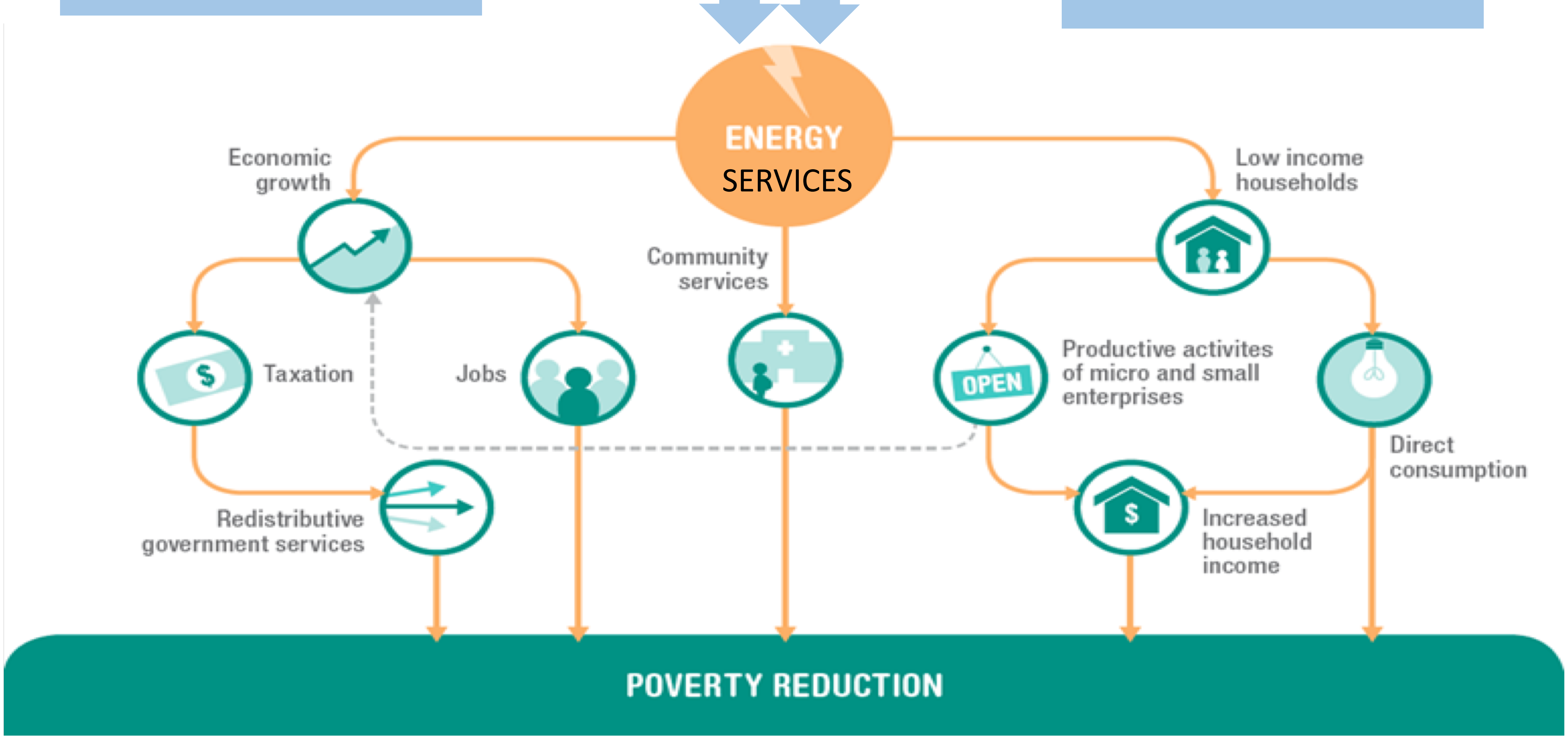
# Energy Efficiency in the Developing World

Meredith Fowlie
UC Berkeley
Amol Phadke
Lawrence Berkeley National Lab

# Modern energy access can fuel economic growth and improve living standards

Supply-side infrastructure
- Generation
- Transmission
- Distribution

Demand-side investments
- More efficient end-use equipment
- Load management



# Energy efficiency investments could *potentially* play an important role in improving energy access

Increase demand-side efficiency

Reduce the need for supply-side infrastructure


Reduce the costs of delivering energy services to consumers

Improve the long-term viability of electricity supply in LIC contexts

# Theoretical framework

- Energy consumers will invest in EE improvements if benefits exceed the costs.
- Benefits/willingness to pay are determined by a host of factors (e.g. income, energy prices, energy access, consumer preferences).

