LEDS: THE ENERGY EFFICIENCY GAME CHANGER

BLOOMBERG NEW ENERGY FINANCE SUMMIT, NEW YORK

TOM ROWLANDS-REES

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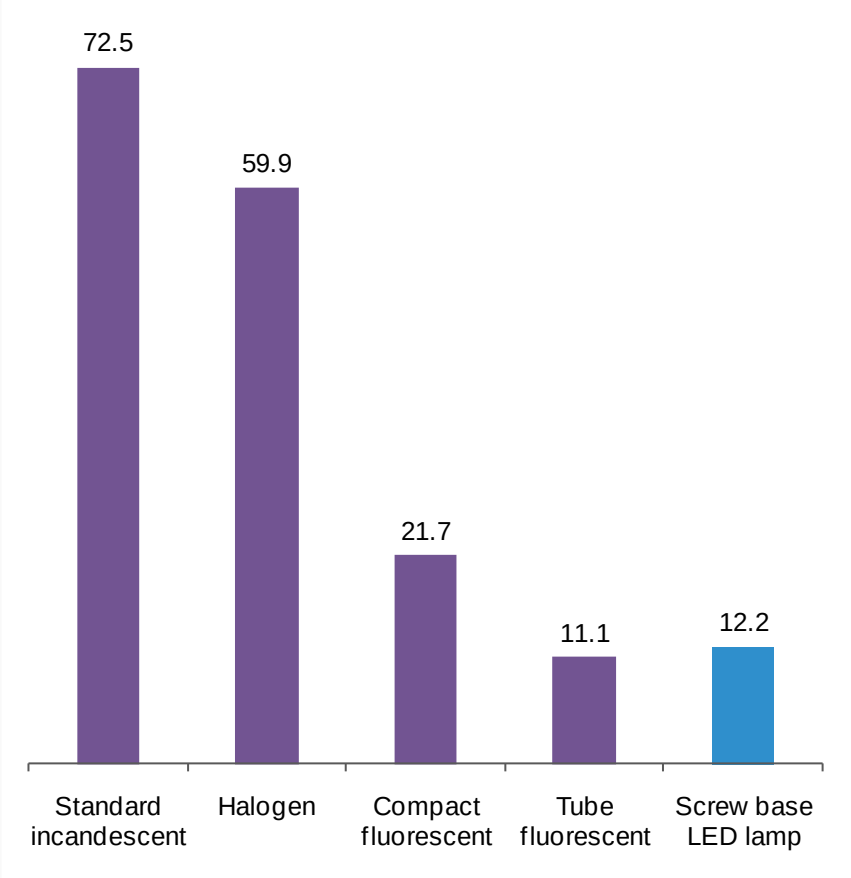
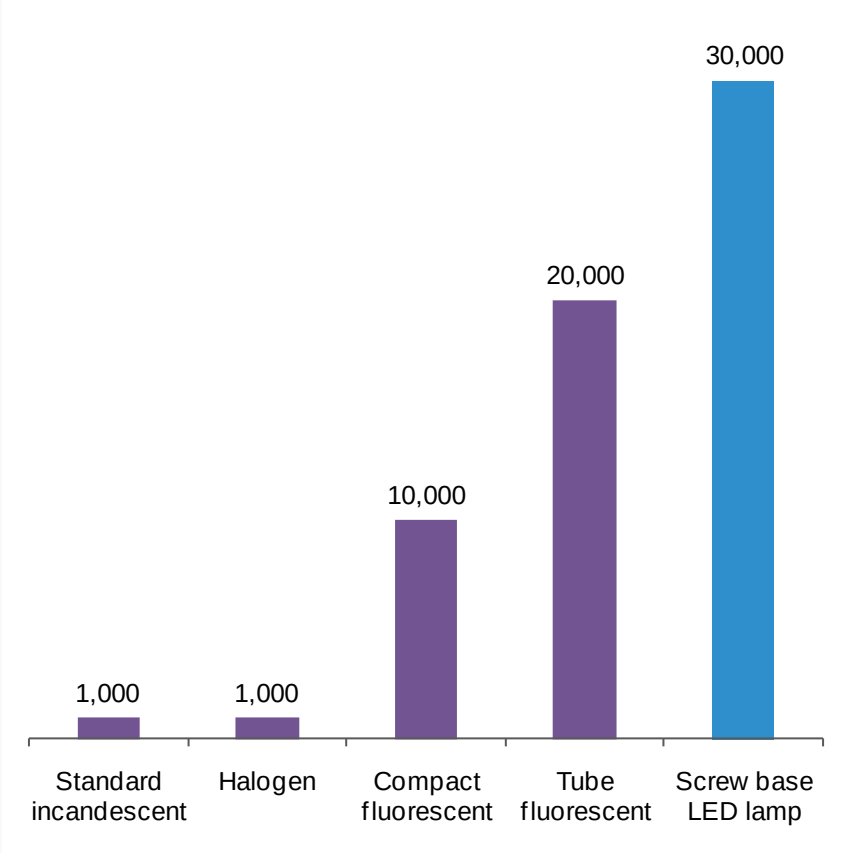
LED LIGHTING KEY PERFORMANCE FIGURES

ENERGY CONSUMPTION OF SELECTED LIGHTING TECHNOLOGIES (W/LM)



Source: Various

ESTIMATED LIFETIME OF SELECTED LIGHTING TECHNOLOGIES (YEARS)



Source: Various

LED LIGHTING VALUE CHAIN

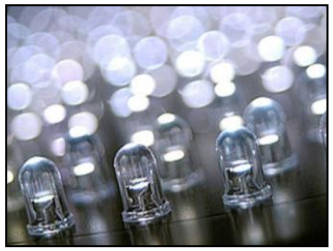
Drivers

- Converting AC mains to DC.
- Converting controlled voltage to controlled current.
- Compact, integrated circuit.

