# Indonesia Lighting Market Study and Policy Analysis

## Final Report

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CLASP
PwC

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| | |
|---|---|
| AILKI | Asosiasi Industri Luminer & Kelistrikan Indonesia<br>Association of Luminaires and Electrical Industry of Indonesia |
| ALINDO | Asosiasi Luminer Indonesia<br>Association of Luminaires of Indonesia |
| APEC | Asia-Pacific Economic Cooperation |
| APERLINDO | Asosiasi Industri Perlampuan Listrik Indonesia<br>Indonesian Electrical Lighting Industry Association |
| ASEAN | Association of Southeast Asian Nations |
| B2B | Business-to-business |
| BAU | Business-as-usual |
| BOE | Barrel of Oil Equivalent |
| BPS | Badan Pusat Statistik<br>Central Bureau of Statistics |
| BSN | Badan Standardisasi Nasional<br>Indonesia National Standardization Agency |
| CAGR | Compound Annual Growth Rate |
| CFL | Compact Fluorescent Lamp |
| $CO_2$ | Carbon Dioxide |
| EBTKE | Direktorat Jenderal Energi Baru, Terbarukan, dan Konservasi Energi<br>Directorate General of New Renewable Energy and Energy Conservation |
| EE | Energy Efficiency |
| EU | European Union |
| FGD | Focus Group Discussion |
| GAMATRINDO | Gabungan Industri Manufaktur Lampu Terpadu Indonesia<br>Indonesian Integrated-Lamp Manufacturing Industry Association |
| GDP | Gross Domestic Product |
| GHG | Greenhouse Gases |
| GWh | Gigawatt-hour |
| HID | High Intensity Discharge |
| HPS | High Pressure Sodium |
| HS | Harmonized (Commodity Description and Coding) System |
| Hz | Hertz |
| IDR, Rp | Indonesian Rupiah |
| IEC | International Electrotechnical Commission |
| IIEC | International Institute for Energy Conservation |
| INSW | Indonesia National Single Window (Trade Statistics) |
| ISO | International Organization for Standardization |
| KAN | Komite Akreditasi Nasional<br>Indonesia National Accreditation Committee |
| KESDM | Kementrian Energi dan Sumber Daya Mineral (also MEMR) |
| kWh | Kilowatt-hour |
| LED | Light Emitting Diode |

| | |
|---|---|
| LFL | Linear Fluorescent Lamp |
| LSPro | Lembaga Sertifikasi Produk<br>Product Certification Body |
| LKPP | Lembaga Kebijakan Pengadaan Barang/Jasa Pemerintah<br>National Public Procurement Agency |
| MBOE | Million Barrels of Oil Equivalent |
| MEMR | Ministry of Energy and Mineral Resources of the Republic of Indonesia (also KESDM) |
| MEPS | Minimum Energy Performance Standard (also SKEM) |
| Mt | Megatonne |
| NDC | Nationally Determined Contribution |
| OECD | Organisation for Economic Co-operation and Development |
| PLN | Perusahaan Listrik Negara<br>Indonesia State-owned Electric Company |
| SDoC | Supplier’s Declaration of Conformity |
| SKEM | Standar Kinerja Energi Minimum (also MEPS) |
| SNI | Standar Nasional Indonesia<br>Indonesian National Standard |
| TWh | Terawatt-hour |
| USD | United States Dollar |

# Executive Summary

Indonesia is the 4th largest country in the world, with over 265 million people in 2018.[1] Gross domestic product (GDP) has been growing by around 5% annually over the past decade,[2] while per-capita income has been concurrently growing by almost 4% annually.[3] The country's steady economic growth has contributed to a doubling in electricity consumption, from 129 TWh in 2008 to 256 TWh in 2018.

The residential sector is the primary electricity user, responsible for nearly 40% of consumption, followed by industrial (37%), commercial (23%), and transportation (0.11%).[4] Coal is the main fuel in electricity generation, responsible for 58% of primary energy consumed, followed by natural gas (27%), renewables (hydro, geothermal, solar, and wind; 8%) and oil (6%).[5]

Under the Paris Agreement, Indonesia committed to reducing greenhouse gas (GHG) emissions by 29% below a business-as-usual (BAU) baseline by 2030, or by 38% below BAU by 2030 with international support. Reaching these unconditional and conditional targets, will require reductions in energy consumption of 19% and 24% below BAU.[6]

The Ministry of Energy and Mineral Resources (MEMR or KESDM), through its Directorate General of New Renewable Energy and Energy Conservation (EBTKE), aims to reduce energy consumption across all sectors by 17% in 2025 relative to BAU through various policies,[7] including energy efficiency standards and labeling for household electric appliances. Energy efficiency regulations for air conditioners and compact fluorescent lamps are already in place, and MEMR plans to issue additional Ministerial Regulations this year to further reduce household energy consumption.

As the leading international voice and resource for appliance efficiency policies and market acceleration initiatives, CLASP, together with local partner PwC, conducted a comprehensive study of lighting in Indonesia. The goal of the study was to characterize the market; inform the development of appropriate and robust testing, standards, and labeling requirements; and assess the potential impacts of these energy efficiency policies.

The team received data and inputs from four trade associations (APERLINDO, AILKI, GAMATRINDO, and ALINDO) and four major manufacturers, comprising 73% of the market, and visited 51 retail stores in six cities. The team also collected government data, reviewed past studies, reviewed manufacturers' websites, and incorporated the findings of CLASP's forthcoming 5000-household, nationwide residential end-use survey. Finally, the team developed policy recommendations and analyzed them using CLASP's Policy Analysis Modeling System (PAMS).

The key findings, summarized below, will inform EBTKE of the opportunity for ambitious energy efficiency policies for fans that save money and reduce energy and $CO_2$ while taking into account the current range of products on the market.

[1] MEMR, Handbook of Energy & Economic Statistics of Indonesia, 2018, p. 3.
[2] GDP Growth (annual %) - Indonesia. (n.d.). World Bank Open Data | Data. https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?end=2018&locations=ID&start=1961&view=chart
[3] Indonesia Economic Snapshot. http://www.oecd.org/economy/indonesia-economic-snapshot/
[4] MEMR, Handbook of Energy & Economic Statistics of Indonesia, 2018, pp. 41-53.
[5] Statistics Report 2018. PLN. https://www.pln.co.id/stakeholder/laporan-statistik
[6] Government of Indonesia, First Nationally Determined Contribution Republic of Indonesia, November 2016, p.10.
[7] President of Indonesia, Presidential Regulation Number 22 of 2017 about National Energy General Plan (RUEN), p. 30.

### Key Findings in the Market Study

Lighting energy use in Indonesia is significant. CLASP's Indonesia-wide 5000-household end-use survey identifies 5.4 lighting points installed per dwelling, operating for 7.6 hours daily. All houses surveyed had lighting. Over 339 million residential lighting products are currently installed, with another 265 million and 28 million units, respectively, in professional and outdoor settings.[8]

The number of lighting products in use (the stock) is forecast to increase at compounded annual growth rate of 3.5% in the residential sector, and 5% in the professional and outdoor sectors. The size of the lighting market was nearly 150 million units in 2018. Imports account for 80% of shipments, with 96% of those imports, by value, from China.

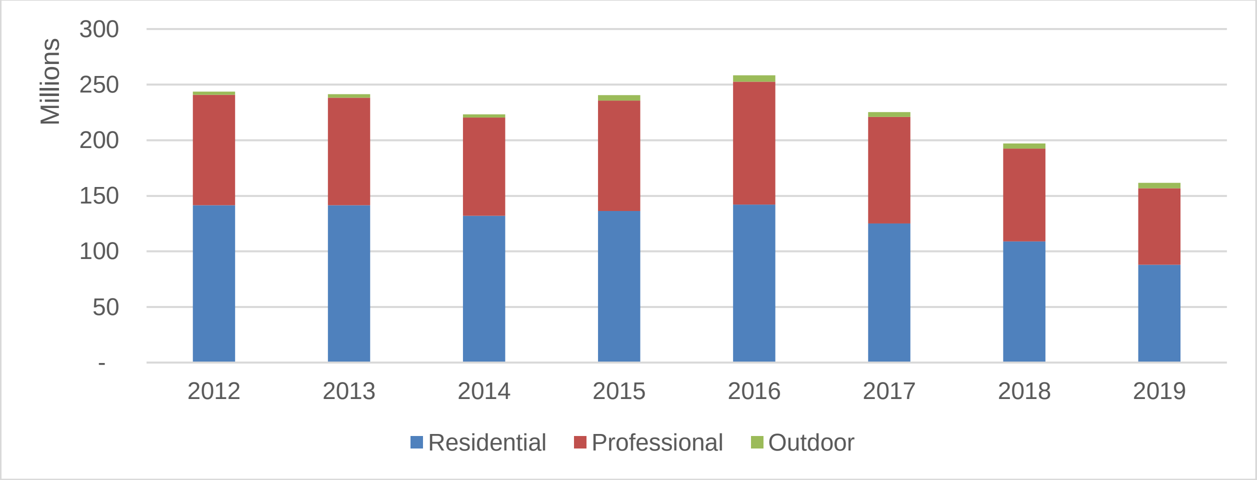


*Figure 1: Historical lighting shipments by sector from 2012 to 2019*

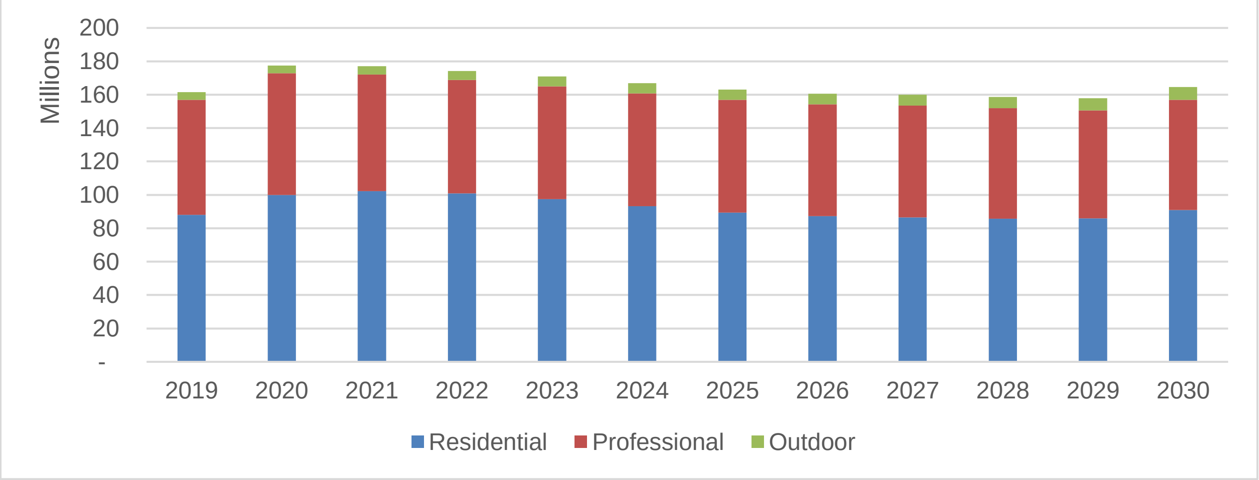


*Figure 2: Lighting shipment forecast by sector from 2019 to 2030*

There has been a steady growth in LED lighting with a corresponding decline in CFLs. The retail market in Indonesia has a high penetration of LEDs at 76%, as compared to CFLs at 24%. IEA has reported that globally, LED residential sales have grown from 5% in 2013 to 40% in 2018. In many markets, the efficacies

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[8] Professional includes both commercial and industrial sectors, while outdoor includes all outdoor lighting whether used for illuminating public streets, or private facilities such the outside of buildings or parking garages.

of LEDs available for residential use have already reached 80-120 lumens/W and are projected to increase to an average of 160 lm/W by 2030.[9]

In outdoor lighting, there has also been a market transformation across many cities as existing High-Pressure Sodium (HPS) streetlights are replaced with energy efficient LEDs, beginning in 2014.[10] Jakarta is a leading example where the municipality was able to increase shares of installed LED street lighting from less than 8% in 2014 to 98% in 2018.

Sales are decreasing as product lifetimes grow due to higher penetration of LED lighting across sectors each year. This trend is expected to continue until the market is fully saturated with LED lighting.

### Policy Options, Recommendations, and Impact Assessment

EBTKE is currently considering regulations for CFL and LED bulbs. CLASP and PwC collected performance data on lamps in retail, on manufacturers' websites, and as reported to EBTKE through the Supplier's Declaration of Conformity (SDoC) with the CFL regulation. While there is a wide range of efficacies on the Indonesian market, with incandescents (<10 lm/W), CFLs (mostly 50–70 lm/W) and LED (mostly 80-110 lm/W), the draft EBKTE regulations can be met by most of the CFLs and LEDs on the market. In the case of CFLs, the few models that may not meet tend to have low shipments, as can be seen in Figure 3. Since the regulations do not target halogen or incandescent lamps, the energy reduction and $CO_2$ mitigation impact from them will be minimal.

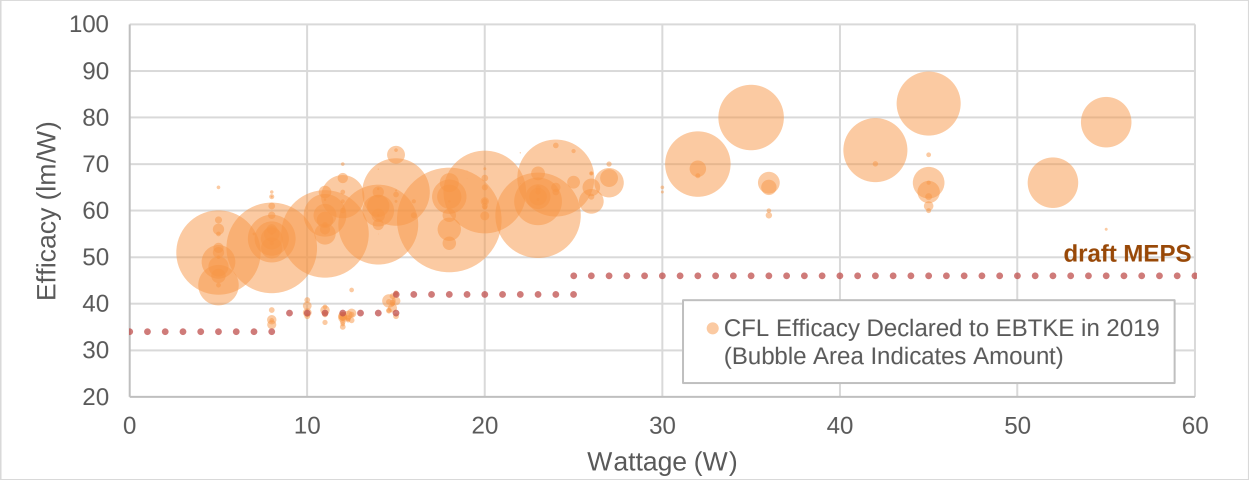



*Figure 3: CFL efficacy declared to EBTKE compared to the MEPS (1-star) requirement under consideration by EBTKE.*

To save significant energy and avoid selectively regulating individual technologies, CLASP recommends the more ambitious, **technology-neutral** MEPS and labeling requirements shown below, which would be met by 66% of models in the market, including 77% of locally manufactured models.

[9] IEA (2019), "Tracking Buildings", IEA, Paris, https://www.iea.org/reports/tracking-buildings
[10] As per interactions with city governments of Jakarta, Surabaya, Bandung

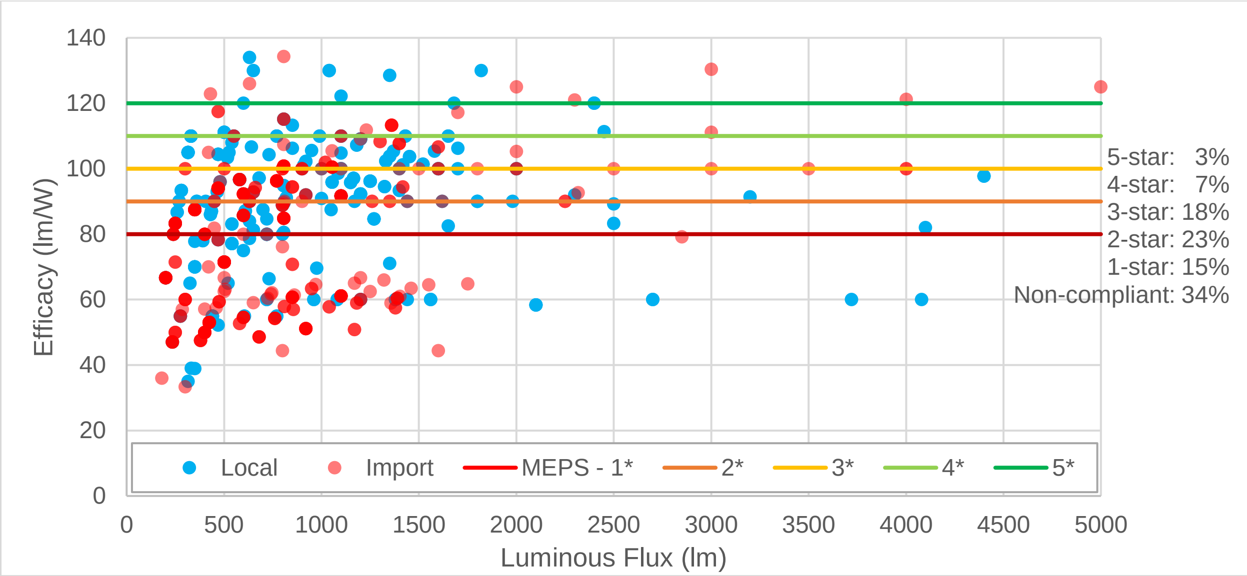



*Figure 4: CLASP recommended requirements for lighting products in Indonesia*

While most LED lamps can meet the proposed MEPS requirement at 80 lm/W, by removing legacy technologies from the market and shifting consumers to LED, this policy would achieve significant energy and $CO_2$ reductions. The policy would establish Indonesia as a leader in Southeast Asia while also saving consumers money. LED lamps tend to be four times as expensive as incandescents, but because they are up to 10 times more efficient and last 10 times as long, they pay for themselves in a month.

In addition, CLASP recommends building on the prior success in the street lighting sector, where the government has driven an almost complete transition from high-intensity discharge (HID) lamps to LED. While the government procurement specifications at 100 lm/W have been effective, LED technology has moved on and there is a further opportunity for energy reductions and $CO_2$ mitigation by increasing the stringency of street lighting to 130 lm/W.

Together, these two MEPS would reduce Indonesia's energy consumption by 49 TWh 2020-2030 and mitigate over 43 MT CO2, as shown by technology and sector in Table 1 and Table 2. Higher star levels can encourage the purchase of even more efficient lamp models, leading to even greater reductions.

*Table 1. Summary of energy reduction for the CLASP recommended MEPS at 80 lm/W for general service lighting and 130 lm/W for street lighting. The limited impacts in 2030 are because all lighting is assumed to have transitioned to LED by then.*

| Lamp Technology | Energy Reduction Annual in 2030 (TWh) | | | | Energy Reduction 2020-2030 (TWh) | | | |
|---|---|---|---|---|---|---|---|---|
| | Res. | Comm. | Outdoor | Technology Total | Res. | Comm. | Outdoor | Technology Total |
| **Incandescent** | 0.0 | 0.0 | 0.0 | **0.0** | 15.4 | 0.0 | 0.0 | **15.4** |
| **Halogen** | 0.0 | 0.0 | 0.0 | **0.0** | 6.5 | 2.9 | 0.1 | **9.5** |
| **CFL** | 0.0 | 0.0 | 0.0 | **0.0** | 5.7 | 0.0 | 0.0 | **5.7** |
| **LFL** | 0.0 | 0.0 | 0.0 | **0.0** | 1.1 | 3.0 | 0.1 | **4.2** |
| **Mercury Vapor** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |

| Lamp Technology | Energy Reduction Annual in 2030 (TWh) | | | | Energy Reduction 2020-2030 (TWh) | | | |
|---|---|---|---|---|---|---|---|---|
| | Res. | Comm. | Outdoor | Technology Total | Res. | Comm. | Outdoor | Technology Total |
| **High Pressure Sodium** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **Metal Halide** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **LED** | 0.0 | 0.0 | 0.6 | **0.6** | 0.0 | 0.0 | 14.0 | **14.0** |
| **Sector Total** | **0.0** | **0.0** | **0.6** | **0.6** | **28.7** | **6.0** | **14.2** | **48.8** |

*Table 2. Summary of $CO_2$ mitigation for the CLASP recommended MEPS at 80 lm/W for general service lighting and 130 lm/W for street lighting. The limited impacts in 2030 are because all lighting is assumed to have transitioned to LED by then.*

| Lamp Technology | Emissions Mitigation Annual in 2030 ($MtCO_2$) | | | | Emissions Mitigation 2020-2030 ($MtCO_2$) | | | |
|---|---|---|---|---|---|---|---|---|
| | Res. | Comm. | Outdoor | Technology Total | Res. | Comm. | Outdoor | Technology Total |
| **Incandescent** | 0.0 | 0.0 | 0.0 | **0.0** | 13.6 | 0.0 | 0.0 | **13.6** |
| **Halogen** | 0.0 | 0.0 | 0.0 | **0.0** | 5.8 | 2.6 | 0.1 | **8.4** |
| **CFL** | 0.0 | 0.0 | 0.0 | **0.0** | 5.0 | 0.0 | 0.0 | **5.0** |
| **LFL** | 0.0 | 0.0 | 0.0 | **0.0** | 0.9 | 2.7 | 0.1 | **3.7** |
| **Mercury Vapor** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **High Pressure Sodium** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **Metal Halide** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **LED** | 0.0 | 0.0 | 0.6 | **0.6** | 0.0 | 0.0 | 12.4 | **12.4** |
| **Sector Total** | **0.0** | **0.0** | **0.6** | **0.6** | **25.3** | **5.3** | **12.6** | **43.2** |

Key stakeholders from government, industry, and trade associations gave their feedback and comments on the findings during a National Workshop on November 20, 2019 in Jakarta and a subsequent focus group discussions (FGDs) with industry hosted by EBTKE in Jakarta on January 29 and March 10, 2020. Stakeholders mostly agreed with the findings of this market assessment during the workshops.