Energy efficiency potential

- Market barriers/failures can distort this cost-benefit calculation and open up an "efficiency gap" in private investment.
- Additional externalities can imply that the socially optimal level of investment exceeds privately optimal levels.

Barriers to tapping this potential

- If market barriers/failures are leading to under-investment, there is potential for welfare improving policy interventions.

Policy response/ experimentation

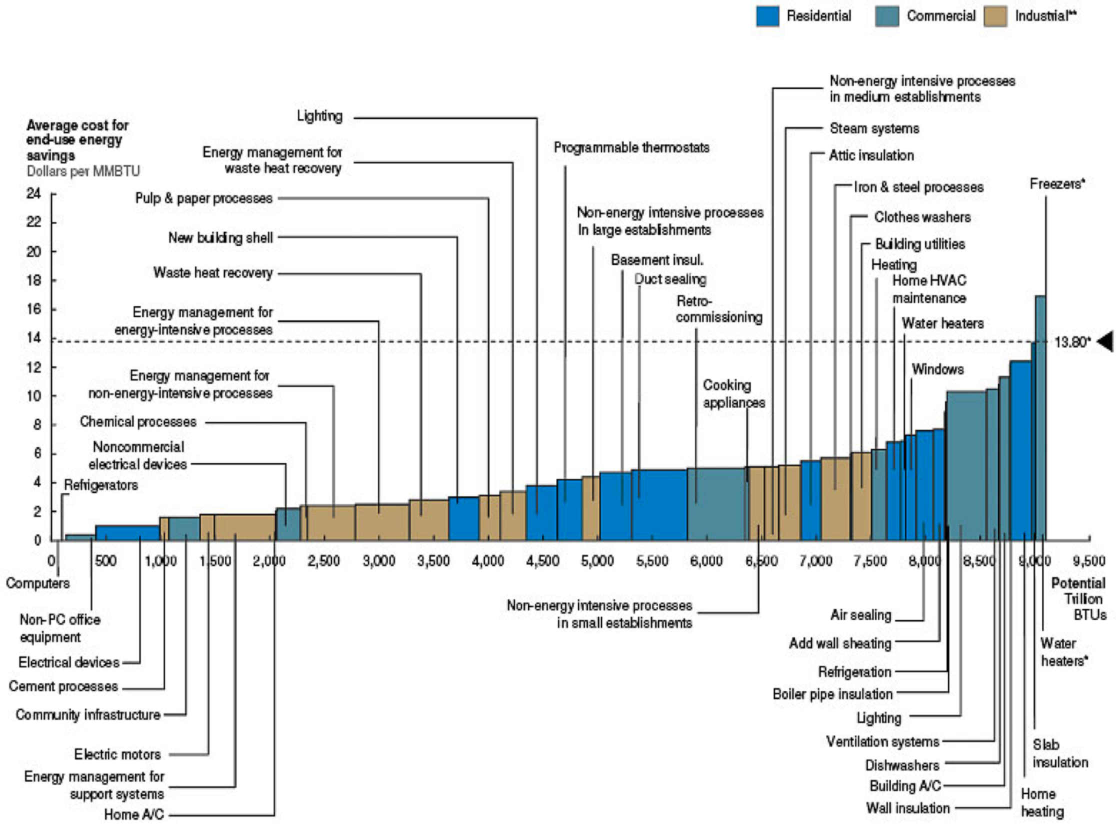
*Lessons learned in high income country settings need not transfer to low income country settings.*

# 1. Where is the greatest energy efficiency potential?

- Descriptive work to synthesize information about end use demand, technology costs and parameters, operating costs is a useful point of departure.

- Advanced data analytics + good research design can facilitate monitoring of *real-world* technology performance and credible measurement of realized savings and impacts.