Chips

- Gallium Nitride grown on Sapphire or Silicon Carbide wafer.
- Single colour light output (blue, UV, red, green)
- Output limited by thermal management capability.

White conversion



- Type I: High power blue or UV LED coated with phosphor (or equivalent) to convert to white light.
- Type II: Combined red, green and blue LEDs to form overall white light.

Aggregation

- Creating sellable luminaire product from component parts.
- Adding optics to create desired light output profile.
- Adapting for existing fittings.

Controls

- Controlling on/off, dimming and colour output (for type II).
- Feedback mechanisms for light consistency and preserving lifetime.
- Allows integration with other systems.

Source: Bloomberg New Energy Finance

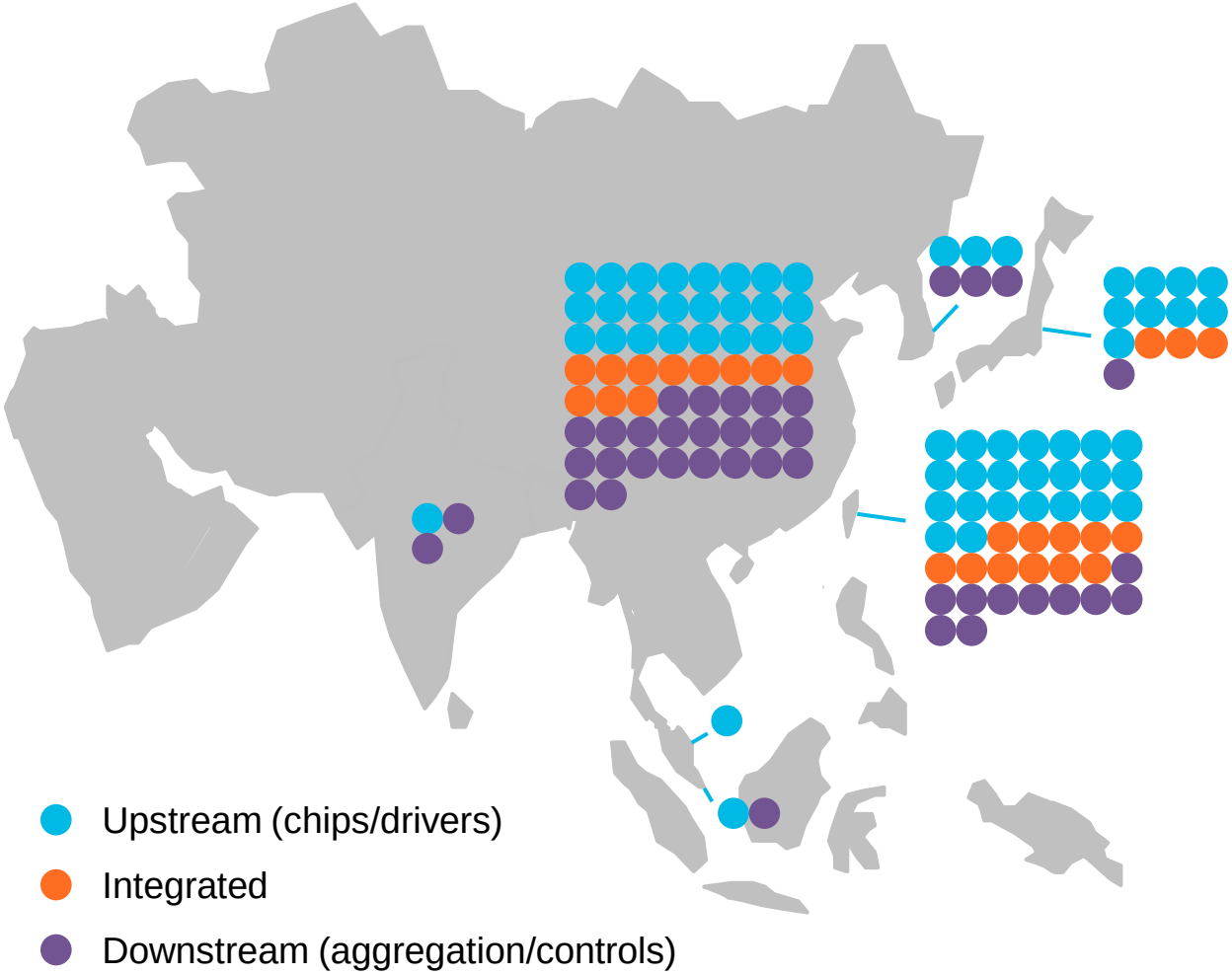
LED LIGHTING VALUE CHAIN PLAYERS

ASIA
NORTH AMERICA
EUROPE

Drivers	Chips	White conversion	Aggregation	Controls
Siemens (Germany)				
Royal Philips Electronics (Netherlands)				
National Semi (US)	Cree (US)			National Semi (US)
Redwood Sys. (US)	Toshiba (Japan)			Redwood Sys. (US)
Sharp (Japan)				Daintree Netw. (US)
Linear Tech (US)	Nichia (Japan)		Foshan E&L (China)	Light ba-tec. (Canada)
HSM (China)	Lattice Power (China)	General Electric (US)		
Monolithic Power (US)	Opto Tech Corp(Taiwan)			
Leadis Tech. (US)	Unity Opto Technology (Taiwan)			
Inventronics (China)	Mitsubishi Chemical (Japan)		Panasonic (Japan)	
	Sanan Optolectronics (China)		Wanstar (Taiwan)	
	Seoul Semic. (Korea)	QD Vision (US)	Shen. Spark (China)	
	Aixtron (Germany)	Nanoco (UK)	Kingsun Opto(China)	
	Everlight (Taiwan)		Bang-Bell (China)	
	Edison Opto (Taiwan)		Infoelite Opto (China)	
	Formosa Ep. (Taiwan)		Dasan AD (Korea)	
	Epistar (Taiwan)			
	Rubicon (US)			
	Huga Opto (Taiwan)			