# Ringkasan Eksekutif

Indonesia adalah negara ke 4 terbesar di dunia, dengan lebih dari 265 juta jiwa pada tahun 2018.[11] Produk Domestik Bruto (PDB) telah tumbuh sekitar 5% per tahun selama dekade terakhir,[12] sementara pendapatan per kapita telah secara bersamaan tumbuh hampir 4% per tahun.[13] Pertumbuhan ekonomi yang stabil di Indonesia telah berkontribusi menaikkan konsumsi listrik dua kali lipat, dari 129 TWh pada tahun 2008 menjadi 256 TWh pada tahun 2018.

Sektor perumahan adalah pengguna listrik yang utama, menyumbang hampir 40% dari konsumsi, diikuti oleh industri (37%), komersial (23%), dan transportasi (0,11%).[14] Batubara adalah bahan bakar utama dalam pembangkit listrik, yang menyumbang 58% dari energi primer yang dikonsumsi, diikuti oleh gas alam (27%), energi terbarukan (air, panas bumi, tenaga surya, dan angin; 8%) dan minyak bumi (6%).[15]

Berdasarkan Perjanjian Paris, Indonesia berkomitmen untuk mengurangi emisi gas rumah kaca (GRK) sebesar 29% di bawah *baseline* Bisnis-Seperti-Biasa (BSB) di tahun 2030, atau 38% di bawah BSB pada tahun 2030 dengan dukungan internasional. Mencapai target tanpa syarat dan bersyarat ini, akan memerlukan pengurangan konsumsi energi 19% dan 24% di bawah BSB.[16]

Kementerian Energi dan Sumber Daya Mineral (KESDM), melalui Direktorat Jenderal Energi Baru Terbarukan dan Konservasi Energi (EBTKE), bertujuan untuk mengurangi konsumsi energi nasional di semua sektor sebesar 17% pada tahun 2025 dibandingkan dengan kondisi BSB melalui berbagai kebijakan,[17] termasuk kebijakan efisiensi energi untuk peralatan listrik umum rumah tangga. Peraturan efisiensi energi untuk AC dan lampu neon ringkas (*Compact Fluorescent Lamp*, CFL) sudah berjalan, dan KESDM berencana untuk mengeluarkan Peraturan Menteri tambahan tahun ini untuk mengurangi konsumsi energi rumah tangga lebih lanjut.

Sebagai perwakilan suara dan sumber daya internasional terkemuka untuk kebijakan efisiensi alat dan inisiatif percepatan pasar, CLASP, bersama-sama dengan mitra lokal PwC, melakukan studi komprehensif penerangan di Indonesia. Tujuan dari penelitian ini adalah untuk mengkarakterisasi pasar, menginformasikan perkembangan uji, standar, dan persyaratan pelabelan produk penerangan yang tepat dan kuat, dan menilai potensi dampak kebijakan efisiensi energi ini.

Tim menerima data dan input dari empat asosiasi perdagangan (APERLINDO, AILKI, GAMATRINDO, dan ALINDO) dan empat produsen utama, yang terdiri dari 73% dari pasar, dan mengunjungi 51 toko ritel di enam kota. Tim juga mengumpulkan data pemerintah, meninjau studi sebelumnya, meninjau situs web produsen, dan menggabungkan temuan survei nasional yang dilakukan oleh CLASP tentang penggunaan akhir pada rumah tangga yang meliputi 5000-rumah tangga. Akhirnya, tim mengembangkan rekomendasi kebijakan dan melakukan analisa dengan menggunakan Sistem Pemodelan Analisis Kebijakan (PAMS) dari CLASP.

Temuan utama yanng dirangkum di bawah ini, akan memberikan informasi kepada EBTKE tentang kesempatan untuk kebijakan efisiensi energi yang kuat untuk produk penerangan, yang dapat memberikan penghematan uang, mengurangi energi dan $CO_2$, serta memperhitungkan kisaran produk saat ini di pasar.

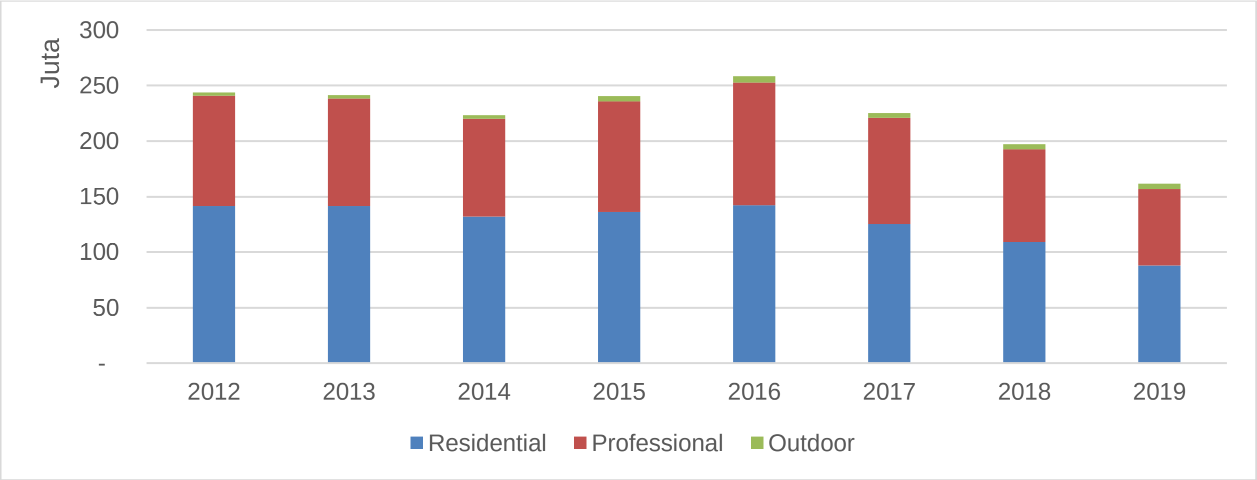
### Temuan Utama dalam Studi Pasar

Penggunaan energi penerangan di negara Indonesia adalah sangat signifikan. Melalui survei penggunaan energi yang dilakukan oleh CLASP di 5000-rumah tangga di Indonesia, telah teridentifikasi bahwa di setiap rumah tangga, ada 5,4 rata-rata titik lampu yang terpasang. Selain itu, penerangan beroperasi selama 7,6 jam setiap hari. Saat ini, ada lebih dari 330 juta unit produk penerangan yang terpasang di semua rumah

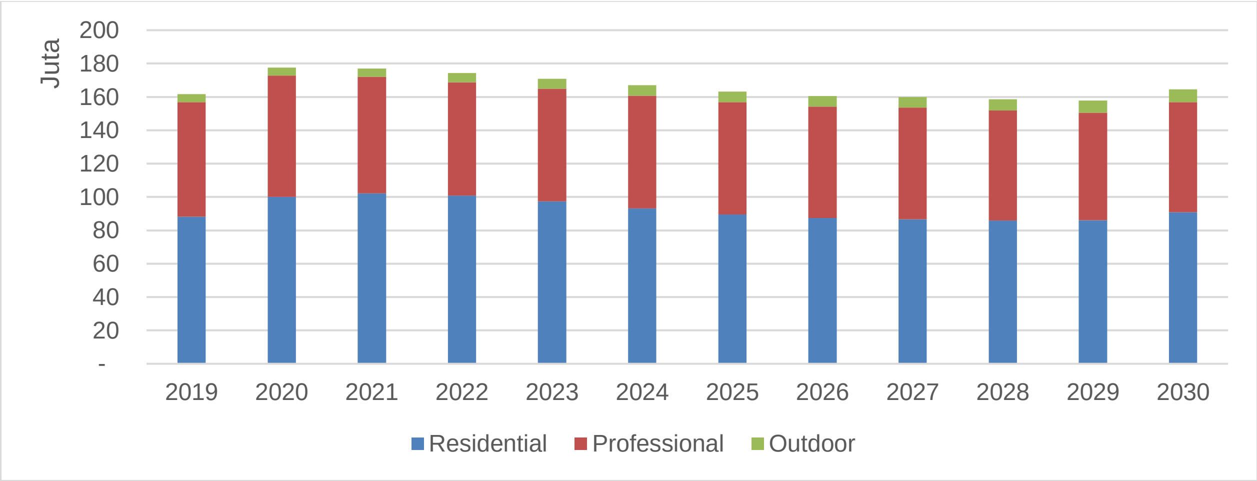
[11] KESDM, Buku Pegangan Statistik Energi & Ekonomi Indonesia, 2018, p. 3.
[12] Pertumbuhan PDB (tahunan %) - Indonesia. (n.d.). Data Terbuka Bank Dunia | Data. https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?end=2018&locations=ID&start=1961&view=chart
[13] Cuplikan Ekonomi Indonesia. http://www.oecd.org/economy/indonesia-economic-snapshot/
[14] KESDM, Buku Pegangan Statistik Energi & Ekonomi Indonesia, 2018, pp. 41-53.
[15] Laporan Statistik 2018. PLN. https://www.pln.co.id/stakeholder/laporan-statistik
[16] Pemerintah Indonesia, Kontribusi Republik Indonesia yang Pertama Ditentukan Secara Nasional , November 2016, p.10.
[17] Presiden Indonesia, Peraturan Presiden Nomor 22 tahun 2017 tentang Rencana Umum Energi Nasional (RUEN), p. 30.

tangga Indonesia. Sedangkan di dalam sektor profesional dan outdoor,[18] masing-masing 265 juta dan 28 juta unit produk penerangan yang digunakan di tahun 2019.

Jumlah produk penerangan yang terpasang diperkirakan meningkat pada tingkat pertumbuhan tahunan sebesar 3,5% di sektor perumahan, dan 5% di sektor profesional dan outdoor. Ukuran pasar penerangan secara nasional tercatat hampir 150 juta unit pada tahun 2018. Sekitar 80% dari jumlah penjualan total nasional berasal dari barang impor, dan 96% dari barang impor tersebut berasal dari Cina berdasarkan nilai jual moneter.




*Gambar 5: Penjualan produk penerangan historis per sektor dari tahun 2012 sampai 2019*




*Gambar 6: Proyeksi penjualan produk penerangan per sektor dari tahun 2019 sampai 2030*

Pertumbuhan stabil dalam penggunaan produk penerangan LED telah teridentifikasi di perkembangan pasar, beriringan dengan penurunan penggunaan produk CFL. Pasar ritel di Indonesia memiliki penetrasi produk LED yang tinggi di angka 76%, dibandingkan dengan produk CFL yang tercatat di angka 24%. IEA telah melaporkan bahwa secara global, penjualan LED di sektor residensial telah tumbuh dengan pesat, dari pangsa pasar sebanyak 5% di tahun 2013 menjadi 40% di tahun 2018. Di banyak pasar, kinerja efikasi

[18] Sektor professional mencakup sektor komersil dan industri, sedangkan sektor *outdoor* mencakup semua produk penerangan yang terpasang di luar bangunan, termasuk penerangan jalan umum, atau fasilitas pribadi, seperti di luar gedung atau garasi parkir.

penerangan dari produk LED yang tersedia untuk penggunaan perumahan telah mencapai 80 sampai 120 lumen/W dan diproyeksikan akan meningkat menjadi rata-rata 160 lumen/W pada tahun 2030.[19]

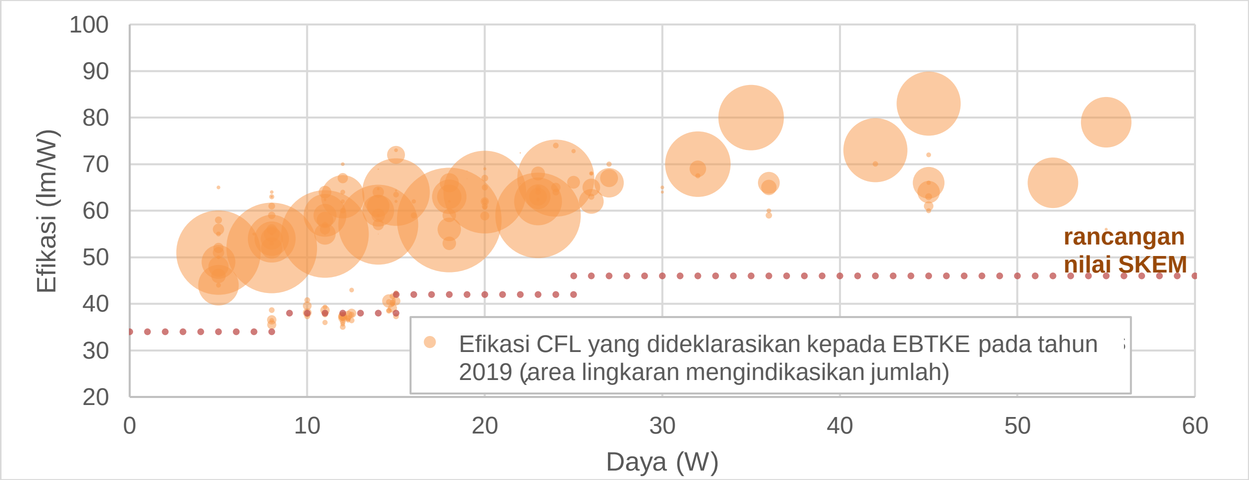
Dalam penerangan luar ruangan, telah terjadi transformasi pasar secara pesat di banyak kota di Indonesia. Hal ini berasal dari penggantian lampu jalan Sodium Tekanan Tinggi (HPS) dengan lampu jalan LED yang hemat energi, yang telah dimulai dari tahun 2014. [20] Jakarta adalah contoh utama dari pergerakan ini, di mana pemerintah kota dapat meningkatkan pangsa penerangan jalan LED dari 8% pada tahun 2014 menjadi 98% pada tahun 2018.

Penjualan produk penerangan secara menyeluruh menurun, yang disebabkan oleh masa pakai produk yang bertambah panjang dan penetrasi penerangan LED yang bertambah tinggi di semua sektor setiap tahunnya. Tren ini diperkirakan akan terus berlanjut sampai ke titik dimana pasar telah sepenuhnya dipadati oleh produk penerangan LED.

### Pilihan Kebijakan, Rekomendasi, dan Penilaian Dampak

EBTKE saat ini sedang mempertimbangkan kebijakan efisiensi energi untuk lampu CFL dan LED. CLASP dan PwC telah mengumpulkan data kinerja produk penerangan yang ditemukan di ritel, di situs web produsen, dan juga data yang dilaporkan kepada EBTKE melalui sertifikasi bermodel *Self-Declaration of Conformity (SDoC)* untuk lampu CFL yang tercakup di dalam Permen No. 18 Tahun 2014.

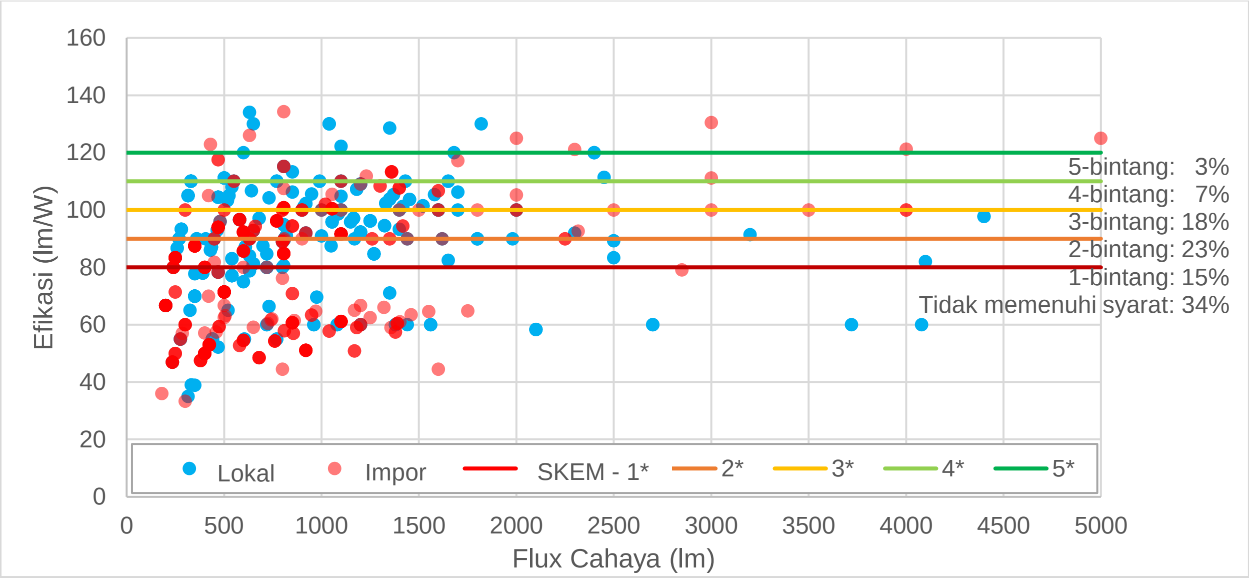
Meskipun ada berbagai nilai efikasi yang ditemukan di pasar Indonesia, dengan lampu pijar (di bawah 10 lm / W), CFL (kebanyakan 50-70 lm / W) dan LED (kebanyakan 80-110 lm / W), rancangan peraturan EBKTE dipastikan akan dapat dipenuhi oleh sebagian besar CFL dan LED di pasar. Khususnya lampu CFL, beberapa model yang mungkin tidak memenuhi cenderung memiliki pengiriman rendah, seperti yang dapat dilihat pada Gambar 7. Karena kebijakan yang dipertimbangkan ini tidak mencakup lampu halogen atau lampu pijar, pengurangan energi dan dampak mitigasi $CO_2$ yang diharapkan menjadi minimal.




*Gambar 7: Persebaran nilai efikasi CFL yang dideklarasikan oleh manufaktur kepada EBTKE terhadap persyaratan SKEM (1-bintang) yang sedang dipertimbangkan oleh EBTKE.*

Untuk menghemat energi yang lebih signifikan dan menghindari pengaturan teknologi individual secara selektif, CLASP memberikan rekomendasi persyaratan SKEM dan perlabelan netral-teknologi yang lebih ambisius, yang ditunjukkan di bawah ini. Persyaratan ini akan dapat dipenuhi oleh 66% model yang ada di pasar, termasuk 77% dari model yang diproduksi secara lokal.

[19] IEA (2019), "Tracking Buildings", IEA, Paris, https://www.iea.org/reports/tracking-buildings
[20] Berdasarkan masukan dari Pemerintah Kota Jakarta, Surabaya, Bandung




*Gambar 8: Rekomendasi CLASP untuk persyaratan regulasi produk penerangan di Indonesia*

Meskipun sebagian besar lampu LED dapat memenuhi persyaratan MEPS yang diusulkan pada 80 lm/W, kebijakan yang direkomendasikan ini akan mencapai pengurangan energi dan CO2 yang signifikan dengan menghapus teknologi lama dari pasar dan menggeser pangsa pasar ke lampu LED. Kebijakan tersebut akan menjadikan Indonesia sebagai pemimpin efisiensi energi penerangan di Asia Tenggara, dan sekaligus memberikan penghematan terhadap konsumen di seluruh negara. Lampu LED cenderung empat kali lebih mahal dari lampu pijar, tetapi karena mereka hingga 10 kali lebih efisien dan bertahan 10 kali lebih lama, mereka membayar sendiri dalam waktu kurang dari sebulan.

Di samping ini, CLASP juga memberikan rekomendasi untuk meneruskan kesuksesan pemerintah di dalam sektor penerangan jalan, dimana pemerintah telah mendorong transisi yang hampir seluruhnya terpenuhi dari lampu *High-Intensity Discharge* (HID) ke lampu LED. Walaupun spesifikasi pengadaan pemerintah di nilai efikasi 100 lm/W telah diberlakukan, teknologi LED telah terus berkembang, dan ada peluang pengurangan energi dan mitigasi $CO_2$ lebih lanjut dengan meningkatkan ketatnya penerangan jalan menjadi 130 lm/W.

Pemberlakuan kedua SKEM ini akan mengurangi konsumsi energi Indonesia sebesar 66 TWh 2020-2030, dan mengurangi lebih dari 58 MT $CO_2$, seperti yang ditampilkan untuk setiap teknologi dan setiap sektor di Gambar 7 dan Gambar 8. Tingkat bintang yang lebih tinggi dapat mendorong pembelian model lampu yang lebih efisien, yang akan mendorong pengurangan yang lebih besar.