Exhibit 7: U.S. energy efficiency supply curve – 2020




* Average price of avoided energy consumption at the industrial price; $35.60/MMBTU represents the highest regional electricity price used; new build cost based on AEO 2008 future construction costs

** Our 49th source of savings, refining processes, offers no NPV-positive savings

Source: EIA AEO 2008, McKinsey analysis

# 2: What (if anything) gets in the way of efficient investments in efficiency?

Investment barriers

- Capital market failures
- Transaction costs
- Information failures/constraints
- Myopia

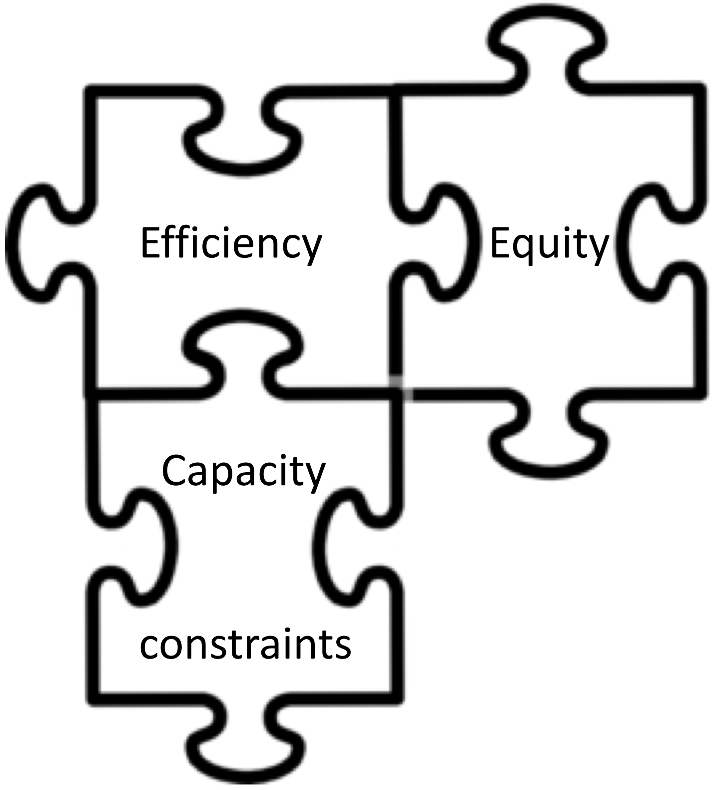
Energy use externalities

- Inefficient electricity pricing
- Environmental externalities
- Network externalities
- Development spillovers

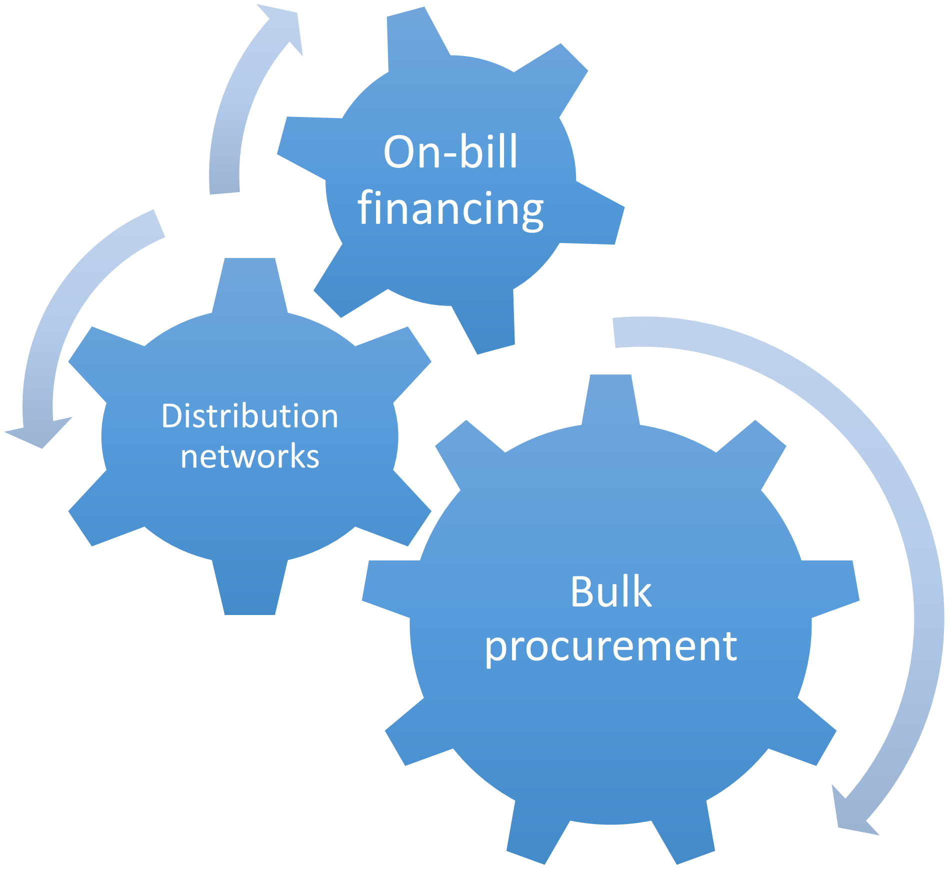
Consumers at a  large West African market for electronic goods