Source: Bloomberg New Energy Finance

DISTRIBUTION OF ACTIVE LED PLAYERS IN ASIA

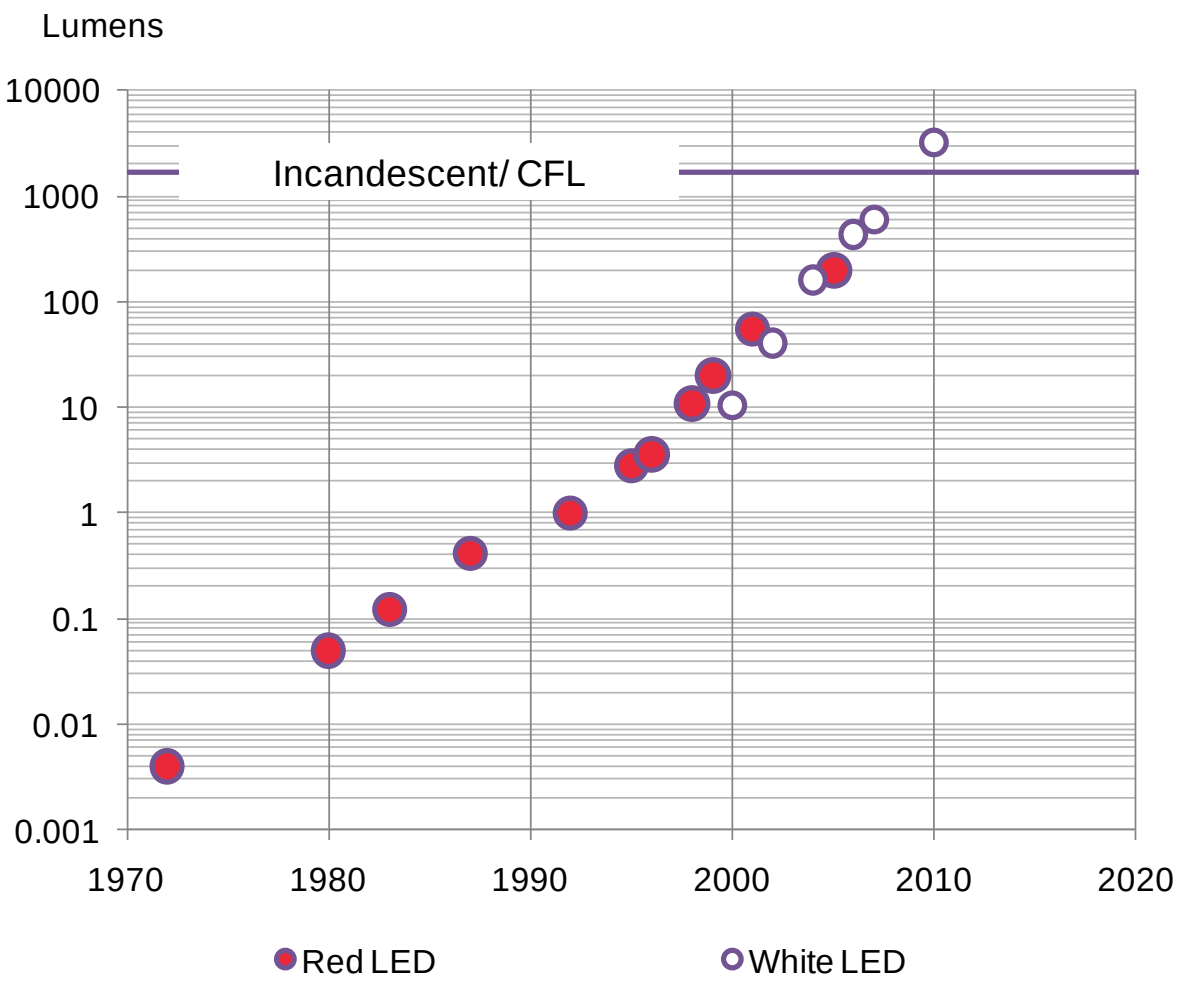


Whilst China has most orgs active in LED lighting, Taiwan has concentrated expertise.

Taiwan and Japan have a strong emphasis on upstream chip manufacture.

Majority of Asian aggregation is based in privately owned Chinese companies.