*Tabel 3. Rangkuman jumlah pengematan energi dari nilai SKEM yang direkomendasikan oleh CLASP di nilai efikasi 80 lm/W untuk penerangan umum dan 130 lm/W untuk penerangan jalan. Dampak terbatas pada tahun 2030 adalah karena semua penerangan diasumsikan telah beralih ke LED pada saat itu.*

| Teknologi Lampu | Penghematan Energi di Tahun 2030 (TWh) | | | | Penghematan Energi dari Tahun 2020 sampai Tahun 2030 (TWh) | | | |
|---|---|---|---|---|---|---|---|---|
| | Rumah Tangga | Komersil | Luar Ruangan | Total per Teknologi | Rumah Tangga | Komersil | Luar Ruangan | Total per Teknologi |
| **Pijar** | 0.0 | 0.0 | 0.0 | **0.0** | 15.4 | 0.0 | 0.0 | **15.4** |
| **Halogen** | 0.0 | 0.0 | 0.0 | **0.0** | 6.5 | 2.9 | 0.1 | **9.5** |

| Teknologi Lampu | Penghematan Energi di Tahun 2030 (TWh) | | | | Penghematan Energi dari Tahun 2020 sampai Tahun 2030 (TWh) | | | |
|---|---|---|---|---|---|---|---|---|
| | Rumah Tangga | Komersil | Luar Ruangan | Total per Teknologi | Rumah Tangga | Komersil | Luar Ruangan | Total per Teknologi |
| **CFL** | 0.0 | 0.0 | 0.0 | **0.0** | 5.7 | 0.0 | 0.0 | **5.7** |
| **LFL** | 0.0 | 0.0 | 0.0 | **0.0** | 1.1 | 3.0 | 0.1 | **4.2** |
| **Uap Merkuri** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **Natrium Tekanan Tinggi (HPS)** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **Logam Halida** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **LED** | 0.0 | 0.0 | 0.6 | **0.6** | 0.0 | 0.0 | 14.0 | **14.0** |
| **Total per Sektor** | **0.0** | **0.0** | **0.6** | **0.6** | **28.7** | **6.0** | **14.2** | **48.8** |

*Tabel 4. Rangkuman jumlah mitigasi $CO_2$ dari nilai SKEM yang direkomendasikan oleh CLASP di nilai efikasi 80 lm/W untuk penerangan umum dan 130 lm/W untuk penerangan jalan. Dampak terbatas pada tahun 2030 adalah karena semua penerangan diasumsikan telah beralih ke LED pada saat itu.*

| Teknologi Lampu | Mitigasi Emisi di Tahun 2030 ($MtCO_2$) | | | | Mitigasi Emisi dari Tahun 2020 sampai Tahun 2030 ($MtCO_2$) | | | |
|---|---|---|---|---|---|---|---|---|
| | Rumah Tangga | Komersil | Luar Ruangan | Total per Teknologi | Rumah Tangga | Komersil | Luar Ruangan | Total per Teknologi |
| **Pijar** | 0.0 | 0.0 | 0.0 | **0.0** | 13.6 | 0.0 | 0.0 | **13.6** |
| **Halogen** | 0.0 | 0.0 | 0.0 | **0.0** | 5.8 | 2.6 | 0.1 | **8.4** |
| **CFL** | 0.0 | 0.0 | 0.0 | **0.0** | 5.0 | 0.0 | 0.0 | **5.0** |
| **LFL** | 0.0 | 0.0 | 0.0 | **0.0** | 0.9 | 2.7 | 0.1 | **3.7** |
| **Uap Merkuri** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **Natrium Tekanan Tinggi (HPS)** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **Logam Halida** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **LED** | 0.0 | 0.0 | 0.6 | **0.6** | 0.0 | 0.0 | 12.4 | **12.4** |
| **Total per Sektor** | **0.0** | **0.0** | **0.6** | **0.6** | **25.3** | **5.3** | **12.6** | **43.2** |

Pemangku utama dari pemerintahan, industri, dan asosiasi perdagangan telah memberikan masukan dan komentar tentang temuan dan kajian dari CLASP selama Lokakarya Nasional yang diadakan pada tanggal 20 November 2019 di Jakarta, dan *Focus Group Discussion (FGD)* berikutnya dengan industri yang diselenggarakan oleh EBTKE di Jakarta pada 29 Januari dan Maret 10, 2020. Pemangku utama yang hadir di acara-acara tersebut telah mengkaji dan menyetujui temuan penilaian pasar ini.

# 1 Background and Introduction

Indonesia is home to over 265 million people.[21] It is the fourth most populous country in the world and its rapidly expanding economy is the largest in Southeast Asia. GDP per capita has risen by 70% during the past two decades and while the end of the commodity price boom weighed on incomes and government revenues, GDP has continued growing at around 5% per year, while per capita income has grown at almost 4% per year.[22]

The manufacturing sector has played an important role in the country's development and it is positioned to continue as an engine of economic growth for the national economy.[23] The home appliances segment in particular has benefited from increasing investments in the country by multinationals such as LG, Sharp, and Panasonic. According to the Ministry of Trade, Indonesia was home to 235 companies in the electronics and home appliance manufacturing business (including component makers) in 2014.[24] The country has one of the strongest manufacturing sectors in the world, accounting for 20.5% of GDP in 2018.[25] The Asian Development Bank expects Indonesia's GDP growth rate to average around 6% between 2020 and 2024 due to its growing manufacturing sector.[26]

Growth in the manufacturing sector has also been attributed to the change in consumption patterns in the country. The middle-class consumer segment is anticipated to grow from 88 million people in 2014 to 140 million by 2020.[27] Retail sales grew by 3.7% in 2018 and household consumption grew 5.5% in 2018, up from 4.9% the year before.[28]

Economic growth has been accompanied by a rise in energy consumption and greenhouse gas (GHG) emissions. Electricity consumption has doubled over the past decade, from 129 TWh in 2008 to 256 TWh in 2018. The residential sector is the primary electricity user, responsible for nearly 40% of consumption, followed by industrial (37%), commercial (23%), and transportation (0.11%) sectors.[29] Coal is the main fuel in electricity generation, responsible for 58% of primary energy consumed, followed by natural gas (27%), renewables (hydro, geothermal, solar, and wind; 8%) and oil (6%).[30]

Indonesia is the world's 11$^{th}$ highest $CO_2$ emitter when considering only emissions due to energy.[31] Indonesia's success in achieving its national climate pledges will be critical to keeping the planet's temperature rise below the 2 °C (3.6 °F) threshold called for in the Paris Agreement. Per the Nationally Determined Contributions (NDCs) of Indonesia, energy efficiency is one of the key measures to reduce GHG (greenhouse gas) emissions from the energy sector. In its NDC, Indonesia committed to reducing greenhouse gas (GHG) emissions by 29% against a business-as-usual (BAU) baseline by 2030, or to reach 38% below BAU by 2030 with international support.[32]

To achieve these reductions and mitigate the effects of climate change on island countries such as Indonesia, EBTKE under MEMR is implementing policies targeted at both energy supply and demand, including the efficiency of household products. MEMR aims to reduce energy consumption across all

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[21] Ministry of Energy and Mineral Resources, Republic of Indonesia, Handbook of Energy & Economic Statistics of Indonesia, 2018
[22] Indonesia Economic Snapshot. http://www.oecd.org/economy/indonesia-economic-snapshot/
[23] The Jakarta Post, Business; https://www.thejakartapost.com/news/2019/02/11/manufacturing-sector-to-drive-indonesias-economy-bappenas.html (accessed on 22 May 2019)
[24] Global Business Guide, Indonesia; http://www.gbgindonesia.com/en/manufacturing/article/2015/electronics_and_home_appliances_manufacturing_in_indonesia_finding_its_edge_11128.php (accessed on 22 May 2019)
[25] The Jakarta Post, Business; https://www.thejakartapost.com/news/2018/12/31/manufacturing-sectors-contribution-to-gdp-above-world-average-minister.html (accessed on 22 May 2019)
[26] The Jakarta Post, https://www.thejakartapost.com/news/2019/02/11/manufacturing-sector-to-drive-indonesias-economy-bappenas.html (accessed on 22 May 2019)
[27] Consumer Durables study by BCG, November 2015
[28] Oxford Business Group; https://oxfordbusinessgroup.com/analysis/loosening-belt-growing-middle-class-boosts-consumer-spending (accessed on 23 May 2019)
[29] Handbook of Energy & Economic Statistics of Indonesia, 2018, pp. 41-53.
[30] Statistics Report 2018. PLN. https://www.pln.co.id/stakeholder/laporan-statistik
[31] Energy Information Administration, 2017 International Emissions, https://www.eia.gov/international/data/world/other-statistics/emissions-by-fuel (accessed 27 February 2020).
[32] Government of Indonesia, First Nationally Determined Contribution Republic of Indonesia, November 2016, p.10.

sectors by 17% in 2025 relative to BAU through various policies, including minimum energy efficiency standards (MEPS) and comparative labeling for energy-using products.[33]

MEPS currently exist for compact fluorescent lamps and room air conditioners, and standards for other products are either in development or pending approval. However, limited or non-existent data on the appliance market makes it challenging for EBTKE to estimate the $CO_2$ reduction potential of other products, to be used as the basis for product selection for new MEPS levels and compliance efforts. Therefore, CLASP and its partners undertook market studies for four products—fans, lighting, refrigerators, and rice cookers—to inform EBTKE's analysis of the market and the characteristics of these products, and to calculate the energy and $CO_2$ reduction potential from setting ambitious efficiency policies.

As the leading international voice and resource for appliance efficiency policies and market acceleration initiatives, CLASP, together with local partner PwC, conducted a comprehensive market study in Indonesia. This study assesses the potential impact of energy efficiency policies for lighting products in Indonesia based on product-level data and market characteristics.

This report first describes the results of CLASP's market assessment, and then looks at the policy options and their impacts.

Market Assessment:

- **Section 1** provides an introduction, background and study objectives;
- **Section 2** describes the approach including scope and key activities;
- **Section 3** provides the overview of the market including key players and a discussion on supply chain and describes the market assessment findings; and
- **Section 4** presents data on market characteristics.

Policy Options and Impacts Assessment:

- **Section 5** summarizes the current draft MEPS and labeling requirements;
- **Section 6** summarizes the current test method referenced by the draft MEPS and compares it to international test methods as well as lab capacity;
- **Section 7** describes the approach to analyzing alternative policies;
- **Section 8** presents the policy options;
- **Section 9** reviews the impacts on consumers, manufacturers, and the nation; and finally
- **Section 10** contains conclusion and recommendations.

[33] President of Indonesia, Republic of Indonesia Presidential Regulation Number 22 of 2017 about National Energy General Plan (RUEN), p. 30.

# Market Assessment

# 2 Market Assessment Methodology

Market assessment is the first step in designing and implementing energy efficiency policies for any appliance. It helps policymakers and other stakeholders understand:

- Product characteristics, market segments, and core issues of the sector;
- Past, present, and future trends in the sector; and
- Impacts of energy efficiency policies.

The CLASP team therefore collected market and product level data, followed by validation and detailed data analysis. Each of these three steps is described in the sections below.

## Step 1 – Market Data Collection Methodology

Data collection was performed by PwC and was conducted through survey questionnaires, interviews, and secondary research, as illustrated in Figure 9. Specific details on field survey methodology are provided in **Appendix B**.

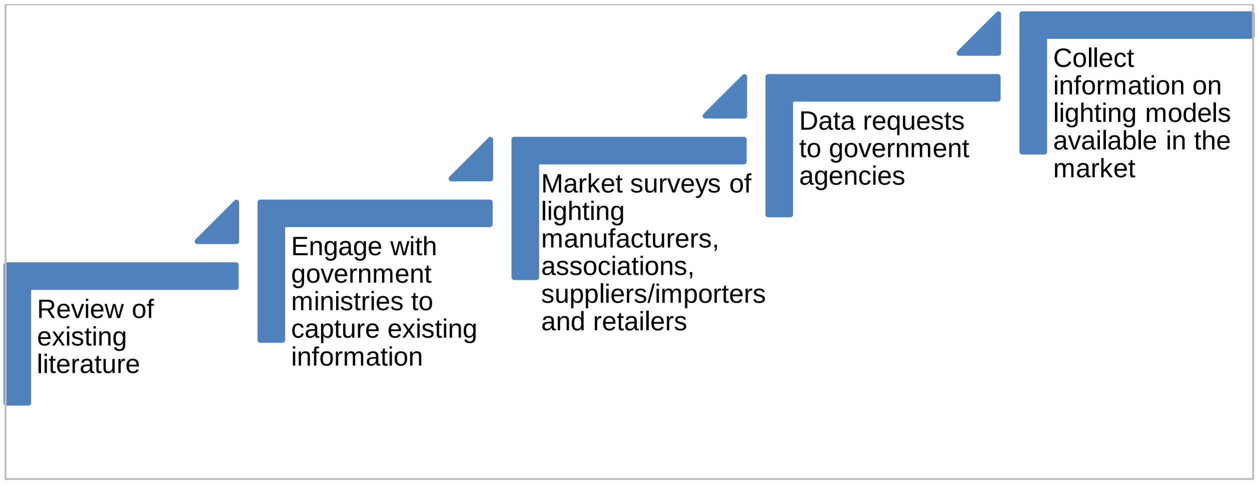



*Figure 9: Data collection steps*

Table 5, below, summarizes our collection strategy for each required data type.

*Table 5. Data type and collection strategy*

| Data type | Data collection strategy adopted |
|---|---|
| Products on the Market and their Characteristics | • Manufacturers' website research<br>• Retailer survey across 6 cities in Indonesia<br>• Market survey of manufacturers and associations |
| Manufacturers and Brands, Supply Chain, Imports and % Local Content | • Secondary research to identify relevant stakeholders<br>• Personal interviews with industry associations for market information<br>• Interviews with manufacturers/suppliers/importers on supply chain<br>• Interview with Ministry of Trade for import/export data |
| Product Lifetime | • Product specifications from manufacturer's datasheets<br>• Interviews and questionnaire-based survey with manufacturers<br>• Association interviews |

| Data type | Data collection strategy adopted |
|---|---|
| Stock, Historical Shipments, Forecasts, and Market Trends through 2030 | • Shipments based on:<br>○ Import data from INSW, BPS, and UN Comtrade<br>○ Questionnaires and interviews with manufacturers and associations<br>• Stock calculated from:<br>○ Population statistics, PLN electricity subscriber data, electrification rate<br>○ Replacement rates based on product lifetime and usage<br>○ Household survey results for lighting points per household, penetration of lighting products by technology and wattage<br>• Forecasting based on income and GDP growth, LED technology diffusion |
| Technology Profiles, Trends, and Barriers to Increased Market Penetration of Efficient Products | • Interviews with manufacturers/suppliers of lighting products to understand technologies in the market, consumer preference, and manufacturing issues |

PwC prepared a data collection plan that included a list of relevant stakeholders to reach out to (see **Appendix D**) and outreach strategy. Data was gathered through following methods:

- *Visits to retail stores (modern retail).* PwC team visited 45 modern retail stores across six cities in Indonesia, as outlined in Table 6. The team selected larger cities across several regions of Indonesia to increase representativeness of the survey. Within each city, teams visited stores different neighborhoods.

*Table 6. Survey of modern retail stores*

| Region | Number of stores surveyed | Number of stores yielding data |
|---|---|---|
| **Jakarta** | 15 | 14 |
| **Bandung** | 6 | 5 |
| **Surabaya** | 9 | 5 |
| **Makassar** | 5 | 4 |
| **Denpasar** | 3 | 2 |
| **Medan** | 7 | 5 |
| **Total** | **45** | **35** |

35 of the stores yielded useful technical data on the products for sale. For the remaining 10 stores the team referenced Krisbow website data for specifications and lamp models, as the stores carried just one or two models from this brand. The team collected data on 762 lamps (578 LED and 184 CFL). The team gathered data from product packaging and price tags, which included model number/name, brand, technology, price, luminous flux, and wattage. Plotted data for products collected from retail and web stores are provided in **Appendix A**.

- *Visits to retail stores (traditional retail).* The team also visited traditional stores across four cities. Interviews with trade associations and manufacturers revealed that traditional stores were cater to different customers and carry different products and brands. A total of 42 brands were identified out of which 31 were not found in modern retail.
- *Web research.* The team researched the websites of the brands identified during the retail survey (both modern and traditional) to further understand product characteristics, including lifetime. While the retail

survey focused on residential lamps, the web survey included professional and outdoor lighting as well. Summary of specification analysis from the retailer survey and website research is covered in Section 0.

- *Focus group meetings with manufacturers.* The team requested data from key manufacturers, including importers, local assemblers, with support of key associations. The team met with the manufacturers to solicit participation in the survey, securing data and other inputs from nine manufacturers, including the four major ones responsible for 73% of sales by volume, along with three of the four associations. Data protection and privacy concerns prevented many companies from sharing data. The market share data compiled in **Section 3.1** is thus based on a mix of verbal responses of manufacturers, associations and completed questionnaires.
- *Data requests to government agencies.* To validate the primary data gathered from the manufacturers and importers, secondary data the team requested data from government agencies. The team collected street lighting data from 10 agencies including city governments of Jakarta, Bandung, Bogor, Surabaya, Tangerang, Makassar, and Medan; Jasa Marga for toll roads; and Ministry of Transportation. The team collected statistics data for population, household size etc. from Statistics Indonesia (Badan Pusat Statistik, BPS), and imports data from BPS, UN Comtrade, and INSW, and Ministry of Trade.

EBTKE and CLASP supported PwC in data collection activities by requesting stakeholders for data collection.

### Step 2 – Data Validation and Market Assessment Findings

PwC conducted a quality check of the collected product data to eliminate any wrongly reported or recorded specifications and market data. For stock, annual shipment calculations a model was developed which is covered in **Appendix E.** EBTKE and CLASP supported the data validation activity by requesting stakeholders to review the initial findings.

GAMATRINDO validated the residential stock and model for estimating annual shipment from stock, while two major lighting manufacturers, Hori and Signify, provided their feedback on professional and street lighting stock. Among the associations, GAMATRINDO was quite proactive in sharing their methodology of estimating residential lighting stock and sales. The association validated the overall findings, as well the replacement factor for stock accumulation and import data to use.

Subsequently, CLASP revised the shipments and stock model to directly draw on import data from BPS and shipments from local manufacturers. The unit shipments by technology were distributed by sector (residential, professional, and outdoor) based on sector splits provided by the primary importer as well as splits seen in other countries. The result was an estimate of residential, professional, street lighting sectors and the lighting technologies within each sector. CLASP then validated these stock estimates against the results of CLASP's 5000-household Indonesia-wide residential end-use from 2019, past studies by CLASP and International Institute for Energy Conservation (IIEC) (from 2014 and 2015), and PLN electricity consumption by sector.

Neither PwC nor CLASP performed any product testing to verify the accuracy of manufacturer-claimed energy performance data. The lighting market assessment was performed using collected product data from retailer survey (762) and website research (439). The dataset includes 1201 models, of which 41 % were found in multiple stores. There were 274 unique models in the retailer survey dataset out of 762. The number of models was further reduced due to incomplete data. For example, the average price of a lamp was calculated based on models with price data, and models without price data were excluded from analysis.

Key stakeholders from government, industry, and trade associations gave their feedback and comments on the findings during National Workshop on November 20, 2019 in Jakarta and a subsequent focus group discussions (FGDs) with industry hosted by EBTKE in Jakarta on January 29 and March 10, 2020. Stakeholders mostly agreed with the findings of this market assessment during the workshops.

### Step 3 – Impact analysis and policy recommendations.

The team then forecasted the annual shipments, across different market segments/sectors over the next 10 years to 2030 with the assumption that all the lighting products by 2030 will shift to energy efficient LED technology. The rate of increasing penetration year on year, the overall stock and annual shipment calculation with its assumptions are provided in **Appendix E** of this report.

Finally, CLASP estimated the energy, emissions, and consumer cost savings under different MEPS scenarios. Under each scenario, the average efficacy of a particular lighting technology in a particular sector would increase with the adoption of standards. CLASP then calculated the savings, which decreased year by year due to the ongoing transition to LED plus a continuing industry-led increase in LED efficacy. This analysis informed policy recommendations for lighting products in Indonesia.

# 3 Lighting Industry at a Glance

## 3.1 Supply Chain Analysis

**Residential users** procure lighting products from retail stores such as modern retail stores like hypermarkets, supermarkets, and department stores; and traditional retail stores like small electrical shops.