# 3. If policy intervention is warranted, what form should it take?

- What market failures/barriers are getting in the way of the most promising efficiency investments?
- How will consumers and producers re-optimize/respond to different policy interventions ?
- How will policy impacts be distributed?
- What policy approaches can be most effective given constraints on administration, implementation, monitoring, enforcement, etc.

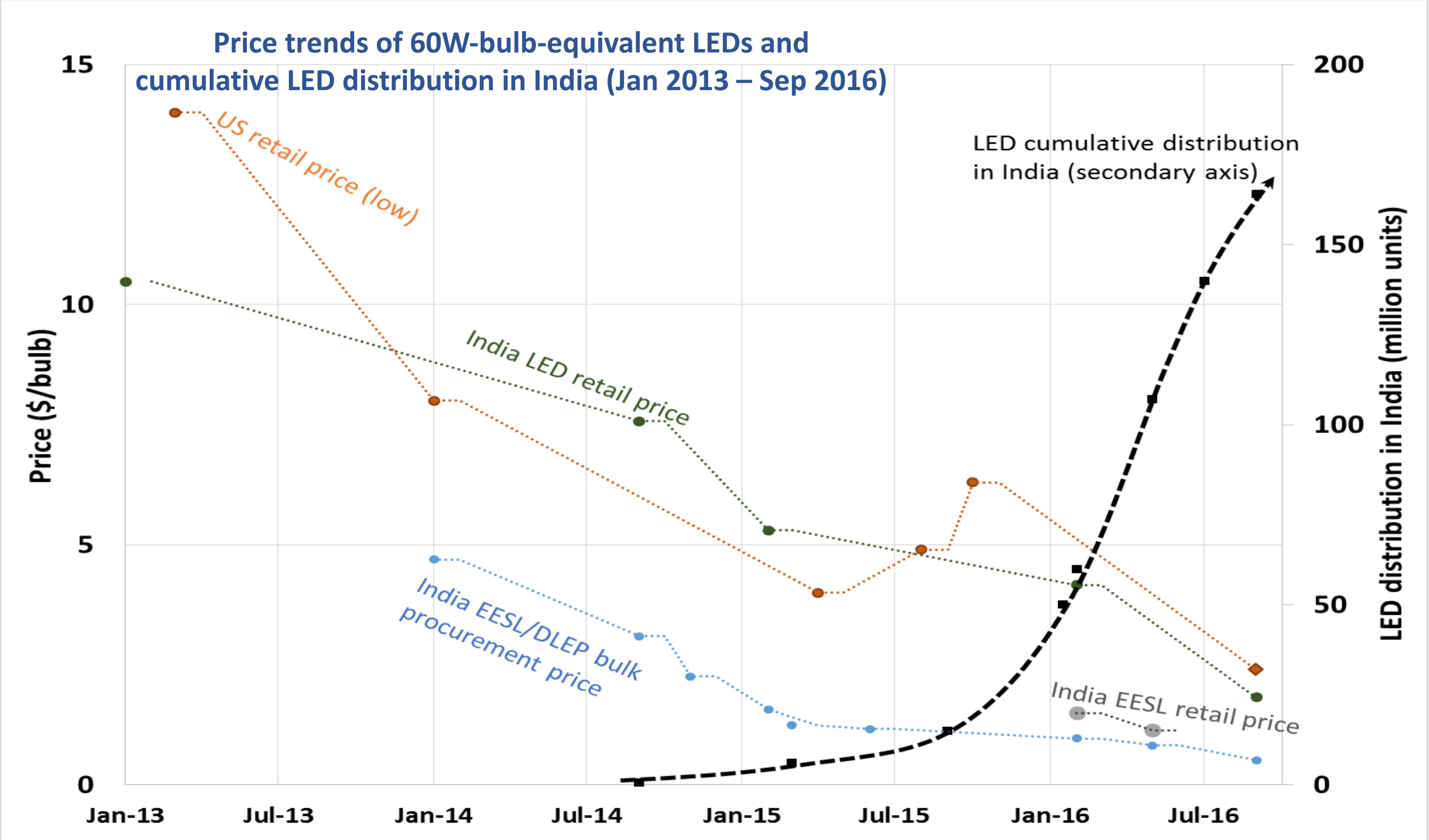


# India’s Domestic Efficient Lighting Program(DLEP)




*“It is much more economical to conserve power than to produce power. However, it is more difficult to conserve power than to produce power because it requires the active participation of scores of people to conserve that amount of power.”*

~ Prime Minister Narendra Modi



Price trends of 60W-bulb-equivalent LEDs and
cumulative LED distribution in India (Jan 2013 – Sep 2016)
15
10
5
0
Price ($/bulb)
200
150
100
50
0
LED distribution in India (million units)
Jan-13
Jul-13
Jan-14
Jul-14
Jan-15
Jul-15
Jan-16
Jul-16
US retail price (low)
India LED retail price
India EESL/DLEP bulk
procurement price
India EESL retail price
LED cumulative distribution
in India (secondary axis)

# Research questions/directions

- Field-based analysis of the most promising energy efficiency investments in LIC settings (e.g. technology costs, realized savings, rebound).
- An empirically grounded understanding of the market failures and barriers that can stand in the way of these investments.
- Research that informs the constrained policy design/implementation choices faced by LICs (weighing both efficiency and distributional concerns).
- Research that evaluates current and future policy experimentation in LIC settings.