HISTORICAL LED MAXIMUM LUMEN OUTPUT



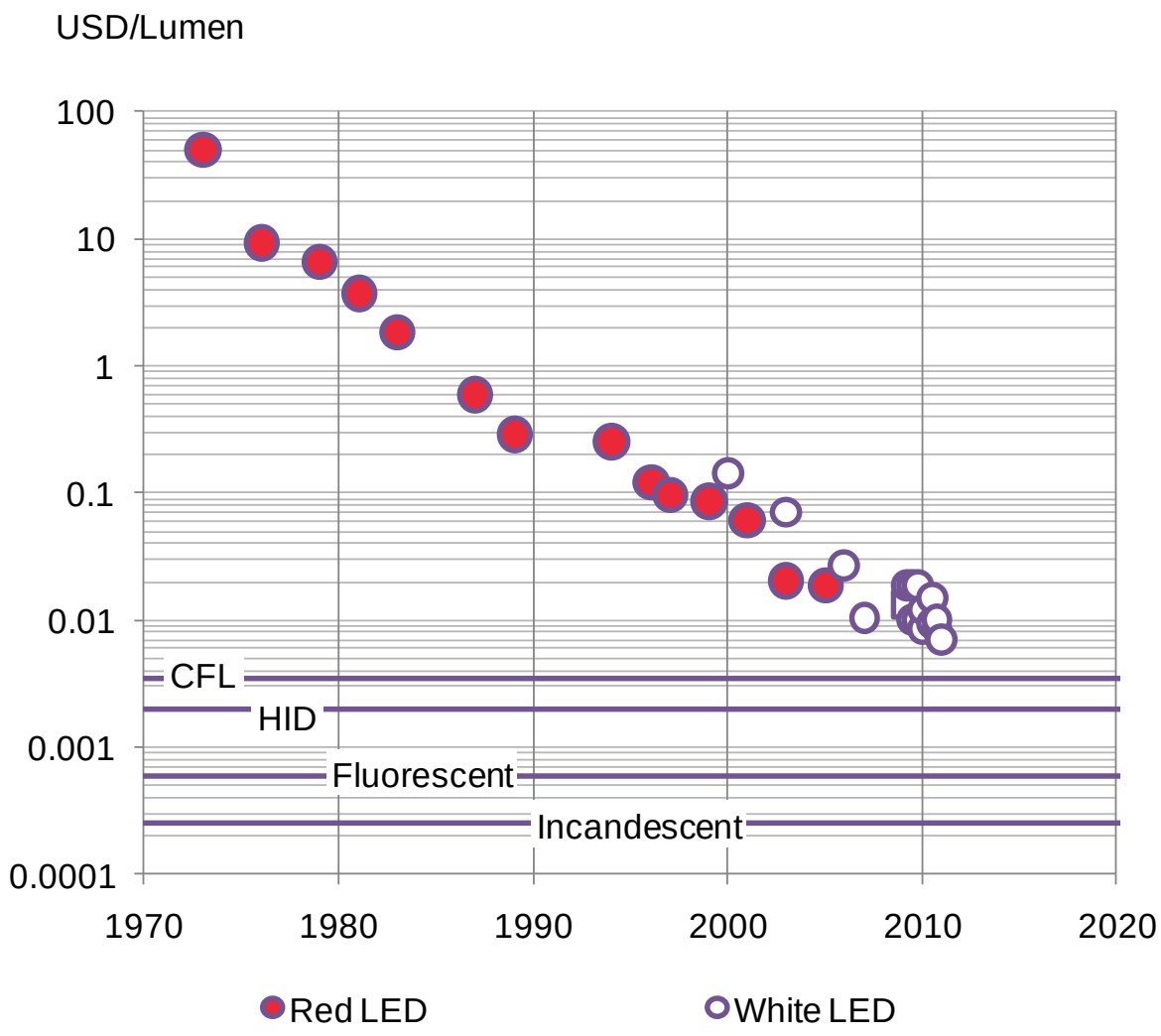
Haitz's law states that every decade the output per LED package increases by a factor of 20.

LED lighting has only been technically feasible for a few years.

Recent progress in LED lighting is <u>not</u> driven by trends in clean energy.

Source: DOE, Bloomberg New Energy Finance

HISTORICAL LED COST



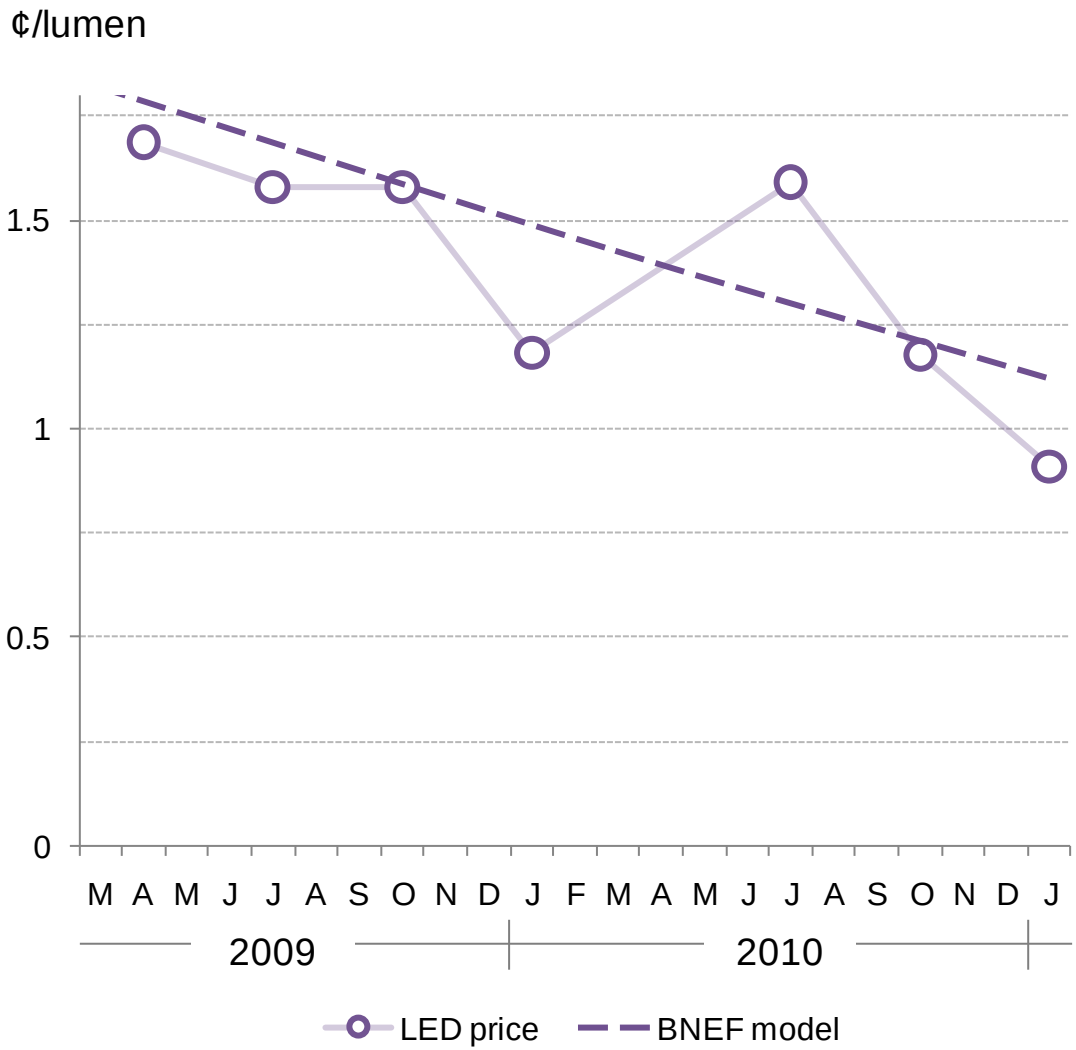
Haitz's law states that every decade the cost per lumen of LED light decreases by a factor of 10.