**Professional end-users** such as commercial and industrial buyers procure directly from wholesalers, importers, or manufacturers using a business-to-business (B2B) procurement method. The availability of lighting technology, its wattage, and price are the deciding factors for consumer selection in residential sector whereas efficacy and pricing take priority in the case of B2B buyers in the professional sector.[34]

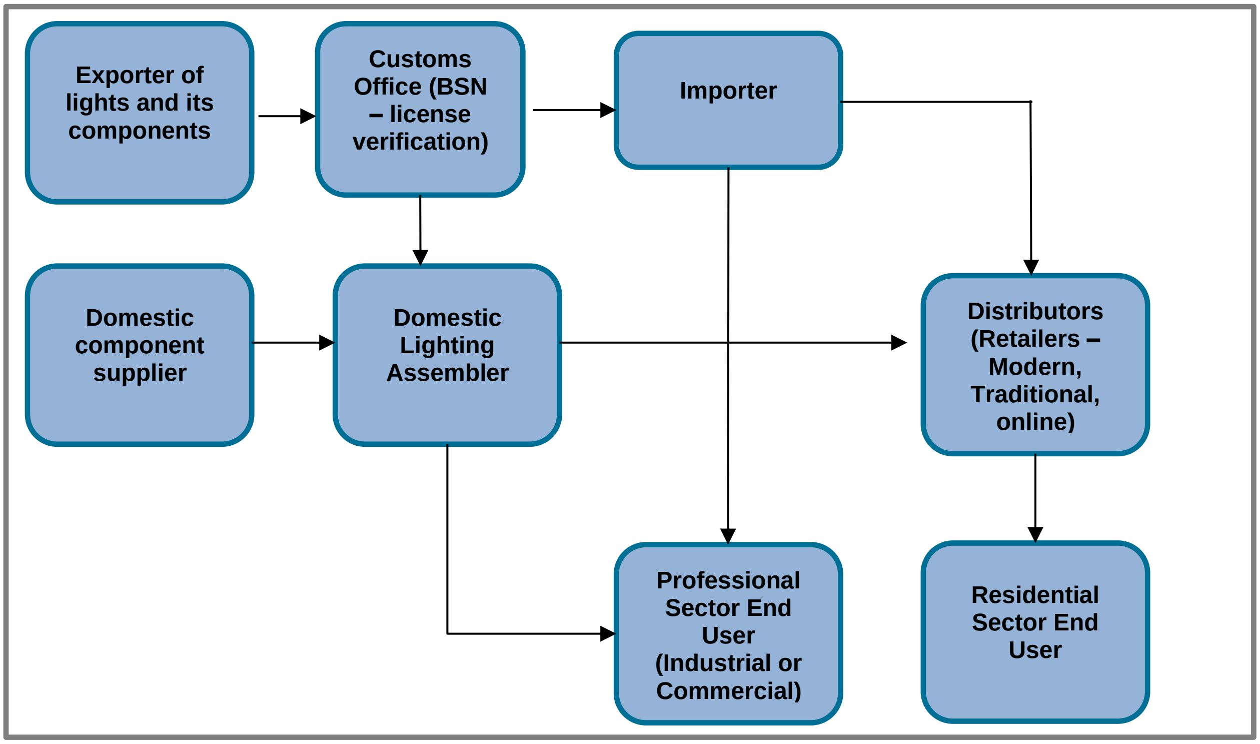



*Figure 10: Supply chain of lighting products (residential and professional)*

In the **street lighting sector** (Figure 3), the National Procurement Agency (Lembaga Kebijakan Pengadaan Barang Jasa Pemerintah - LKPP) publishes city government tenders for government and street lighting projects. Manufacturers use LKPP's online platform of LKPP to bid on these projects.

[34] As per interviews with select manufacturers and industry experts

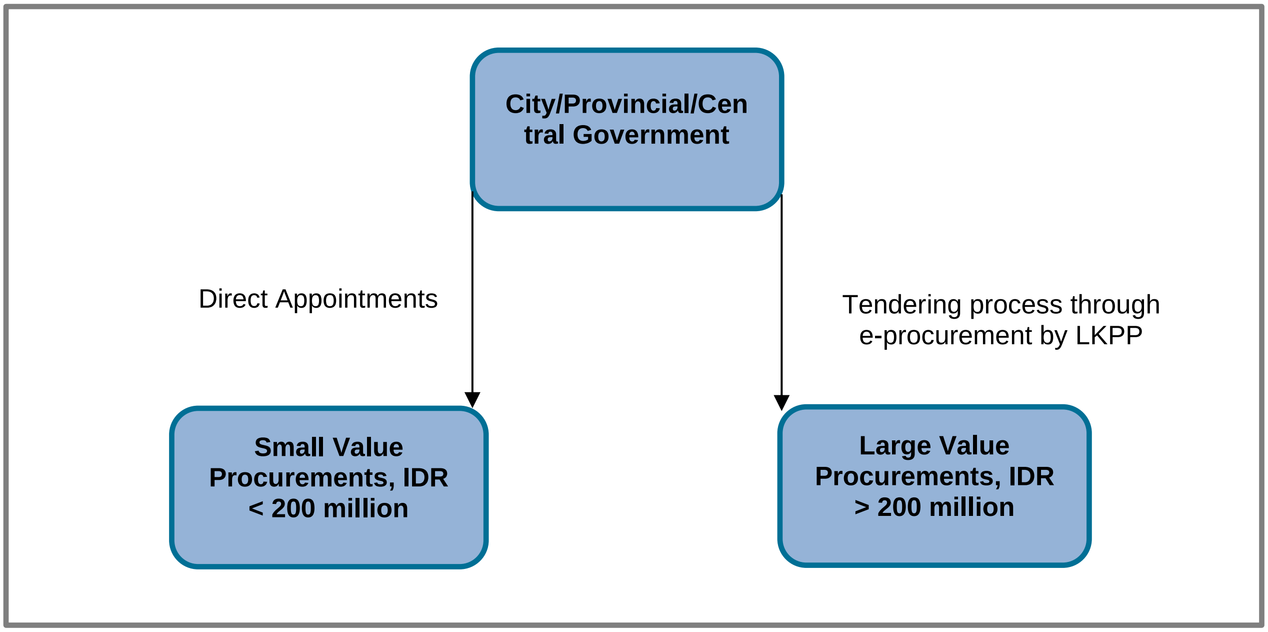



*Figure 11: Street lighting procurement flow*

Imports of lighting products into Indonesia must meet Ministry of Industry requirements. The product must have **National Standardization (Standard Nasional Indonesia/SNI) license** before it can be imported and sold in Indonesia. This license is issued by BSN (Bedan Standardisasi Nasional). The products need to comply with general safety, and in the case of CFLs, minimum performance requirements, before being made available in the market. At present are is no minimum performance requirements for other types of lamps or luminaires.

In a typical import setup, the OEM manufacturer supplies either lighting components or a complete lighting assembly. The components or assembly is imported, checked as per applicable standards, tested, labeled and then distributed to local manufacturers, wholesalers, and/or retailers. Validation checks take place after the product/components reach the customs office.

### 3.1.1 Imports

The CLASP team estimates total lighting imports at 111 million units in 2019, including incandescent, halogen, Compact Fluorescent Lamp (CFL) and Linear Fluorescent Lamp (LFL), High-Intensity Discharge (HID) lamps, and Light Emitting Diode (LED) lamps for general illumination. This estimate is primarily based on BPS data but is also informed by INSW and UN Comtrade. In particular, the BPS data (which is reported in kilograms), was converted into units based on the average weights in UN Comtrade.

The resultant estimate of units compared favorably with INSW data (128 million units in 2019), but was considered more accurate as it included a more complete time series and more Harmonized System (HS) codes, which allowed the team to confirm that special-purpose lamps and components were excluded. During interviews, lighting associations APERLINDO and GAMATRINDO reported that imports account for 80% of sales volume in Indonesia. Domestic production (assembly) accounts for the remaining 20% of sales volume.

After compiling shipment data reported by GAMATRINDO and several local manufacturers in 2018, CLASP compared the total to the import estimate and found that **domestic production represents 29% of**

**shipments.** The proportion varies by technology, from 39% for incandescent, 27% for CFL, and 13% for LED, though this is likely an undercount as not all manufacturers reported data for 2018 nor broke out their shipments by technology. According to the trade associations, local lighting manufacturers prefer importing LED components and assembling locally, while importing CFLs manufactured in China is more cost effective.

Moreover, the mercury used in CFLs is treated as a potential risk to the environment during disposal, which has resulted in several manufacturers and importers shifting toward LED products. Panasonic closed its CFL manufacturing facility in Indonesia as the company migrated to LED production. Indonesia prohibits the importation of mercury, but CFL imports are exempted under its trade regulation 75/M-DAG/PER/10/2014 - ratification of 'Minamata Convention on Mercury'. While CFL and incandescent imports into Indonesia continue, it is evident that the Indonesian market is shifting towards more efficient LED technology in lighting, as seen in Figure 12.

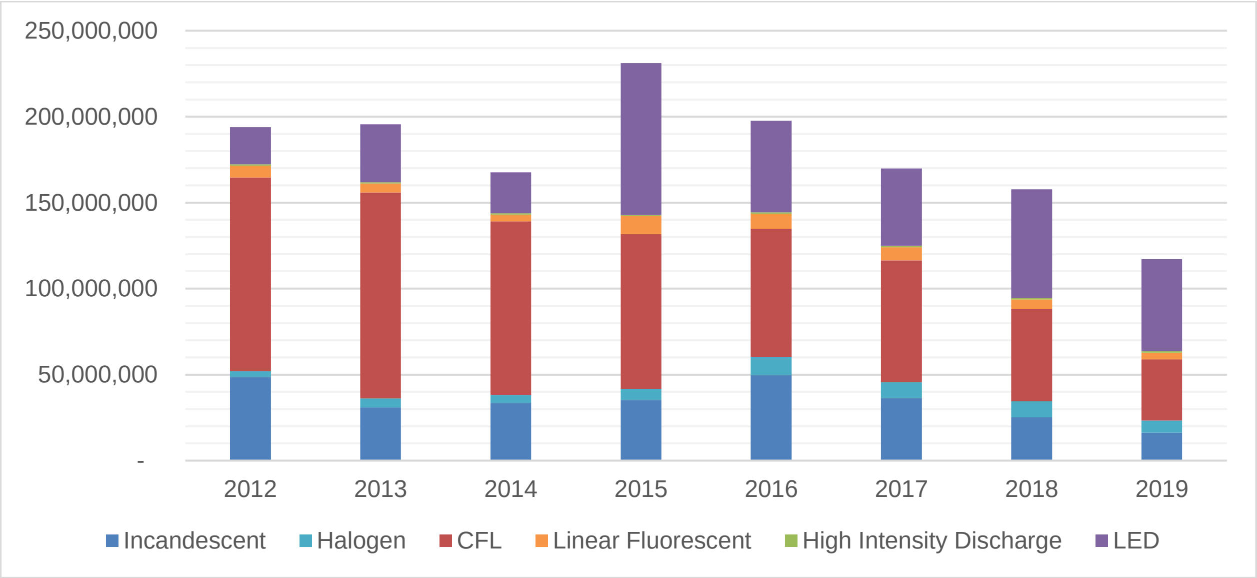



*Figure 12: Lighting Imports by volume, based on BPS weight data and UN Comtrade unit weights.*

**China** is the largest exporter of lighting products for Indonesia. **96%** of lighting products by value were imported from China in 2018 as shown in Table 7.[35]

*Table 7. Lighting imports from China (Ministry of Trade)*

| | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| **Total Imports, million USD** | 222 | 259 | 217 | 210 | 219 |
| **Imports from China, in million USD** | 185 | 209 | 179 | 200 | 211 |
| **Percentage Imports from China** | 83 % | 81 % | 82 % | 95 % | 96 % |

[35] Export data from Ministry of Trade & INSW

### 3.1.2 Exports

The quantity of lighting exports has fallen at a rate of almost 60% over the past five years, as can be seen in Figure 13. Exports are now less than 2% of imports. A possible reason for the decline is the shift toward LED technology for which Indonesia is not a manufacturing hub. Japan and Singapore are the two nations where the majority of lighting products are exported, as shown in Table 8.

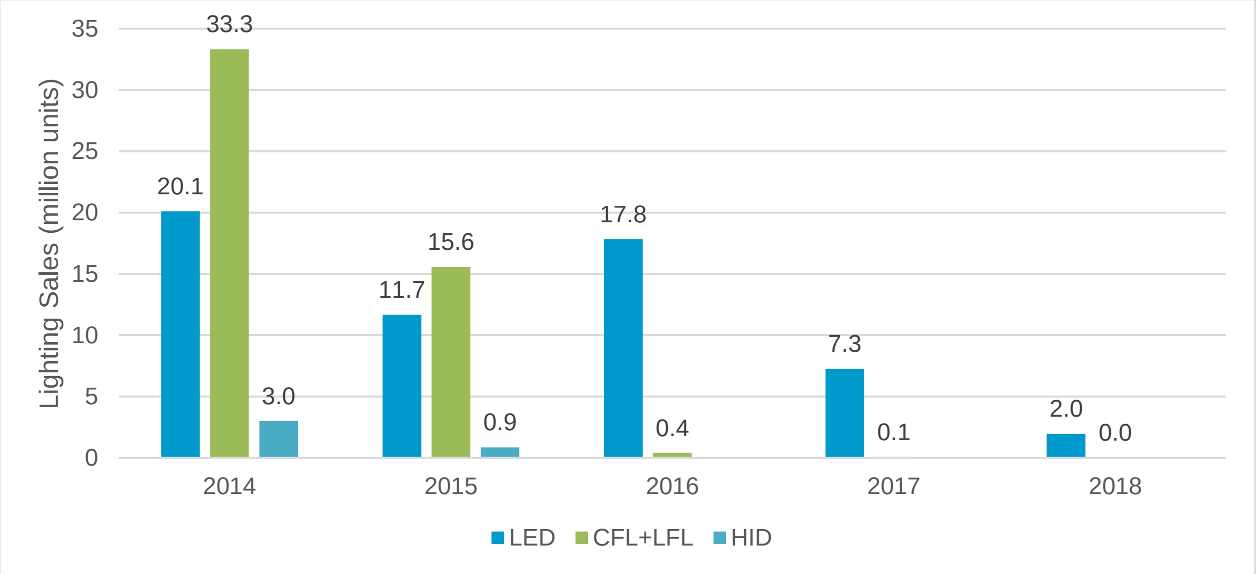



*Figure 13: Exports by volume in million units, from Ministry of Trade*

*Table 8. Lighting export share percentage of countries (in million USD), from Ministry of Trade*

| Exports in million USD | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| **Japan** | 52.09 | 23.5 | 3.79 | 2.55 | 1.06 |
| **% Share** | 63.7 % | 62.5 % | 15.5 % | 26 % | 40.7 % |
| **Singapore** | 19.13 | 6.09 | 8.59 | 2.30 | 0.002 |
| **% Share** | 23.4 % | 16.22 % | 35.1 % | 23.5 % | 0.1 % |

### 3.1.3 Local Manufacturing

Indonesian lighting manufacturers and importers are organized into several trade associations based on import versus local manufacture and product type. Based on interviews, local manufacturing in Indonesia has been declining due to high-volume and lower-cost competition, primarily from China. Local manufacturers are currently focused on supplying the price-sensitive rural market, where they can supply lower-efficacy LEDs (50 lm/W), CFLs, and incandescent cost-competitively (approximately 10,000-20,000 IDR at retail).

Increased efficacy requirements would require local manufacturers to compete at the higher efficacy levels common around the world (where the multinational companies have a volume advantage), while also exposing them to unfair competition from smuggled products.

There is no local content requirement (Tingkat Konten Dalam Negeri, TKDN) for lighting in Indonesia, which would allow local manufacturers that assemble products from mostly local components to receive tax breaks and other incentives. Regardless, at present, local manufacturers producing LED lighting import around 80% of the components by value, while as mentioned above, CFLs are primarily imported.

However, street lighting, which is procured by local government, must be manufactured with 40% local content. This has impelled at least one multinational manufacturer, Philips, to open a factory in Indonesia.[36]

Summarized information on local manufacturing activities are provided in **Appendix C**.

## 3.2 Key Players

Key players were identified by:

1. Engagement with Associations – APERLINDO, GAMATRINDO, AILKI, ALINDO
2. Survey of modern stores across 6 cities – Jakarta, Bandung, Surabaya, Makassar, Denpasar, Medan
3. Survey of traditional stores across 4 cities - Jakarta, Surabaya, Medan and Makassar
4. Web research of Bang-Beni database and other database resources

| Retailer Survey | APERLINDO | GAMATRINDO | Traditional Store Survey | Other Sources |
|---|---|---|---|---|
| • 19 Brands identified<br>• Represents majorly residential lighting products | • 44 brands<br>• More than 90 % are importers and rest assemblers | • 8 manufacturers (29 brands)<br>• Mostly local producers and assemblers | • 43 brands<br>• Out of them 31 addtional brands were identified | • Bang-Beni database had a total of 67 brands, with 12 additional brands |

*Figure 14: Sources for Brand Identification*

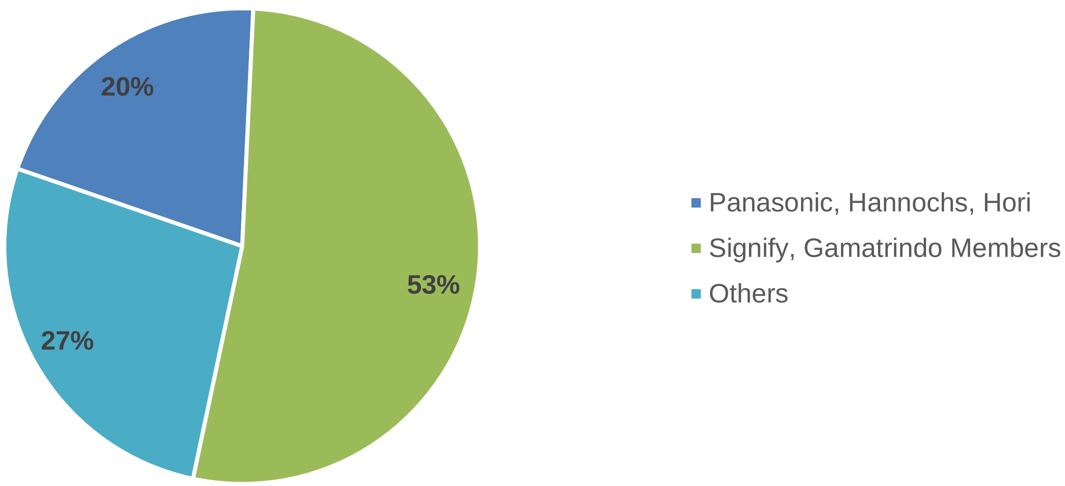



*Figure 15: Key Lighting Players*

[36] Interview with GAMATRINDO, 28 January 2020.

There are 4 active lighting associations in Indonesia, each meant for a unique purpose:

- GAMATRINDO: Local manufacturer association founded in 2013 with 10 members (8 active) and 29 brands;
- APERLINDO: Broader lighting association, made up mostly of importers;
- AILKI: A smaller association of larger brands such as Panasonic, Osram, Philips, and GE;
- ALINDO: Luminaire manufacturer association.

APERLINDO has the largest membership base with 44 members. More than 90 % of its members are importers of lighting products. GAMATRINDO represents local lighting assemblers (producers) and has 8 active members.

ALINDO has members which produce luminaires (mostly streetlights and outdoor lighting). AILKI is an association of global lighting producers investing in Indonesia. The specifications of lighting products across brands were analyzed and the analysis is presented in subsequent section. GAMATRINDO members are mostly local producers. Signify, Panasonic, Hori and Hannochs import lighting products for residential sector. Lighting products for public procurement like streetlights are produced in Indonesia.

Signify (Philips Lighting) is the largest player in terms of sales revenue, sales volume, model availability, and brand visibility. They opened a factory in Karawang in the year 2018 for streetlight production. The lights produced in their factory are meant for public procurement. Residential lighting products are all imported by Signify. The firm has a distribution network across 37 cities in Indonesia. They stopped the production of incandescent lamps in the year 2013-14.

# 4 Market Characteristics

## 4.1 Market Size

CLASP estimates the lighting market (annual shipments) in Indonesia at **164 million units in 2019,** with sales declining at a rate of **-15% over the past 3 years**. Installed lighting stock was estimated at **691 million units in 2019,** with annual growth rate of **2%** over the past 3 years**.** The decline in shipments can be attributed to replacement of existing CFL, linear fluorescent (LFL), incandescent, HID, and incandescent lamps with longer-lifetime LED lamps across all sectors.[37] So, even while the shipments are falling, the stock continues to increase as the lamps remain in service longer.

This trend has been observed around the world as countries all undergo the transition to LED technology. In addition, some growth is due to increases in the number of households, household income, economic growth, and infrastructure (road) development and reconstruction. The stock and annual shipments estimation approach and calculation are discussed in detail in Appendix E, while the key assumptions and findings are presented in the sections below.

### 4.1.1 Market Demographics at a Glance

Population, household size, electrification rates, and household incomes contribute to demand for lighting in the residential sector. The industrial growth rate and the economic growth rate of the country contribute to demand for professional and outdoor products. Therefore, the analysis used the following projected growth rates to model the growth of stock (lamps in use) in future years (2020-203).

- Income growth rate is 3.5%:[38] this is expected to drive residential lighting demand in the second half of the next decade.
- This is higher than the forecasted population (and expected household) growth rate of 0.9%[39]; CLASP used the higher income growth rate to reflect that lighting demand will come not just from population growth and household creation but purchase of additional lamps and expansion/reconstruction of houses.
- Electrification rates has reached 98.86% in the 3rd quarter of 2019 from 84.35% in 2014;[40] with almost full electrification, and all electrified households illuminated,[41] the number of households with lighting is not expected to grow.
- Gross domestic product (GDP) growth rate is 5%:[42] this has been modeled to continue into the future, driving the stock of professional and outdoor lamps.
- As the stock has been growing at rates different from the ones above (e.g., based on shipments and lifetimes, the model shows residential stock falling at -1.5% over the past three years, while outdoor stock has been growing at 14%), the forecast uses a gradual change in the stock growth rate, averaging the previous year's growth rate with the long-run growth rates listed above (3.5% for residential and 5% for other sectors), such that the long-run growth rates are modeled to fully take effect in the second half of the decade (2025-2030).
- As LED lighting continues to grow in popularity, the stock of other lamps is assumed to continue decreasing at either the lesser of: (1) the current rate of decline or (2) the rate necessary for all lighting to be replaced with LED by 2030.

[37] The finding was validated by a lighting association from Indonesia, GAMATRINDO
[38] Indonesia Economic Snapshot. http://www.oecd.org/economy/indonesia-economic-snapshot/
[39] World Bank, Population Estimates and Projections, https://datacatalog.worldbank.org/dataset/population-estimates-and-projections
[40] MEMR Blog Post. Growing by 3% per Year, Electrification Ratio in 3rd Quarter Reaches 98.86%. https://www.esdm.go.id/en/media-center/news-archives/growing-by-3-per-year-electrification-ratio-in-3rd-quarter-reaches-9886
[41] CLASP's 2019 5000-household residential end-use study found 100% of electrified households had lighting installed.
[42] Indonesia Economic Snapshot. http://www.oecd.org/economy/indonesia-economic-snapshot/

### 4.1.2 Sales Trend and Forecast

**Annual Shipments – By Sector**

After falling over the past five four years, annual shipments are expected to slightly increase in 2020, then continue falling through 2029. By 2030, the transition to LED is expected to be complete. With lifetimes no longer increasing as dramatically, shipment growth will again begin to track with population and GDP growth. Figure 16 shows historical shipments by sector, while Figure 20 shows the forecast.

