ as a result of the lower prices and higher penetration this would achieve. This is a tenfold savings over what the solar subsidies are projected to deliver. In the European Union, if governments

Exhibit 3

LED lighting is an economically attractive means of achieving CO₂ abatement.



¹Total cost of ownership.
²Reduction of CO₂ in 2015 due to efficiency improvement in medium-duty vehicles of 3.5 to 16 tons.
³Assumptions for 2015: price – LED ~€20, incandescent ~€0.6; luminous efficacy – LED 150 lumens per watt, incandescent 12 lumens per watt.
Source: European Commission; McKinsey CO₂ abatement cost curve

mandated adoption of LED lighting for traffic signals and street lights, the programs could contribute significantly to the “20-20-20” EU goal (a 20 percent CO₂ reduction to be met by 2020).

5. Technology transitions create significant uncertainty

Examples of earlier technological transitions reveal risks as well as benefits for incumbent players. When cameras shifted from analog to digital in less than 10 years, for example, companies like Leica nearly vanished from the market in Germany, while others like Canon managed to increase market share.

Solution: Follow the lead of successful traditional semiconductor players

When managing the transition from traditional lighting to opto-semiconductors, incumbents can incorporate the factors that made traditional semiconductor players successful. For example, incumbents can rigorously manage

an R&D road map to realize 20 to 30 percent annual cost reductions, or they can build a learning engineering organization to bring yield curves up quickly (starting at less than 10 percent). They can also employ fast decision processes to manage product life cycles of less than one year and institute sophisticated planning processes to manage volatility of more than 30 percent in volumes year to year in combination with significant capital commitments.

The road ahead: Shifting into high gear

The five roadblocks that we have discussed have kept LED lamps in the slow lane to adoption, with society and consumers largely missing out on their great potential. We have indicated our strong belief that the industry can overcome them, by acting in close partnership with component manufacturers, retailers, and regulators. A cleared path to accelerated LED adoption will also lead to a sustainably profitable, large-scale LED business.

In our base case, LED retrofit could achieve 37 percent penetration by 2015, a scenario largely in line with the industry's expert consensus of 30 to 35 percent. This rate can be accelerated by the comprehensive approach we have indicated to the five main barriers: making operational improvements to drive down costs, improving the marketing of LED products in stores, establishing third-party lighting providers for the commercial markets, successfully attracting government support via subsidies, and increasing focus among manufacturers on LED's potential.

By overcoming these five barriers, the industry could drive a five-year LED retrofit adoption rate above 50 percent. At that point, LED would become the dominant technology in consumer and commercial lighting, providing the industry with a crucial new source of profits for years to come. ○

Oliver Vogler is an alumnus of McKinsey's Munich office, where **Dominik Wee** is an associate principal and **Florian Wunderlich** is a director. Dominik Wee and Florian Wunderlich are core members of McKinsey's LED Competence Center. Copyright © 2011 McKinsey & Company. All rights reserved.

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