As chip prices decrease, the emphasis switches onto aggregators to bring costs of LED lighting down.

Increasing production capacity will drive costs down further for the next decade at least.

Source: DOE, LEDInside, Bloomberg New Energy Finance

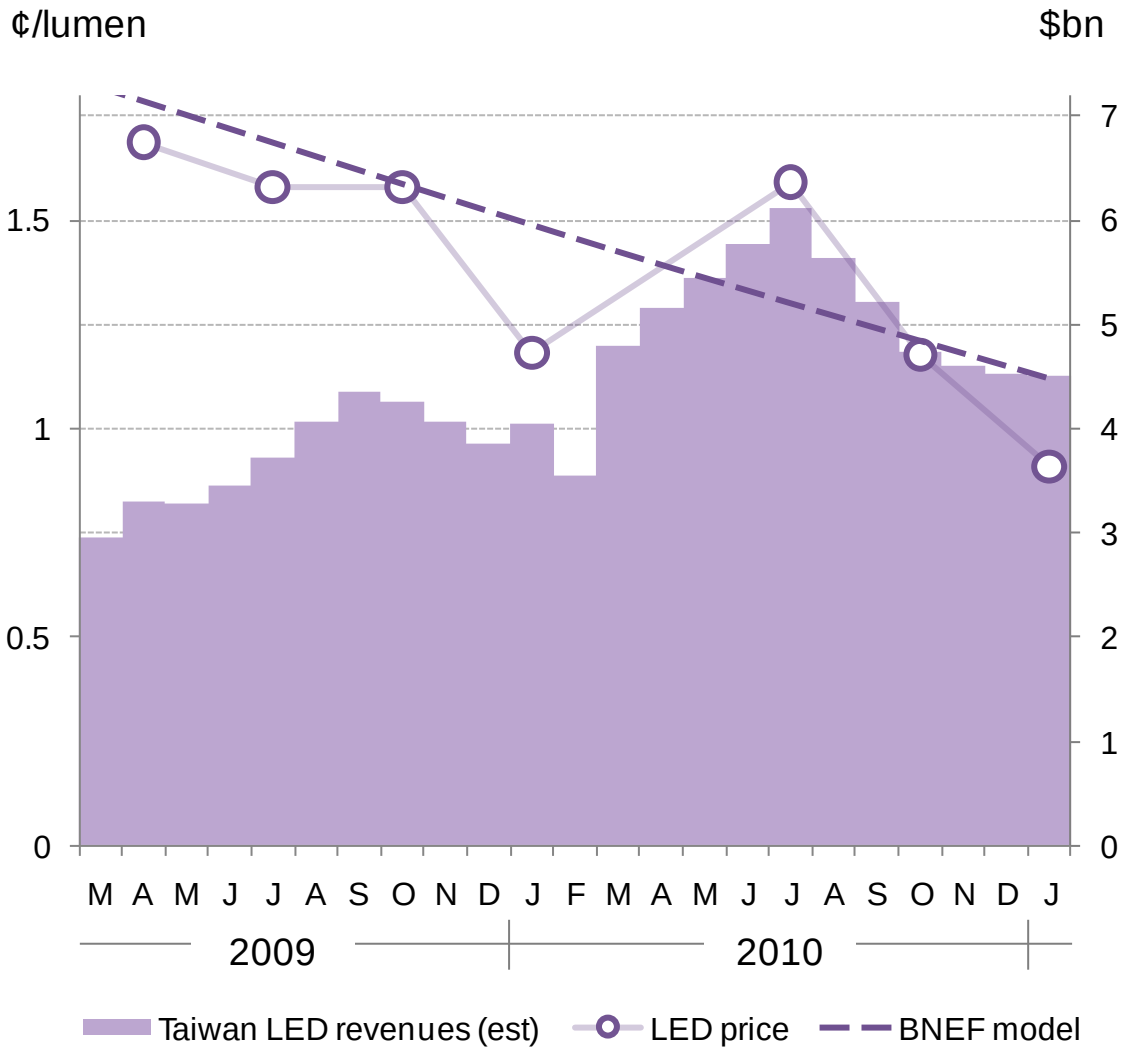
HISTORICAL LED MARKET PRICE



LED prices are on a downward trend with short-term fluctuations due to supply-demand imbalance.