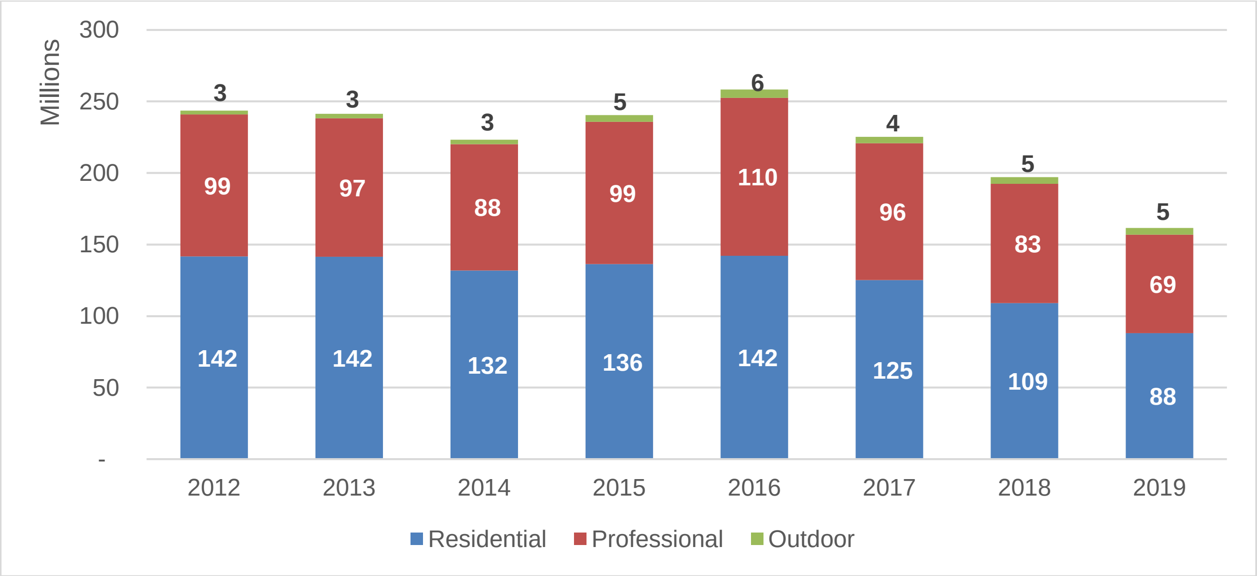



*Figure 16: Historical shipments by sector*

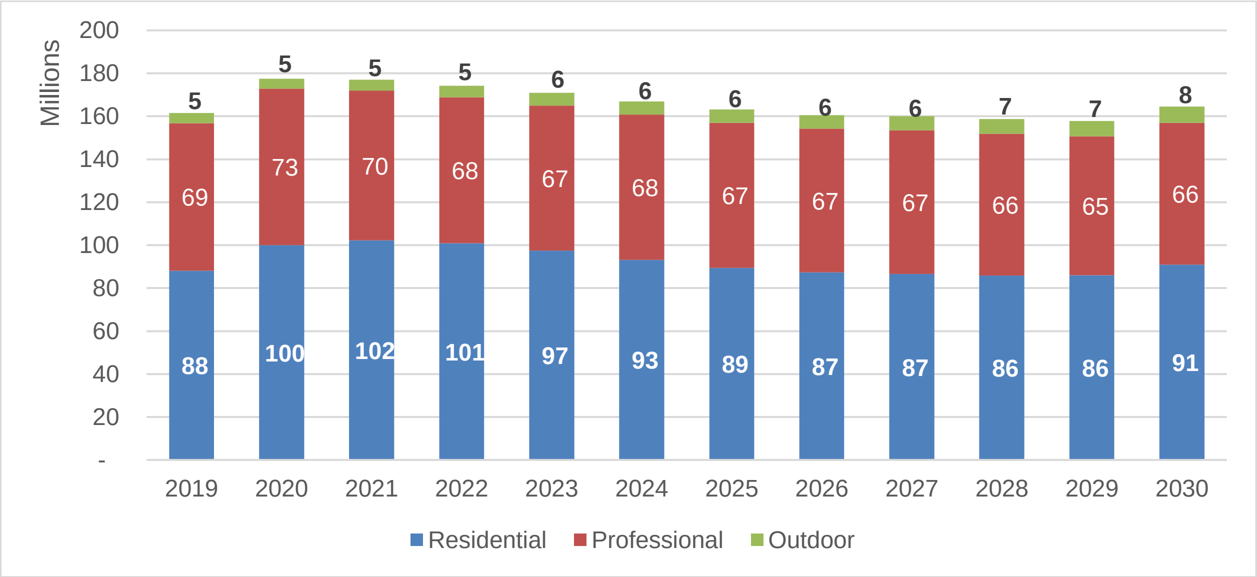



*Figure 17: Shipment forecast by sector*

**Annual Shipments – By Technology**

Since 2013, the lighting market in Indonesia has been increasingly dominated by LED technology. This is attributable to global manufacturers shifting their research and development to LEDs, which have seen efficacy improvements of 7 lm/W/year on average and rapid declines in price, while other technologies have stagnated, as shown in Figure 18 and Figure 19. The historical shipments by technology are shown in Figure 20 and Figure 21. Section 4.2 contains a fuller discussion of the different lighting technologies.

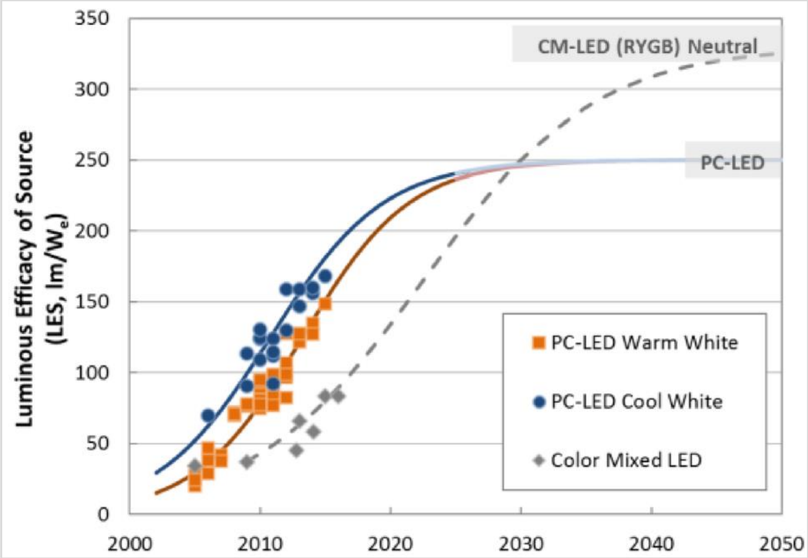



*Figure 18: Efficacies of commercial LED light sources*[43]

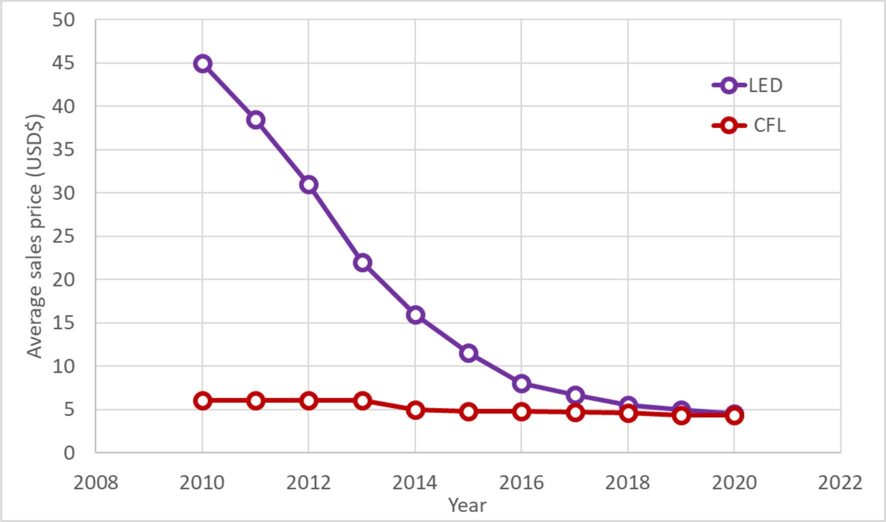



*Figure 19: LED vs. CFL Retail Price for a 60W replacement lamp*[44]

[43] *Solid-State Lighting*, 2017 Suggested, Research Topics, Office of Energy Efficiency and Renewable Energy, US Department of Energy, September 2017. https://www.energy.gov/sites/prod/files/2017/09/f37/ssl_suggested-research-topics_sep2017.pdf Measured at 25°C and 35 A/cm2 current density; PC refers to phosphor-converted blue or violet LEDs, while CM refers to color-mixed red, yellow, green, and blue LEDs, to achieve white light.

[44] Memoori research, 2014. http://www.allledlighting.com/author.asp?section_id=3271. Average global prices; local prices may differ from these averages due to volume of imports, local market conditions, and consumer demand.

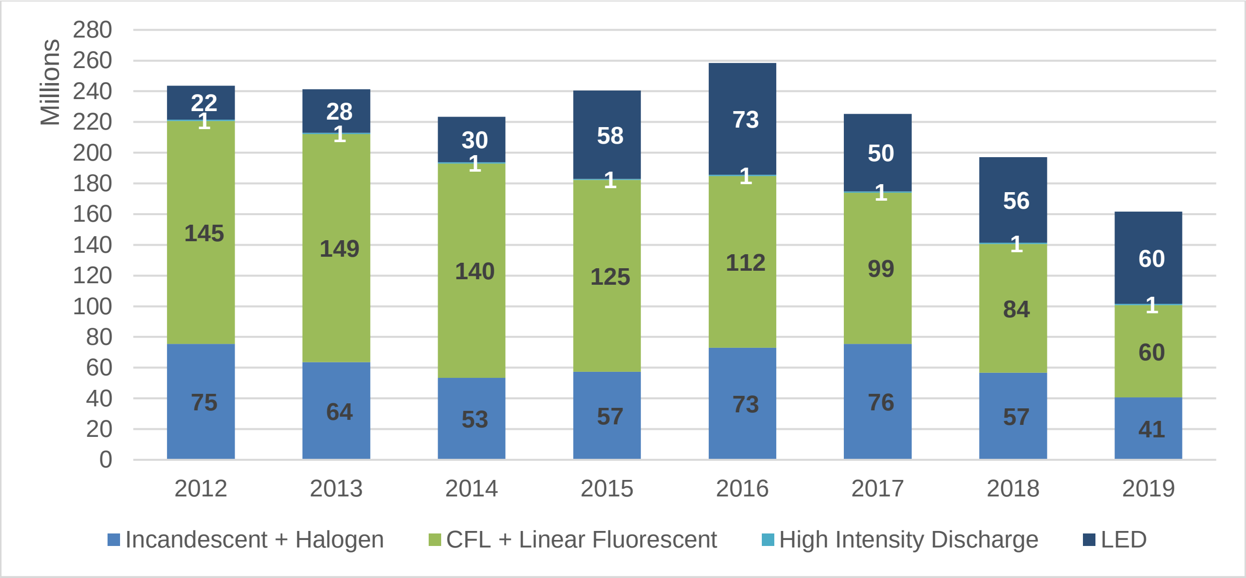



*Figure 20: Total historical shipments by technology*

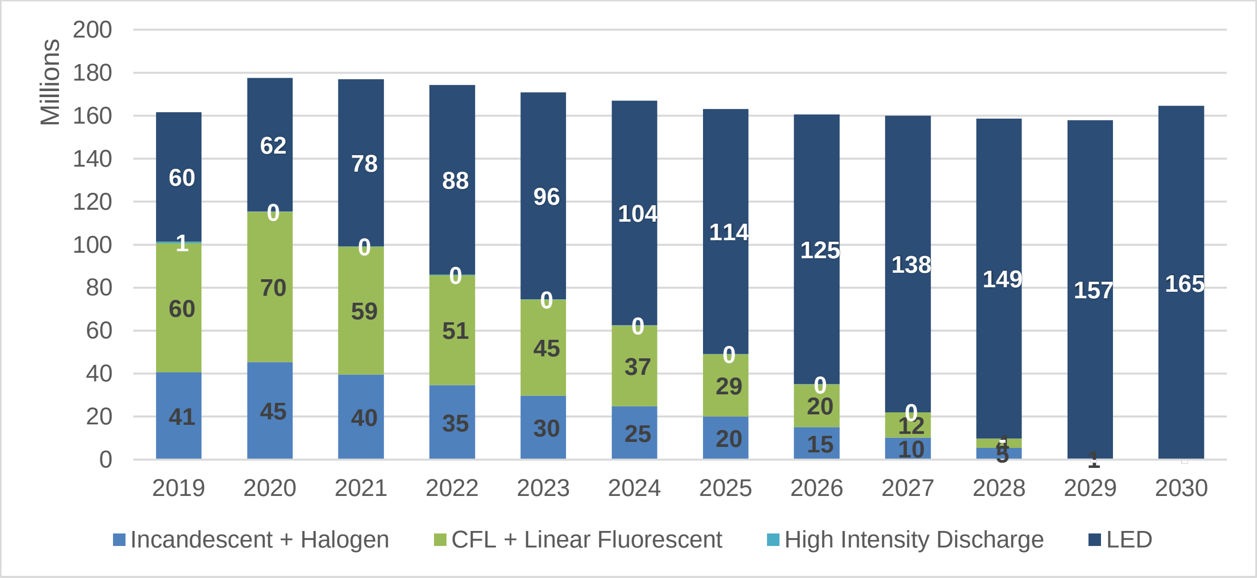



*Figure 21: Total shipments forecast by technology*

Finally, the shipments forecasts by technology are shown for residential lighting in Figure 22, professional lighting in Figure 23, and outdoor lighting in Figure 24.

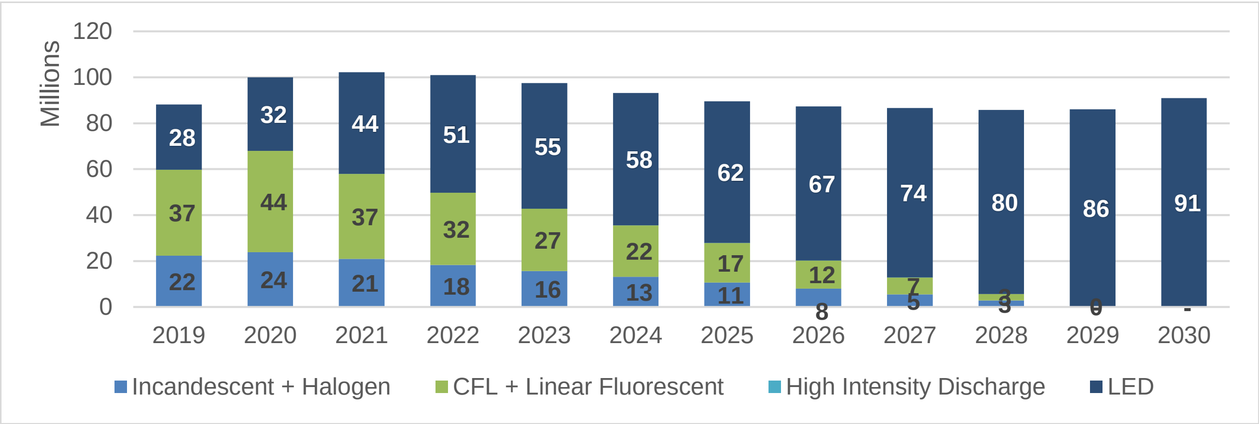



*Figure 22: Residential shipments forecast by technology*

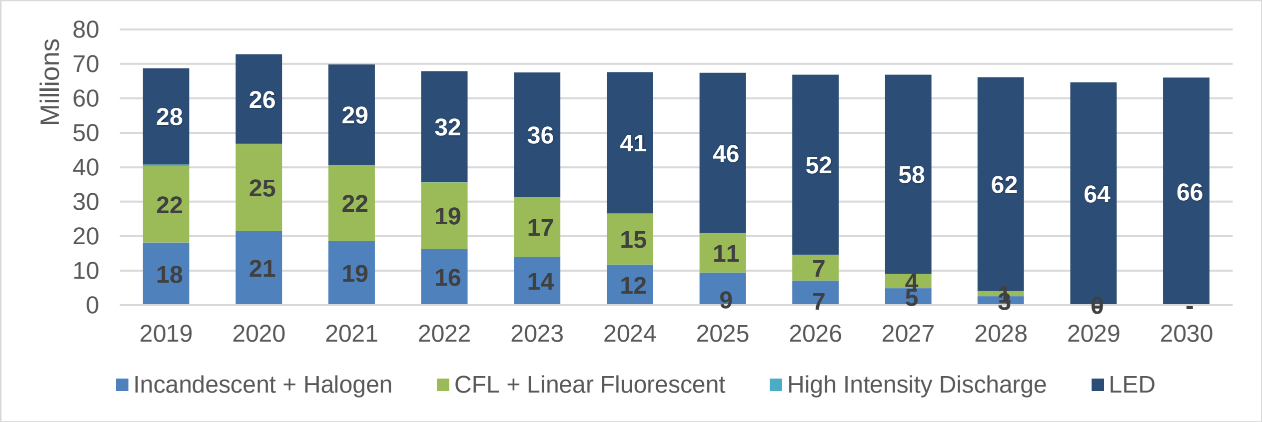



*Figure 23: Professional shipments forecast by technology*

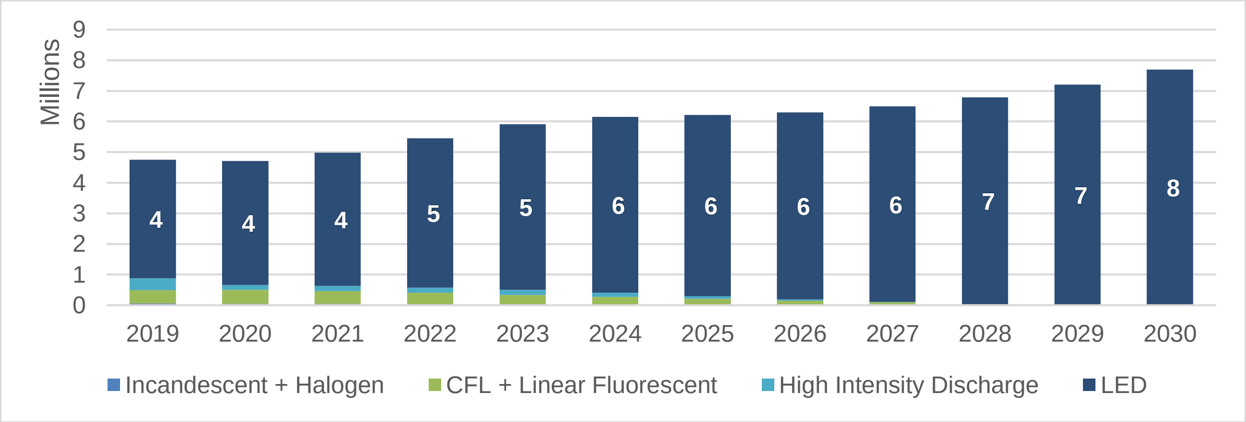



*Figure 24: Outdoor shipments forecast by technology*

### 4.1.3 Stock

Lighting stock is estimated to increase at compounded annual growth rate of 3.5% for residential and 5% for both professional and outdoor, growing from 684 million units in 2019 to 1,035 million units in 2030 on account of increasing population and economic growth. Residential lighting stock percentage in 2019 was estimated to be 334 million units (49% of the total) while professional lighting stock was 324 million (47%) and outdoor lighting was 27 million units or 4%. The stock forecast appears by sector in Figure 25 and by technology in Figure 26.