# Supporting slide for LED price trends

- **Global:** According to information available on the website of LEDinside, a market research firm, retail price of 60W-equivalent LED bulbs in the global market has dropped by about 40% on average, from $21.9 in August 2013 to $8.2 in August 2016.
- **United States (U.S.):** US DOE's Sold State Lighting Program has been tracking the LED-based dimmable A19 60W-equivalent replacement lamps. Their price has dropped by 80% from 2010 to 2015, specifically $40 ($50/klm) in 2010 to $15 ($19/klm) in 2012 and $8 ($10/klm) in 2015. Price of dimmable LEDs is estimated to be a bit greater than that of non-dimmable LEDs. There have been promotions for some LED products, which led to a general price rebound for 60W LED replacement bulbs, e.g., around October 2015. In 2016, some of the same type non-dimmable LED bulbs are sold at $2.4-$4 per bulb at amazon.com.
- **China:** According to information available on the website of LEDinside, a market research firm, retail price of 60W-equivalent LED bulbs in China has dropped by about 55%, in terms of an average market price, from $18.3 in May 2014 to $8.2 in September 2016. A low price of the same type LED bulbs has dropped by 45% from $5.7 to $3.1 during the same period.
- **India:** Retail price of 9W LED bulbs are estimated to have dropped by about 70% from Rs.400 (USD$6) in September 2014 to RS.120 (USD$1.8) in September 2016. During the same period, EESL LED bulk procurement price dropped by more than 80% from Rs.204 (USD$3.1) to Rs.34 (USD$0.5), leading to the cumulative distribution of more than 160 million LEDs in the country.
- While the LED price has been decreasing, there was a general price rebound and a wide range of 60W-equivalent LED bulb price, for example, in  November 2014, a high price in the global market was $50 ($16.8 on average), while a low price $2.1.