Source: LEDInside, Bloomberg New Energy Finance

HISTORICAL LED MARKET PRICE AND CHIP REVENUES

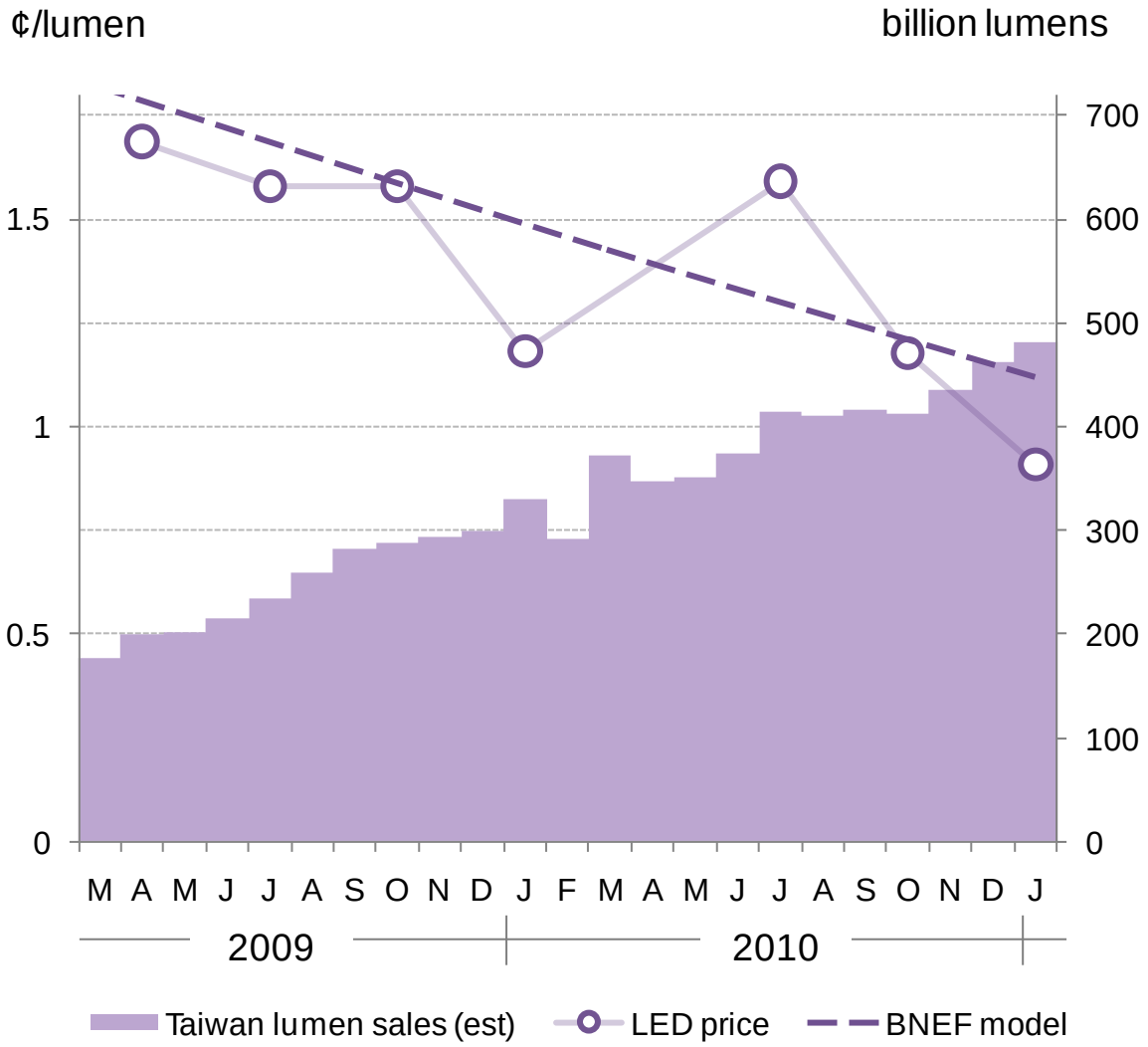


LED prices are on a downward trend with short-term fluctuations due to supply-demand imbalance.

Chipmaker revenues are increasing overall with short-term fluctuations caused by changes in market price.