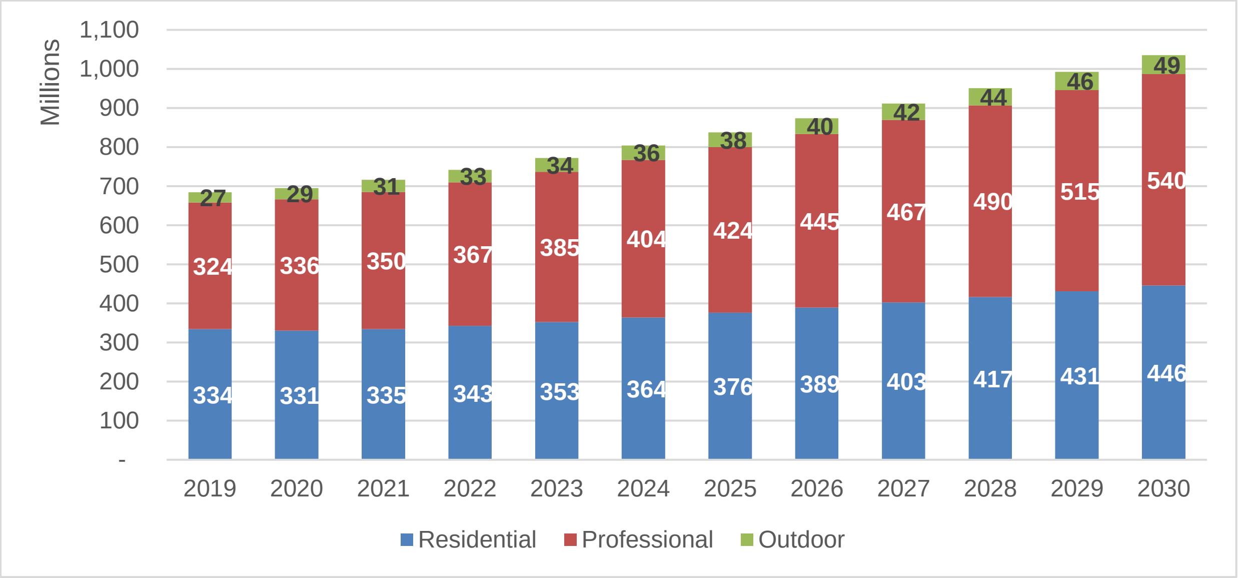



*Figure 25: Lighting stock forecast by sector*

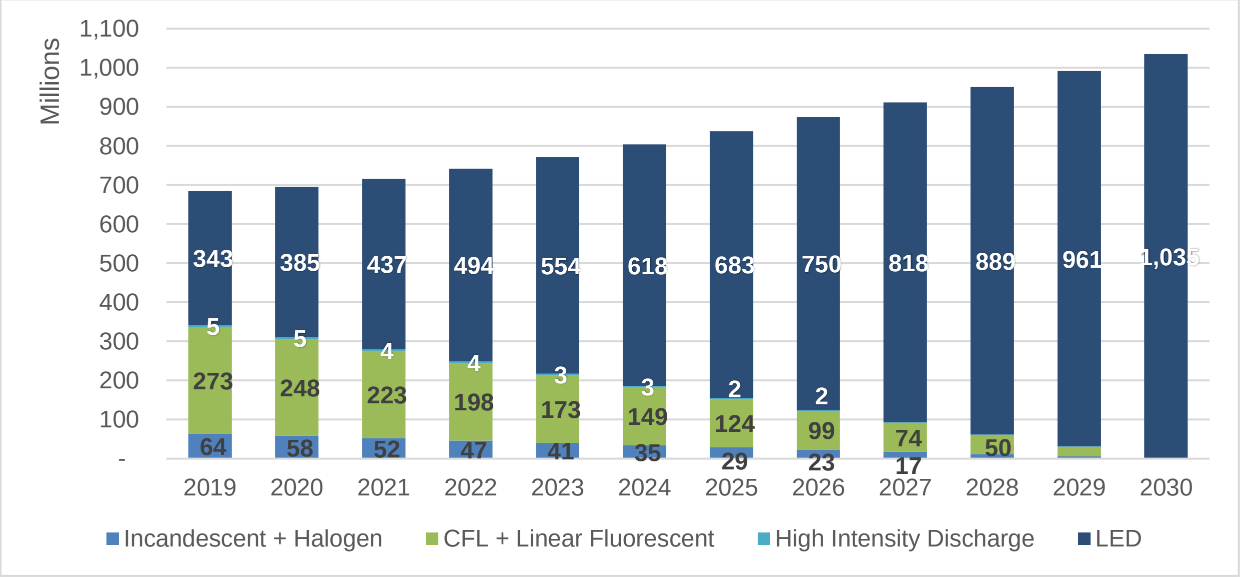



*Figure 26: Total lighting stock forecast by technology*

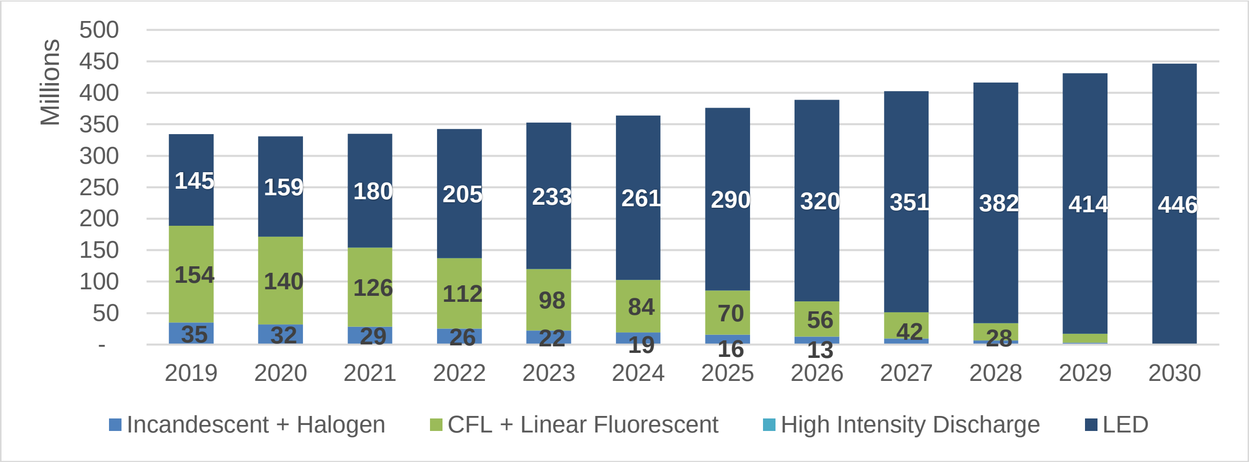



*Figure 27: Residential lighting stock forecast by technology*

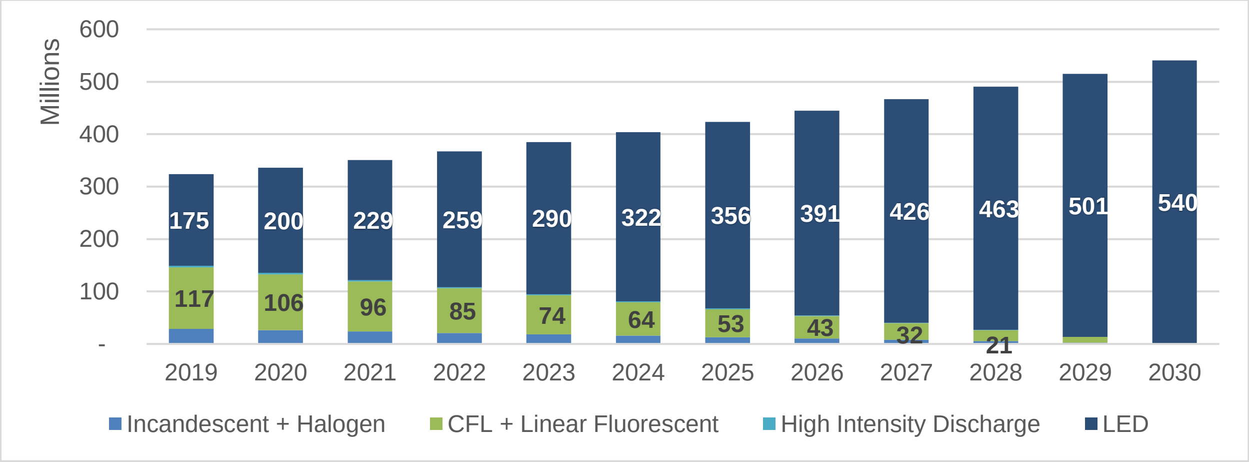



*Figure 28: Professional lighting stock forecast by technology*

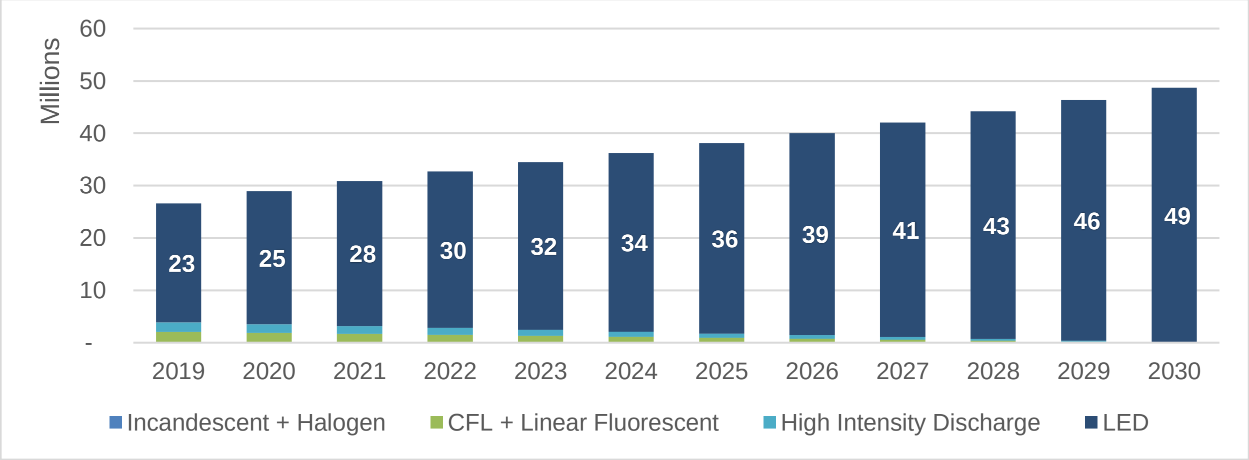



*Figure 29: Outdoor lighting stock forecast by technology*

## 4.2 Lighting Models in the Market

PwC and CLAPS collected lamp data collected through retail and web research and analyzed them by **technology, lifetime**, and **efficacy.** These characteristics and their typical values in the market are described below. The results for each lamp technology and sector were incorporated into the lighting model to estimate energy consumption under a variety of scenarios in subsequent sections of this report.

### 4.2.1. Technology

Indonesia is seeing a rapid transition to energy efficient lighting technology. Incandescent lamps have been disappearing from the market, replaced first by CFL and now LED lamps. During the retailer survey, the team collected data for a total of 765 lamp models. 76% were LED, 24% were CFL, while only 0.4%, or three models, were incandescent. Follow-up research of online retail stores and price lists of specialized lighting stores found additional 39 incandescent lamp models available directly to the consumer. Nonetheless, LEDs dominate the retail as shown in Figure 30 and on the web as shown in Figure 31.

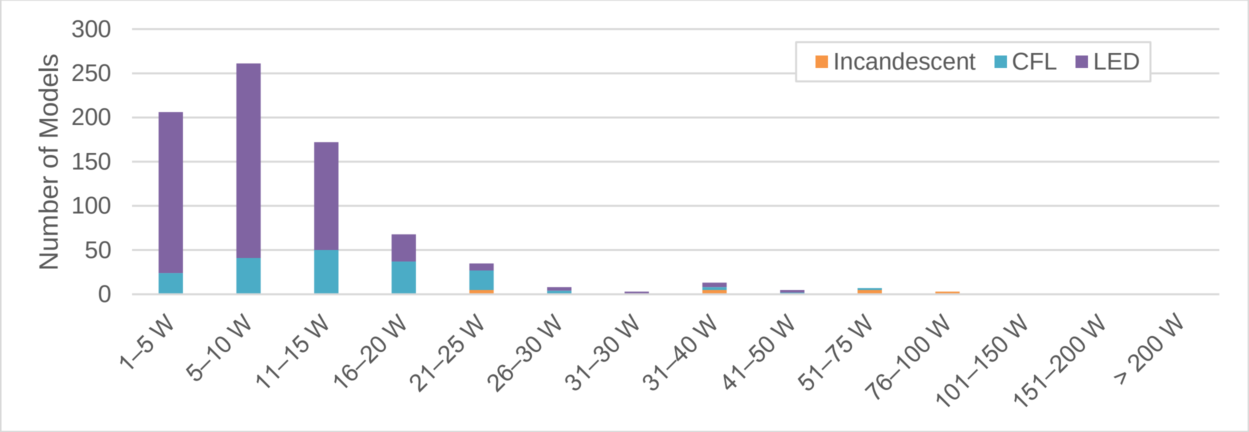



*Figure 30: Distribution of consumer lamp models by technology and wattage in the retail market*

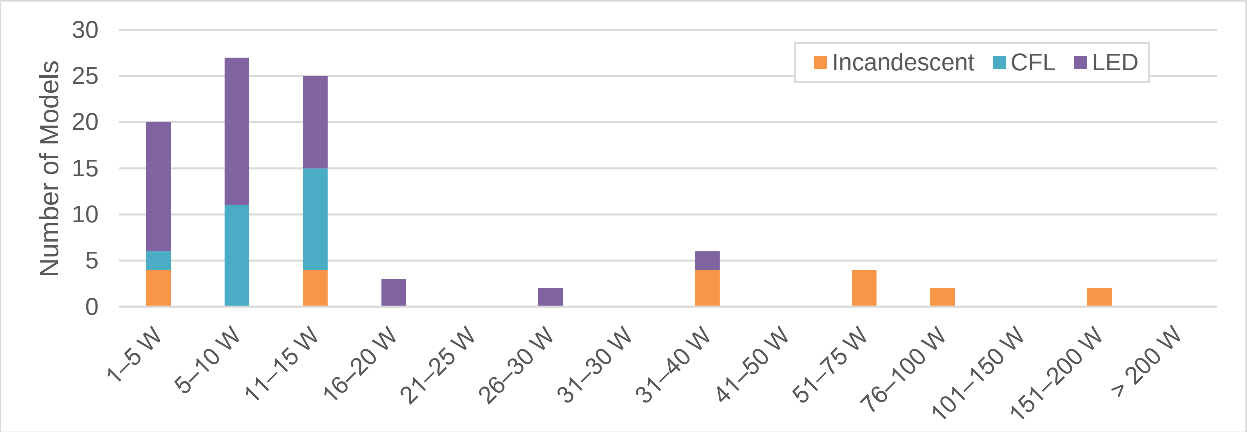



*Figure 31: Distribution of consumer lamp models by technology and wattage on the web*

Despite their limited model count, incandescent lamps do continue to be both produced and imported in large numbers. GAMATRINDO members produced approximately 16 million units in 2018, while BPS reported 1.261 million kg of imports in 2019 (estimated as 16 million units as well, at an average weight of

78 grams per lamp).[45,46] Halogen lamps, a minor improvement on incandescent, constitute another 550 thousand kg of imports (estimated at 7 million at 78 grams per lamp).[47,48]

The total estimated number of incandescent and halogen lamps shipped throughout the country (40 million in 2019) is comparable to that for CFLs (54 million). GAMATRINDO confirms that 50% of incandescent lamps continue to be sold to very price-sensitive residential consumers while the other 50% are for professional applications where heat is required, such as poultry farms and bakery display cabinets.

Under CLASP's usage and lifetime assumptions (Section 4.2.2), this results in a residential stock of 35 million incandescent and halogen units; CLASP's residential end-use survey found approximately 6% of lamps in homes are either incandescent or halogen, based on their wattage and the distribution of models in the market, for a residential stock of 21 million.

A similar transition is occurring in the professional and streetlight sectors, where LEDs are replacing fluorescent and high-intensity discharge (HID) lamps,[49] respectively. Imports of the legacy technologies have been falling, while LED have been on the rise, as shown in Figure 32. Local production is expected to follow a similar trend.

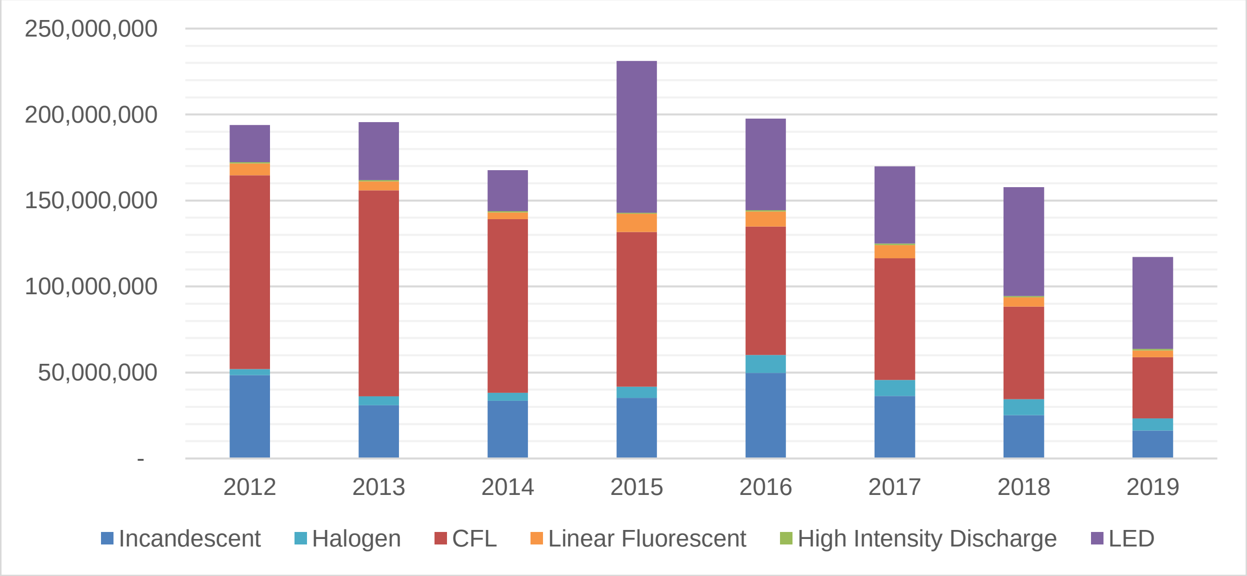



*Figure 32: Imports of lamps into Indonesia, by volume.[50]*

[45] BPS imports for the following HS codes:

- 85392233: Other reflector lamp bulbs,for domestic lighting,power<=200W & voltage>100V
- 85392239: Other reflector lamp bulbs, power<=200W & voltage>100V
- 85392293: Oth filament lamp,excl ultra-violet/infra-red halogen,power<=200W&>100V,for domestic lighting
- 85392299: Oth filament lamp,excl ultra-violet/infra-red halogen,power<=200W&>100V
- 85392930: Oth filament lamp,excl ultra-violet/infra-red, for otherreflector lamp bulbs
- 85392950: Oth filament lamps,exc tungsten halogen,oth have capacity, >200W&<300 and voltage > 100V
- 85392990: Oth filament lamps,exc tungsten halogen,oth have capacity, >300W

[46] 78 g is the average weight of incandescent lamps in the UN Comtrade database for Indonesia 2014-2018.

[47] BPS imports for the following HS codes (there is little domestic production):

- 85392140: Other reflector lamp bulbs of tungsten halogen
- 85392190: Other tungsten halogen

[48] The 78 g incandescent weight was assumed for halogen as no halogen data were reported in UN Comtrade.

[49] HID includes high-pressure sodium (HPS), metal halide (MH), and mercury vapor (MV).

[50] Estimated volume based on BPS weight and the following average lamp weights from UN Comtrade: incandescent and halogen, 78 g; CFL and linear fluorescent, 146 g; HID, 649 g; LED, 184 g.

Figure 33 illustrates all the lighting technologies available on the Indonesian market. Linear fluorescent, HID, or halogen technologies were not available at retailers: they are only available for sale by manufacturers and distributors through the B2B route.

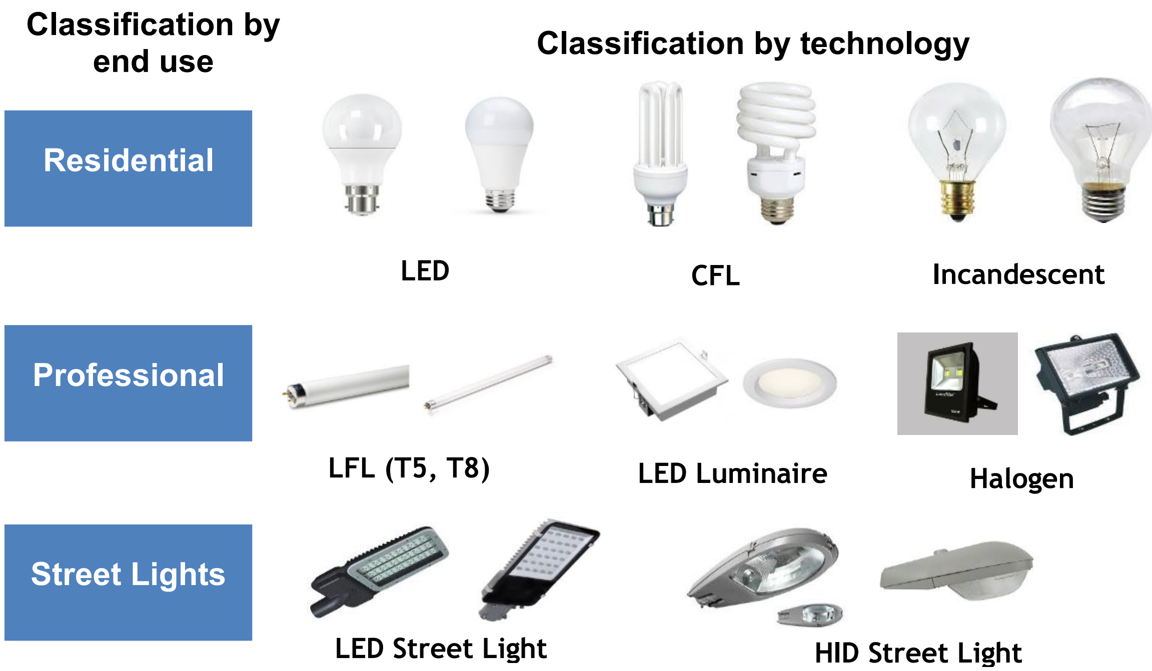



*Figure 33: Six lighting technologies in the Indonesian lighting market*

## 4.2.2. Lifetime

Lifetime information was found through web research for 307 lamps. There exists a high degree of variation in the lifetime values in lighting products across technologies. No testing of the products was performed to validate the data.