Source: LEDinside, Bloomberg New Energy Finance

HISTORICAL LED MARKET PRICE AND LUMEN SALES



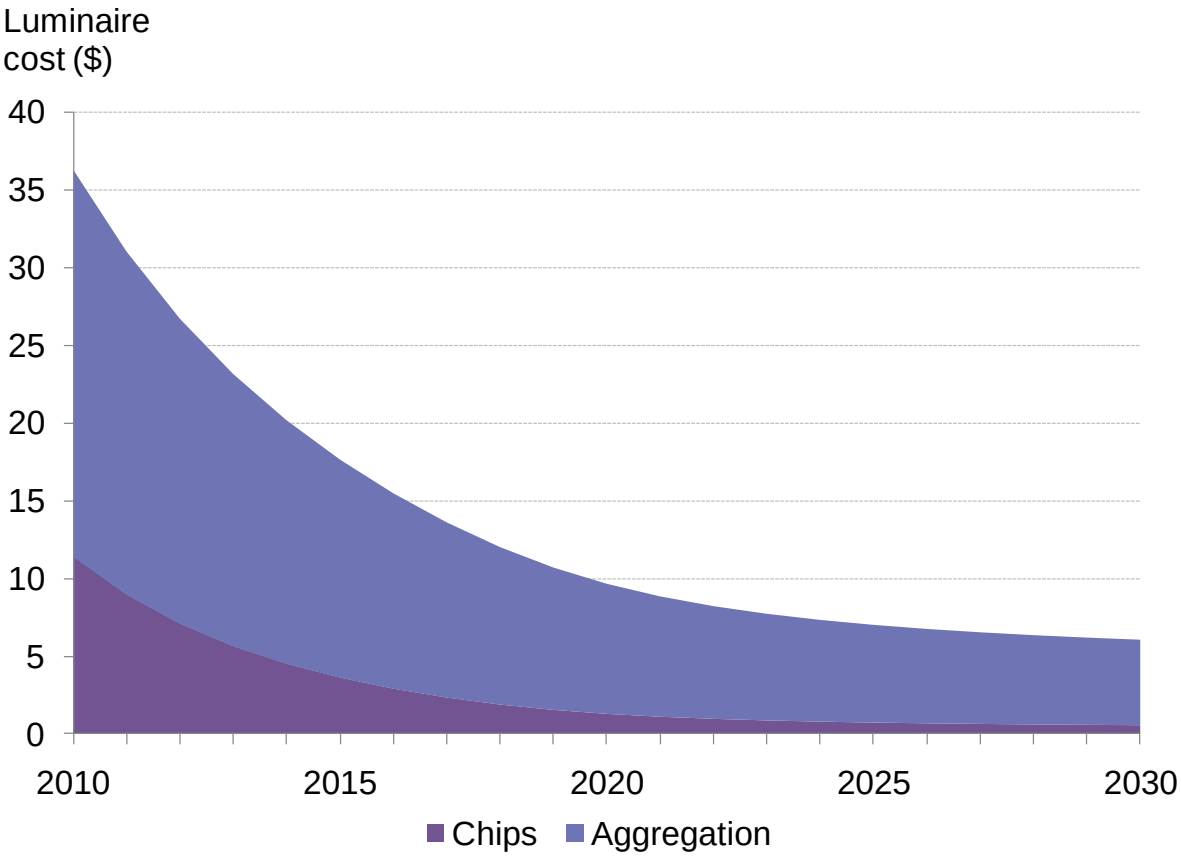
LED prices are on a downward trend with short-term fluctuations due to supply-demand imbalance.

Chipmaker revenues are increasing overall with short-term fluctuations caused by changes in market price.

Overall sales in LED lumens are increasing rapidly, and are unaffected by price fluctuations.

Source: LEDinside, Bloomberg New Energy Finance

PROJECTED COST OF 1,000 LUMEN (60W EQUIVALENT) LED LIGHT FIXTURE



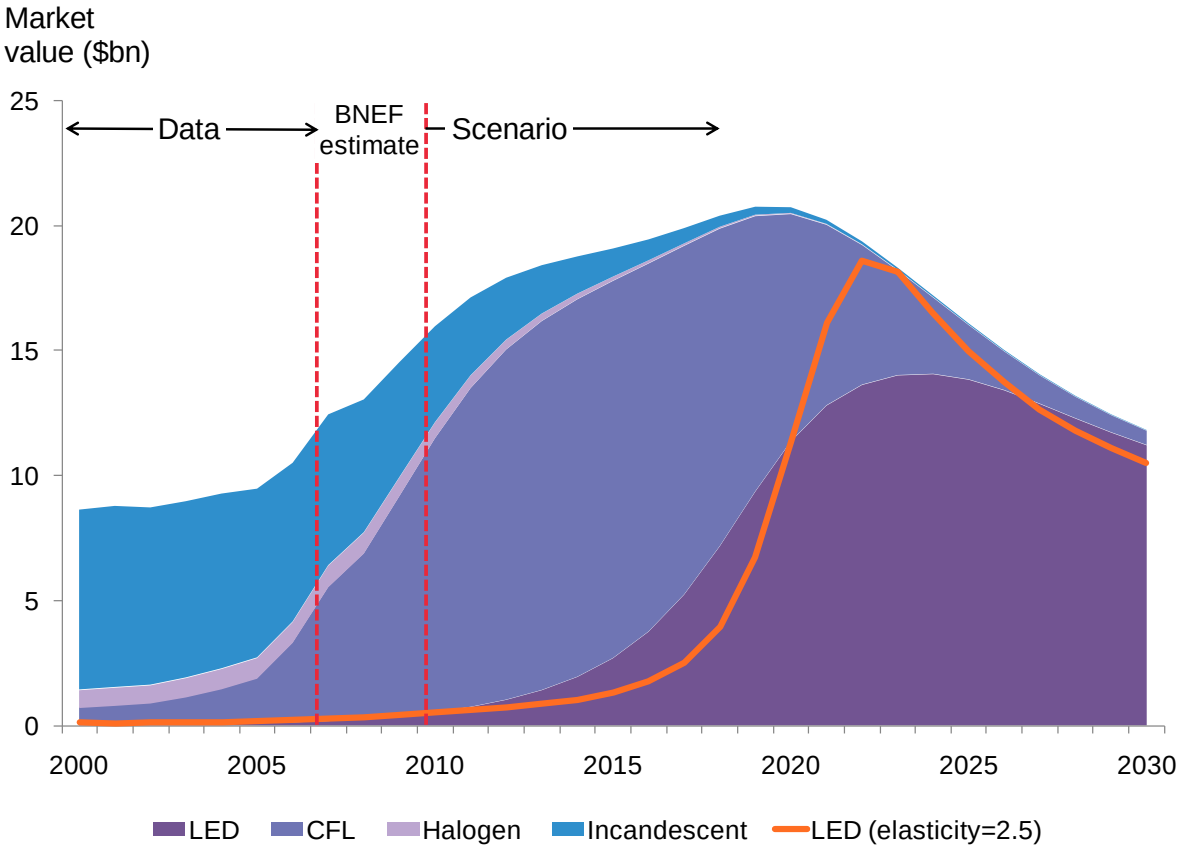
Main driver for cost reduction will be the downstream aggregation, not chip manufacture.

The majority of future revenue captured by the LED lighting industry will be for aggregators.

We don't expect to see LED chips to become truly commoditised for at least 10 years.

Source: Bloomberg New Energy Finance.

HISTORICAL AND PROJECTED SCREW-BASED LIGHTING REVENUES IN SELECTED COUNTRIES, BY TECHNOLOGY TYPE



New lighting technologies, particularly CFLs, will drive growth in lighting industry for 10 years.

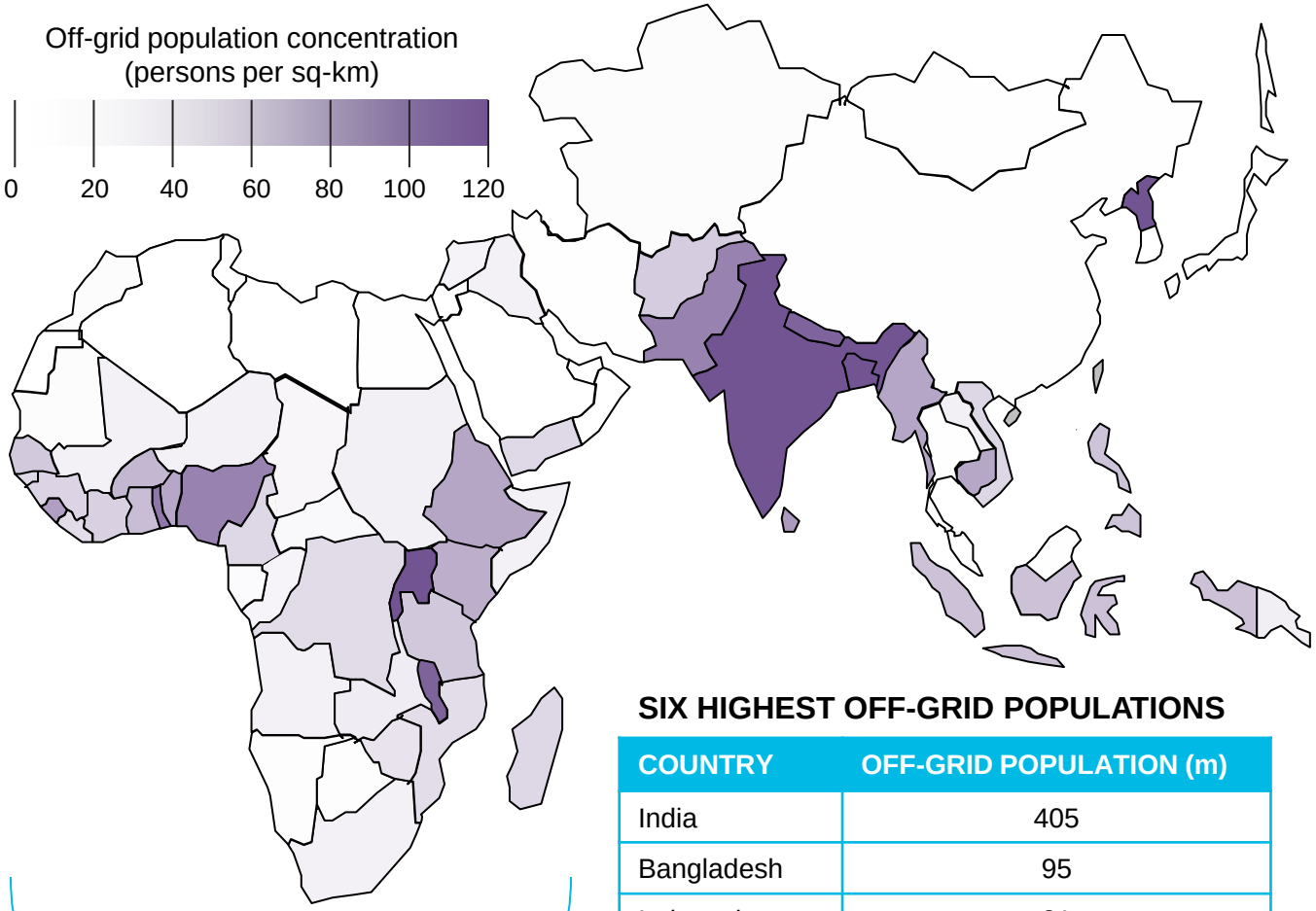
LED lighting will not leapfrog CFLs – instead they will penetrate the CFL market once costs come down.

The combination of falling prices and long replacement cycles could be problematic for the industry, post 2020.

Note: Countries included are European Union, Switzerland, Norway, United States, Canada, Australia, New Zealand, Japan, Korea.

Source: Bloomberg New Energy Finance.

OFF-GRID POPULATION CONCENTRATION IN AFRICA AND ASIA



Annual spend on fuel-based lighting in Asia: **$23bn**

Annual spend on fuel-based lighting in Africa: **$17bn**

SIX HIGHEST OFF-GRID POPULATIONS

COUNTRY	OFF-GRID POPULATION (m)
India	405
Bangladesh	95
Indonesia	81
Nigeria	81
Pakistan	70
Ethiopia	67

Source: National Geophysical Data Center, Bloomberg New Energy Finance.

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