Specific to LED, the price increases with lifetime (warranty years offered), such that low- and middle-income households typically choose a lifetime of 8000 to 10,000 hours.[51] In case of CFLs, the lifetime in typical products was found to be between 2000 and 6000 hours as reported by GAMATRINDO. These lifetimes would lead to an LED being replaced in 5 years and a CFL in 3 years (based on 5-hour daily operation of lamps).[52]

In the professional sector, the lifetime varies between 15,000 and 50,000 hours. In case of LED for street lighting, lifetime varies between 25,000 and 50,000 hours. The range of lifetimes is shown in Table 9.

*Table 9. Typical useful lifetime range for lighting products[53]*

| Lighting Types | Min Lifetime (hrs.) | Max Lifetime (hrs.) | Sector |
|---|---|---|---|
| **CFL** | 2,000 | 15,000 | Residential |
| **LED** | 8,000 | 50,000 | Residential |
| **HPS (HID)** | 18,000 | 24,000 | Street |
| **LED** | 25,000 | 50,000 | Street |

[51] Per interviews with lighting experts from the industry
[52] As per inputs received from GAMATRINDO
[53] Website research of lighting products and manufacturers present in Indonesia

| Lighting Types | Min Lifetime (hrs.) | Max Lifetime (hrs.) | Sector |
|---|---|---|---|
| **LED** | 15,000 | 50,000 | Professional |
| **Fluorescent** | 8,000 | 25,000 | Professional |
| **Halogen** | 2,000 | 2,000 | Professional |
| **HID** | 2,100 | 32,000 | Professional |
| **Incandescent** | 1,000 | 2,000 | Professional, Residential |
| **Induction** | 80,000 | 80,000 | Street, Outdoor |

### 4.2.3. Residential

**Luminance**

As mentioned above, the retail market is dominated by LED and CFL models for residential use. These lamps were found to have a typical luminous flux output of 400 to 1200 lumens: 70% of LED lamps and 75% of CFL lamps found on the web and in retail had luminous flux in this range.

**Efficacy**

The performance of a lamp or a luminaire is defined by its efficacy is defined as the ratio of luminous flux to power, measured in lumens per watt. The efficacies for LED and CFL lamps found on the web and in retail can be seen Figure 34 across the luminance range.

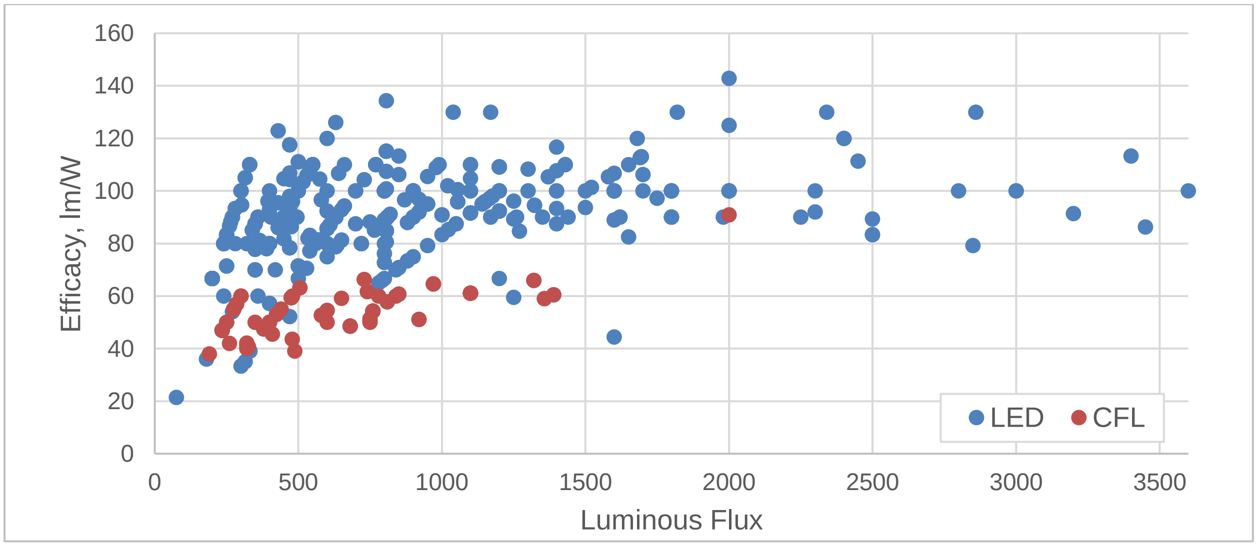



*Figure 34: Distribution of LED and CFL efficacy and luminous flux in residential lighting (web and retail)*

For the most common lamps between 700 and 900 lumens, LED lamps were found to be **60 %** more energy efficient than CFL lamps, while their average price was **40 %** higher.[54] These and other common characteristics are shown in Table 10, below.

[54] Validated by GAMATRINDO

*Table 10. Typical lamp comparison in residential lighting (LED and CFL, web and retail)*

| Characteristic | LED | CFL |
|---|---|---|
| **Typical lumen range** | 700 to 900 lumens | 700 to 900 lumens |
| **Min. Wattage** | 6 W | 18 W |
| **Max. Wattage** | 11 W | 15 W |
| **Avg. Wattage** | 8.7 W | 13.5 W |
| **Min. Efficacy** | 30 lm/W | 50 lm/W |
| **Max. Efficacy** | 134 lm/W | 66 lm/W |
| **Avg. Efficacy** | 89 lm/W | 58 lm/W |
| **Avg. Price in IDR**[55] | 79,219 IDR | 56,224 IDR |

**Efficacy Distribution in LED lamps (n = 712 models)**

As illustrated in Figure 35**, 53%** of LED lamps in the market have efficacy in the range of 80 and 100 lumens/Watt, while **21 %** of LED lamps have efficacy lower than 80 lm/W.

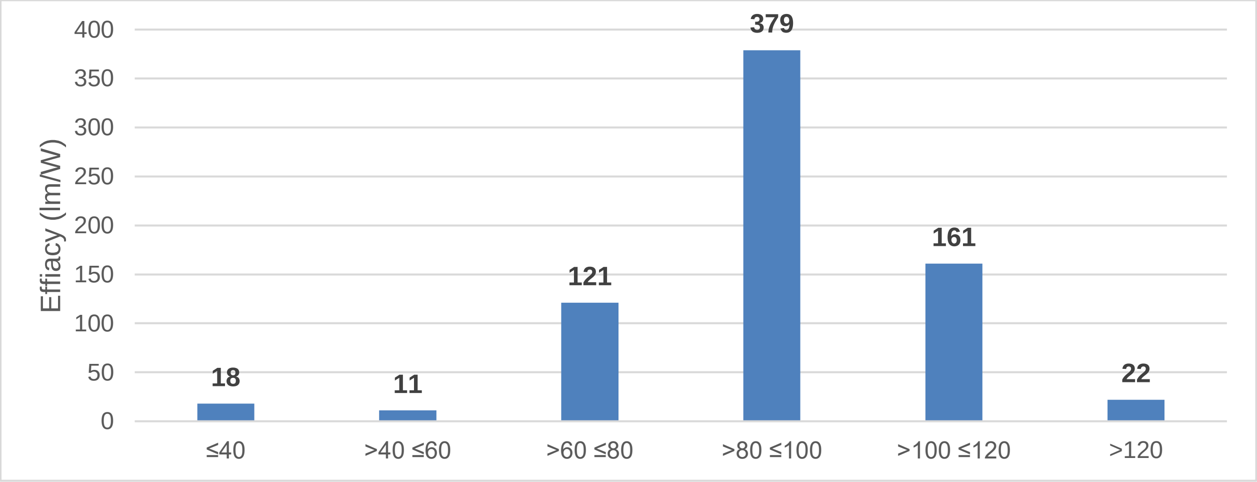



*Figure 35: LED model distribution by efficacy in lm/W (Residential)*

[55] Exchange rate consideration (1 USD = 13949.14 IDR)

**Efficacy Distribution in CFL lamps (n = 206 models)**

The performance distribution of CFLs is shown in Figure 36. These lamps are currently regulated in Indonesia, with labeling but no MEPS required. As can be seen, roughly half have efficacy greater than 57 lm/W.

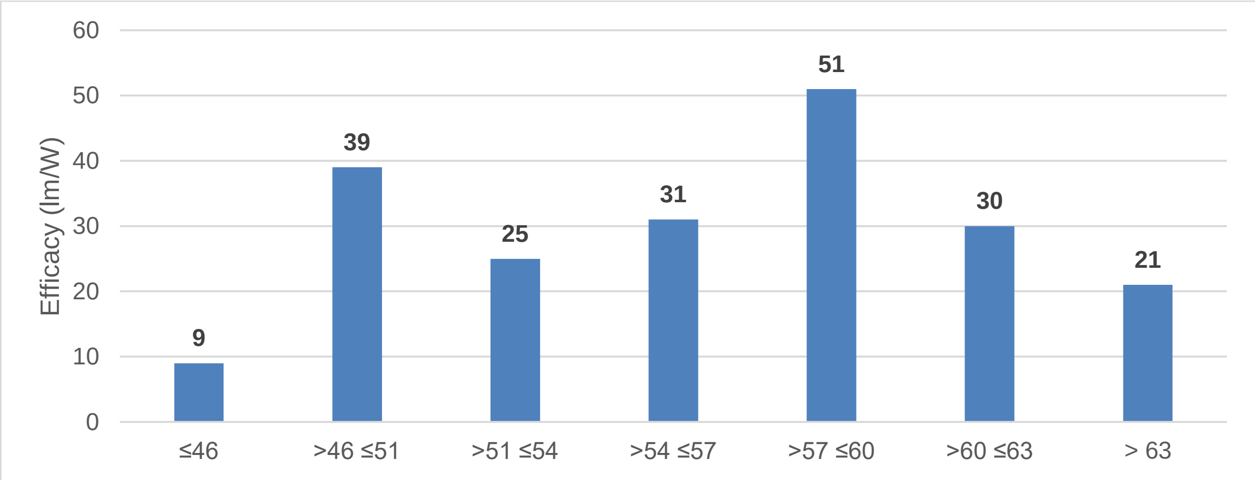



*Figure 36: CFL model distribution by efficacy (Residential)*

## 4.2.4. Professional

As no professional lamps were available in retail stores, PwC collected their specifications through research of manufacturer web sites across 28 brands. Table 11 shows their typical characteristics. As these were manufacturers' product specifications, they did not include price data. The predominant luminous flux for indoor professional lighting is 2,000 lumens,

*Table 11. Typical specifications for professional lamps*

| Professional (commercial and industrial use) | | | | |
|---|---|---|---|---|
| Technologies | Wattage | Lumens | Efficacy | Avg Life (hrs) |
| Halogen | 60 | 840 | 14 | 2,000 |
| Incandescent | 80 | 655 | 8 | 2,000 |
| Fluorescent T5 | 28 | 2700 | 96.4 | 20,000 |
| Fluorescent T8 | 30 | 1825 | 60.8 | 20,000 |
| Fluorescent T12 | 40 | 2500 | 62.5 | 20,000 |
| LED linear | 24 | 2000 | 83 | 50,000 |
| HID (outdoor) | 80 | 6200 | 78 | 24,000 |

**Efficacy Distribution in Professional Lighting (Lamps and luminaires, n = 244)**

The majority of professional models identified were LED with the rest were distributed across the technologies – CFL, fluorescent, halogen, incandescent, induction,[56] metal halide, and other HID. Figure 37 shows their efficacies versus luminous flux.

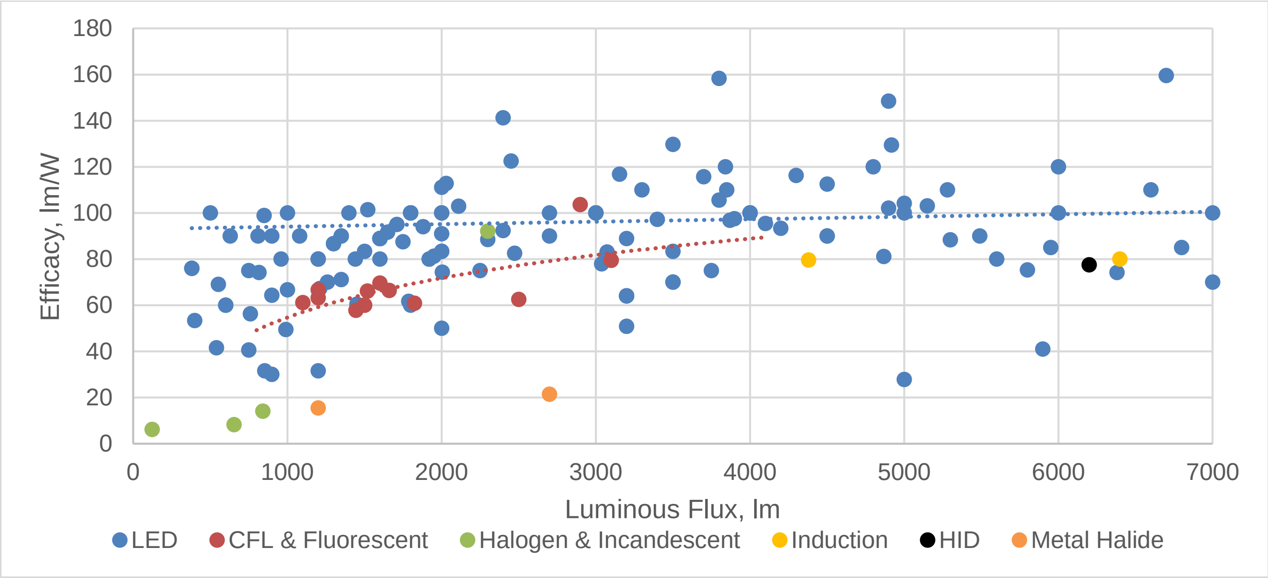



*Figure 37: Professional lighting efficacy*

## 4.2.5. Public Street Lighting

Manufacturers confirmed in interviews that new street lighting has transitioned almost entirely to LED technology. Nonetheless, HID lamps continue to be imported with over 540 thousand estimated imported in 2019. These are reportedly intended for repair of existing streetlamps. The drive toward efficiency started in the year 2014 in selected cities of Indonesia. Details are presented in Appendix H.

PwC collected 113 street lighting specifications from the LKPP (National Public Procurement Agency) E-CATALOG for the month of May 2019 and validated them with the procurement departments for street lighting for Jakarta province and cities of Bogor, Surabaya, and Bandung.

**100 %** of the 113 sample models considered from the LKPP data had efficacy levels higher than 95 lm/W. The typical luminous flux was 6000 lumens. Table 12 summarizes the range of typical characteristics, while Figure 38 through Figure 40 present more detailed analysis.

*Table 12. Typical LED streetlight characteristics*

| Typical Characteristic | LED Street |
|---|---|
| **Typical Wattage Range** | 30 to 120 W (72 % i.e. 82 models) |
| **Typical Lumens Output Range** | 3300 to 12000 lumens |

[56] A fluorescent technology in which the gas is excited through electromagnetic induction outside the tube. There are no electrodes, resulting in much longer lifetimes.

| Typical Characteristic | LED Street |
|---|---|
| **Typical Efficacy** | 100 to 130 lm/W |
| **Typical Price for 30 W LED** | 3,000,000 IDR[57] |

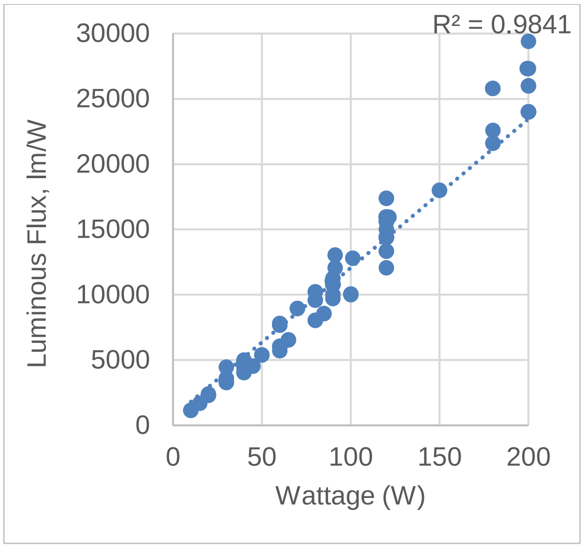



*Figure 38: Streetlight luminance versus wattage range (n = 113 models)*

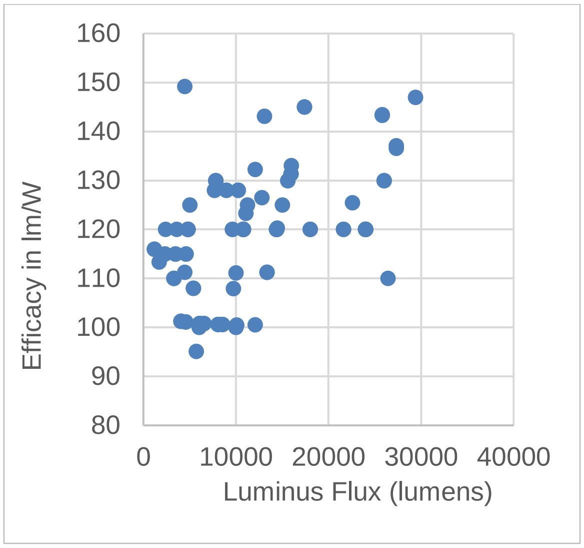



*Figure 39: Streetlight efficacy*

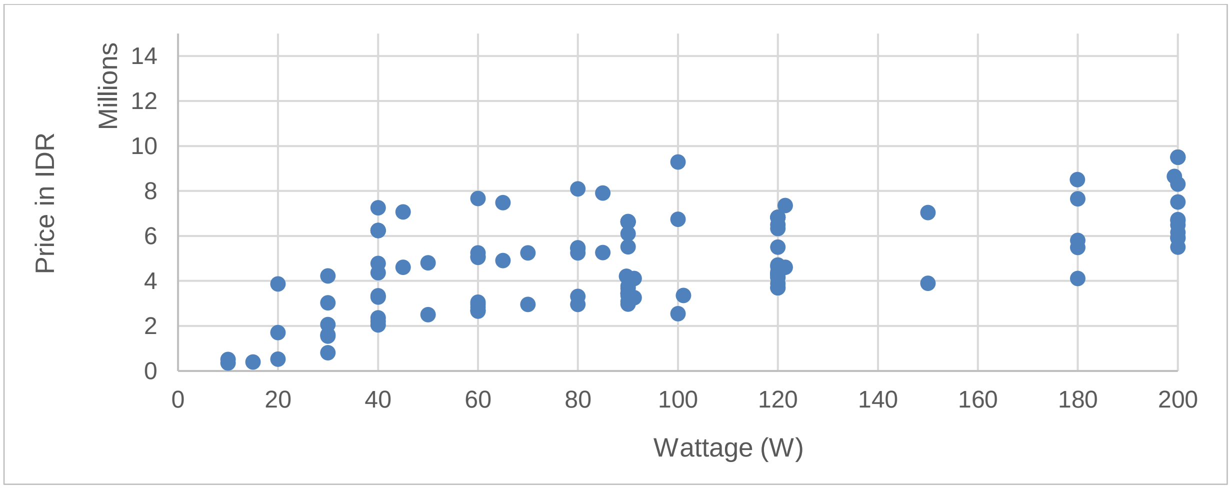



*Figure 40: LED streetlight price range versus wattage*

[57] Price for 30 W LED street varies between IDR 805,000 to 4,222,280 IDR

In addition to general requirements on efficacy, wattage, and luminous flux, procurement departments provide further technical specification requirements for streetlights. For example, the specifications used by the city government of Bandung are presented in Table 13; these are considered typical across the country.

*Table 13. Typical procurement requirements for LED streetlights by Bandung municipality*

| Specification | Requirement | Notes |
|---|---|---|
| **Luminaire Housing Material Requirements** | Aluminum (processed through pressure full die cast) | Protection of housing from corrosion from heavy rains and humidity; better heat dissipation |
| **Minimum Ingress Protection Requirement** | IP 65 | Protection of inside of luminaire from dust and rain |
| **Connected Power (tolerance)** | 70 Watt ± 5% | Ensure that connected power is within maximum allowable limits |
| **Minimum Lifetime** | 50,000 hrs. | Ensures durability |
| **Input Voltage and Frequency Rate** | 220V ± 10% or 198-242 V/ (50/60 Hz) | General requirements |
| **Color Temperature** | 4000 ± 200 K | General requirements |
| **Minimum Lumen Efficacy** | 100 lm/W | Efficacy requirement |
| **Minimum Lumen Output** | 7,000 Lumens | Resultant luminous flux given power and efficacy |
| **Power Factor** | > 0.9 | General requirements |
| **LED Driver (Surge Protection Minimum Requirement)** | 10KV | General requirements |
| **Minimum Impact Protection** | IK Min 08 | General requirements |

# Policy Options and Impact Assessment

# 5 Review of Current and Draft Regulation

## 5.1 Current CFL MEPS and Comparative Labeling Regulation

Ministry of Energy and Mineral Resources (MEMR/KESDM) in Indonesia mandated the 'Energy Efficiency Label' for CFL in June 18, 2015. This policy is regulated through the MEMR Regulation No. 18, 2014, and was signed in June 2014. This Regulation replaces previous MEMR regulation No. 06 of 2011.

The label specifies minimum requirements for performance of CFLs sold in Indonesia, but not efficacy. The regulation requires an energy efficiency label on the packaging disclosing the star level ranging between 1 and 4, with 4 stars indicating highest efficacy. Finally, the regulation requires registration of products with MEMR and third-party testing. (LED requirements are under development.)

The performance testing standard followed for CFL labelling is the SNI IEC 60969. It is mandatory to comply with safety standard of SNI 04-5504-2001 and its revisions. The labelling requirement are presented in Table 14 and Table 15, below.

*Table 14. CFL MEPS Minimum Requirements*

| Compliance Criteria Requirements | Minimum Requirements |
|---|---|
| **Measured Power** | Range to be between +5% and - 10% |
| **Maximum Total Harmonic** | 5% |
| **Lumen maintenance factor (after 2000 hrs. operation)** | Lumen output ≥ 80% of claimed value |
| **Minimum lifetime** | 6000 hrs |

*Table 15. Star-rating values for CFL products*

| Power (Watt) | Efficacy Value (lm/W) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2700 K to 4400 K | | | | 4400 K to 6500 K | | | |
| | 1 Star | 2 Star | 3 Star | 4 Star | 1 Star | 2 Star | 3 Star | 4 Star |
| **≤ 8** | <34 | ≥34 | ≥44 | ≥54 | <32 | ≥32 | ≥42 | ≥51 |
| **> 8 - 15** | <38 | ≥38 | ≥48 | ≥58 | <37 | ≥37 | ≥46 | ≥55 |
| **> 15 - 25** | <42 | ≥42 | ≥52 | ≥62 | <41 | ≥41 | ≥50 | ≥59 |
| **> 25 - 60** | <46 | ≥46 | ≥56 | ≥66 | <45 | ≥45 | ≥54 | ≥63 |

| | |
|---|---|
| Program scope & technical specifications | MEPS for Lamps |
| Existing status | Labeling for CFL Lamps in Effect and under Revision;<br>MEPS for CFL Lamps under Development<br>MEPS and Labeling for LED Lamps under Development |
| Reference with Government regulation | Regulation of the Minister of Energy and Mineral Resources Number 18 Year 2014 on the Energy Efficient Labelling of Self-ballasted Lamps |
| Implementing body | EBTKE |
| Referenced test standard | SNI IEC 60969:2009 |
| Parameters graded | Efficacy value (lumen/watt) |

| | |
|---|---|
| Key definitions | Self-ballasted lamps, domestic producers, importers, labelling permit, supplier's declaration of conformity (SDoC), conformity evaluating agencies |
| Calculation for efficiency limits for Label | Lumen per watt |
| Label band | 4 bands (see Table 15 on the previous page) |
| Label criteria for Signs EE label | SNI 04-6958-2003 |
| Key stakeholders that have been part of developing the draft MEPS | MEMR, industry players, associations |
| Competent authority | EBTKE<br><br>Manufacturers or importers, before affixing Energy Efficient Label on the lighting package, must obtain permission from the Director General |
| Documents required to be submitted for seeking permission for Labeling | Manufacturers of domestic self-ballasted lighting or importers must apply to the Director General by enclosing the following documents:<br><br>a) SDoC;<br><br>b) Photocopies of a certificate for using Indonesian National Standard Label Product 04-6504-2001 or its amendments;<br><br>c) Photocopies of a test result report of the sampled products in accordance with SNI rules published by a conformity evaluating agency;<br><br>d) Photocopy of the certificate of quality management system ISO 9001: 2008 or its amendments that is published by a quality management system certification agency and accredited by the National Accreditation Committee or an accreditation body of another country which has established a mutual recognition arrangement with the National Accreditation Committee in quality management system certification;<br><br>e) Photo of the self-ballasted lamp products;<br><br>Guidance on reading the self-ballasted lamp production code. |
| Additional documents required to be submitted by the Importers | N/A |
| Process | The Director General's office is the verifying authority for the applications of energy efficient labeling submitted by manufacturers and/or importers of self-ballasted lamps.<br><br>Based on the results of verification of application, the Director General may approve or reject the license for application of Energy Efficient Labeling. |

| | |
|---|---|
| | The process is generally to be done in 7 (seven) working days from the receipt of complete applications.<br>In case the application is approved, the Director General gives permission for Energy Efficient Labeling.<br>The information on labeling permission is also provided to Customs for keeping a check on products at the time of import.<br>In case of rejection, the Director General shall notify in writing to the applicant accompanied by reasons for refusal.<br>The application must be conducted for each import. |
| Labeling period validity | Not mentioned in the Regulation |
| Reporting requirements | Not mentioned in the Regulation |

## 5.2 Draft MEPS and Comparative Labeling Regulation

Draft regulations currently under development by EBKTE include the revised requirements shown in Table 16 and Table 17, which include both labeling tiers as well as MEPS (the lowest tier has a greater-than-or-equal-to symbol). The scope of these draft requirements is only CFL lamps.

*Table 16. Draft star-rating values for CFL products (Correlated color temperature < 4400 K)*

| Power (Watt) | Efficacy Value (lm/W) | | | |
|---|---|---|---|---|
| | 1 Star | 2 Star | 3 Star | 4 Star |
| **≤ 8** | ≥32 | ≥34 | ≥44 | ≥59 |
| **> 8 - 15** | ≥36 | ≥38 | ≥48 | ≥64 |
| **> 15 - 25** | ≥39 | ≥42 | ≥52 | ≥68 |
| **> 25 - 60** | ≥43 | ≥46 | ≥56 | ≥76 |

*Table 17. Draft star-rating values for CFL products (Correlated color temperature ≥ 4400 K)*

| Power (Watt) | Efficacy Value (lm/W) | | | |
|---|---|---|---|---|
| | 1 Star | 2 Star | 3 Star | 4 Star |
| **≤ 8** | ≥31 | ≥33 | ≥42 | ≥57 |
| **> 8 - 15** | ≥35 | ≥37 | ≥46 | ≥62 |
| **> 15 - 25** | ≥38 | ≥41 | ≥50 | ≥65 |
| **> 25 - 60** | ≥42 | ≥45 | ≥54 | ≥68 |

EBTKE has also tentatively formulated the following requirements for LED lighting products, in Table 18.

*Table 18. Draft star-rating values for LED products*

| Power (Watt) | Efficacy Value (lm/W) | | | |
|---|---|---|---|---|
| | 1 Star | 2 Star | 3 Star | 4 Star |
| **≤ 8** | 45 – 49 | > 49 – 52 | > 52 – 55 | > 55 |
| **> 8 - 15** | 46 – 51 | > 51 – 54 | > 54 – 57 | > 57 |
| **> 15 - 25** | 47 – 53 | > 53 – 56 | > 56 – 59 | > 59 |
| **> 25 - 60** | 48 – 55 | > 55 – 58 | > 58 – 61 | > 61 |

## 5.3 Comparison with Other ASEAN Countries

Since 2015, ASEAN countries have been working to align lighting regulations through the ASEAN SHINE initiative to enhance regional trade and reduce electricity consumption and greenhouse gas emissions.[58] After studying the market and existing policies, the group developed a Regional Policy Roadmap, which contributes to the regional goal of reducing energy intensity by 20% by 2020 and 30% by 2025, relative to 2005.[59]

In addition to harmonized testing (summarized in Section 6.2), countries have agreed to MEPS of 80 lm/W by 2023. The standards are technology-specific and exclude some common lamp types, such as CFLs.

*Table 19. Compilation of lighting policies in ASEAN countries*

| Lamp Type | Features within scope of another standard | Lumen range | Wattage | Cap Types | Length (mm) |
|---|---|---|---|---|---|
| Non-directional LED Bulb | Included within scope of IEC 62612<br>• Rated power up to 60 W;<br>• Rated voltage of > 50 Vac up to 250 Vac;<br>• a lamp cap as listed in IEC 62560 | ≥ 130 lm | ≤ 60 W | E14, E27, B15, B22d | |
| Linear LED | | | | | 550 -1300 |
| Linear Fluorescent | Included within scope of IEC 60081 | | | | 550 -1300 |

Figure 41 shows the ASEAN proposed requirements against LED bulb test results from various ASEAN countries. The tests were conducted in 2017 according to CIE S025. 69% of LED lamps on the market could meet the proposed requirements.[60]

[58] Jean-Marc Alexandre, "ASEAN SHINE Lighting: LWG recommendations - Regional Policy Roadmap and follow-up" Slide presentation, 19-20 April 2018, pp. 2-3.
[59] ASEAN SHINE, "Harmonization of Energy Performance Standards for Lighting: A Regional Policy Roadmap," https://www.aseanshine.org/download/get/bf8229696f7a3bb4700cfddef19fa23f
[60] Jean-Mark Alexandre, pp. 14-17.

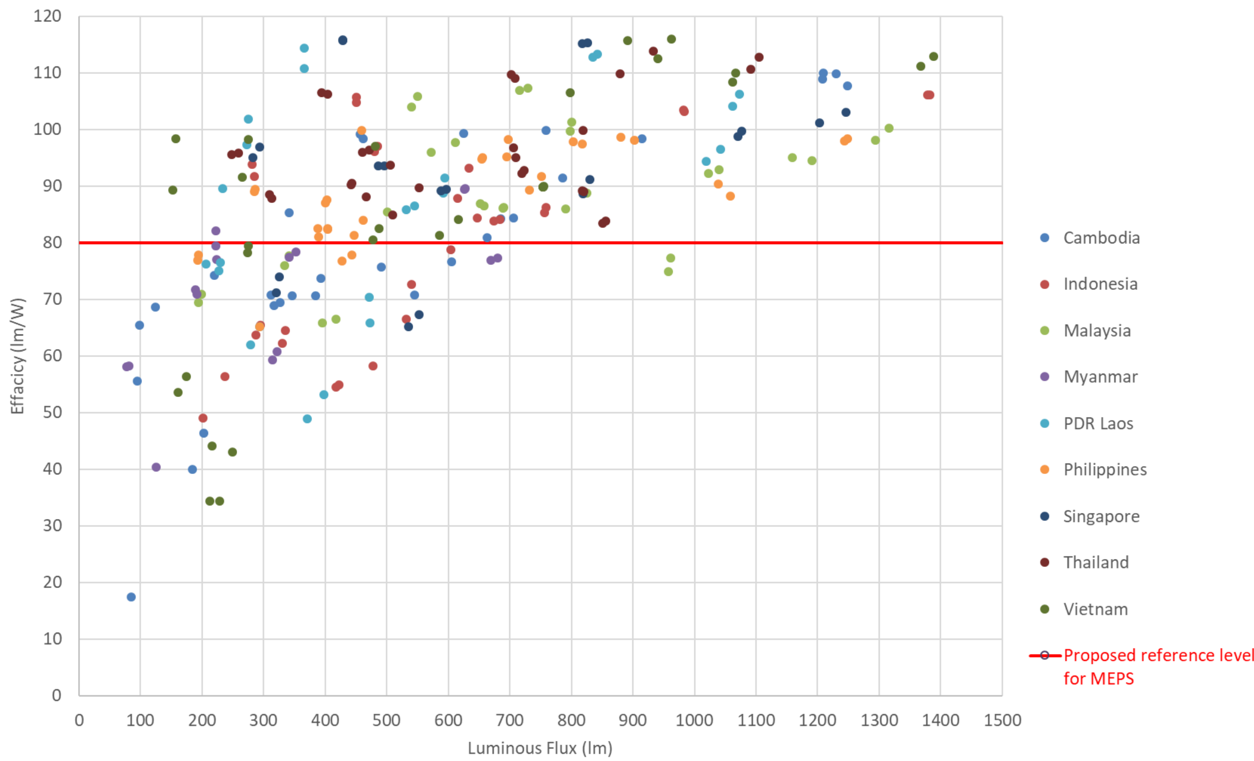



*Figure 41: Efficacy of LED lamps from ASEAN benchmark testing in 2017 for LED A-shape lamps*

Several countries in ASEAN already have lighting policies in force, including MEPS. These are summarized in the Table 20. Further details for each country are provided in the individual subsections.

*Table 20. Status of lighting MEPS in ASEAN and their adoption year for the most common lamp types (850 lm/W for residential and 2000 lm/W for commercial, resulting in roughly 15 W residential CFL, 10 W residential LED bulb, and 30 W LFL).*

| Country | Year Adopted | Typical CFL MEPS (lm/W) | Typical LED MEPS (lm/W) | Typical LFL MEPS (lm/W) | Technology Neutral? |
|---|---|---|---|---|---|
| **Philippines** | 2007 | 60 | None | 70 | No |
| **Malaysia** | 2014 | 60 | 55 | 70-80 | No |
| **Singapore** | 2015 | 54 | 54 | None | Yes |

Compilations of the enforced levels for CFLs, LEDs, and LFLs in Southeast Asia are provided in the subsequent figures, namely Figure 42, Figure 43, and Figure 44 respectively. Plotted in dots are the distribution of models identified through this market study in Indonesian web and retail stores for CFLs and LEDs. The majority of both CFL and LED products sold in the market would be considered compliant in nearly all neighboring countries. Indonesia must seize the opportunity to increase the applicable MEPS levels to achieve the targeted ASEAN harmonization and to further advance energy efficiency for lighting as practiced by the neighboring ASEAN countries over the past decades.

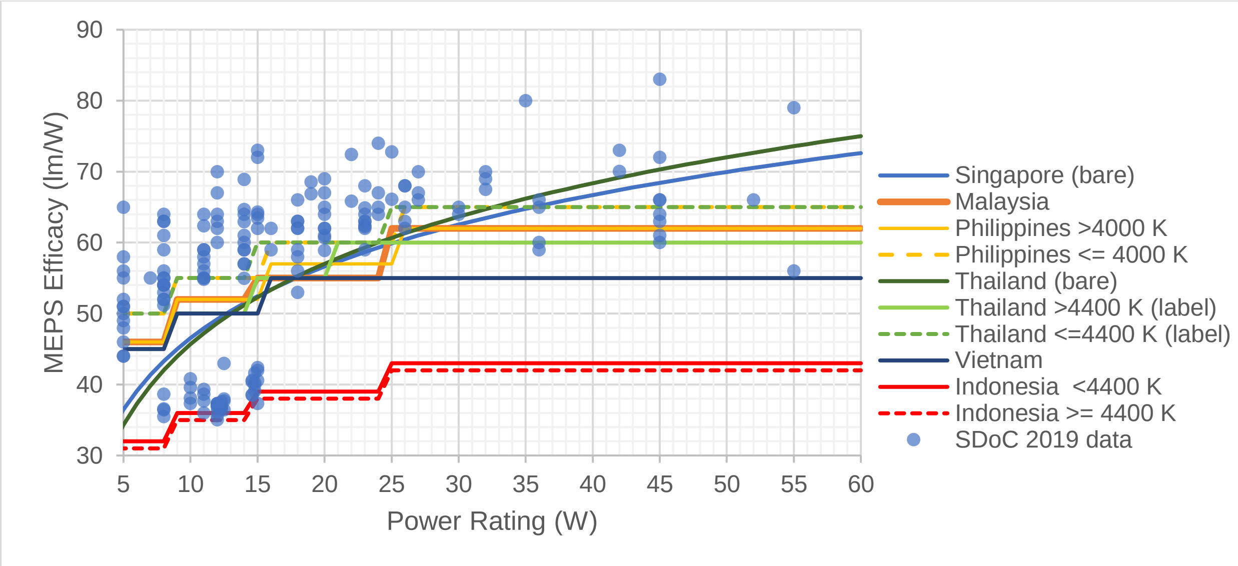



*Figure 42: Compilation of CFL MEPS in ASEAN countries, against the distribution of CFL market performance as reported to EBTKE*

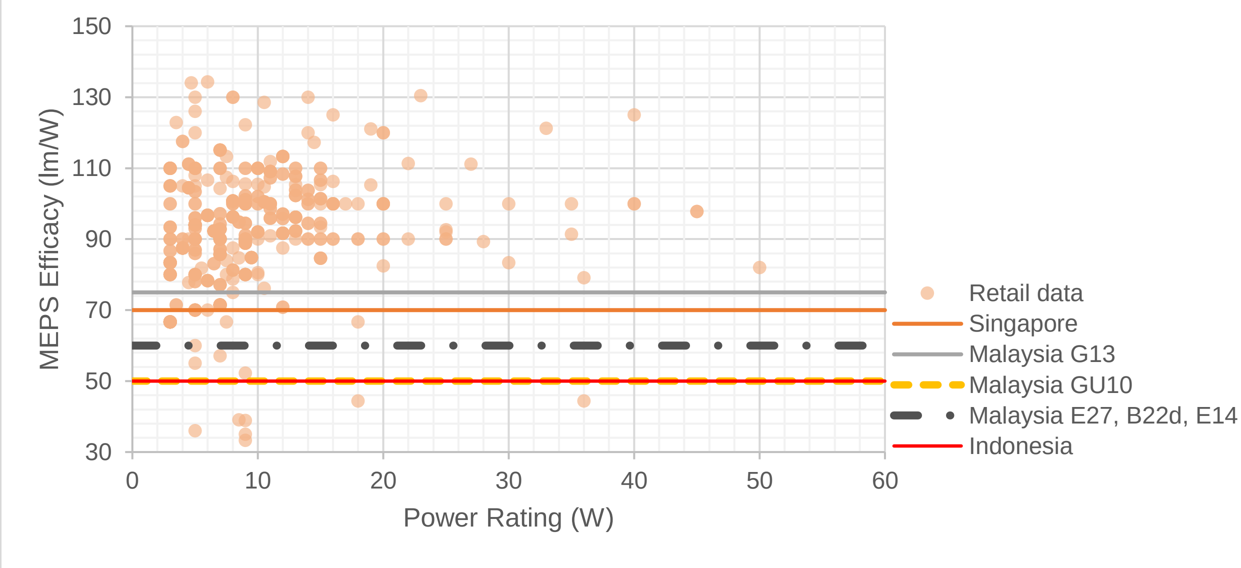



*Figure 43: Compilation of LED MEPS in ASEAN countries, against the distribution of LED market performance identified in Indonesian web and retail stores*

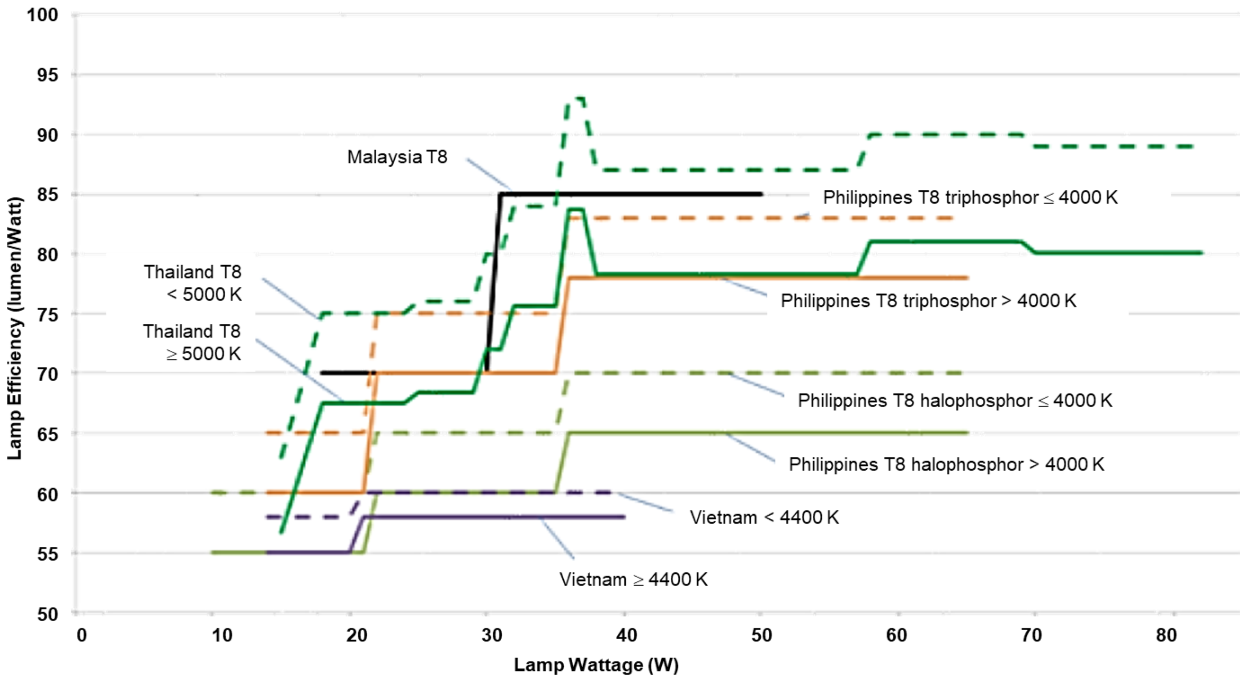



*Figure 44: Compilation of LFL MEPS in ASEAN countries[61]*

### 5.3.1 Malaysia

Malaysia's lighting MEPS were developed in 2014 and are specified in Malaysian Standard MS 2598:2014[62]. The regulation covers T5 and T8 double capped fluorescent lamps, self-ballasted single-capped lamps, namely CFL for general lighting service, single-capped fluorescent lamps (non-integrated CFLs) and circular fluorescent lamps for general lighting service, self-ballasted LED lamps for general lighting service, and tungsten filament incandescent lamps. The details are listed in Table 21, below.

*Table 21. Malaysian lighting MEPS*

| Group | Type | Power Rating (W) | Minimum Efficacy (lm/W) | Reference Standard & Additional Requirements |
|---|---|---|---|---|
| **Double-capped fluorescent lamps** | T8 | ≥ 18 to < 31 | 70 | i) the performance testing standard shall be in accordance with MS IEC 60081; ii) the endurance parameters tested shall not be less than 80 % of the initial lumen output value and the failure rate of not more than 10 % of sample population after 2 000 h operation. |
| | | ≥ 31 | 80 | |
| | T5 | ≥ 14 to < 15 | 75 | |
| | | ≥ 15 | 80 | |

[61] Lighting Technology Scoping Paper. ASEAN SHINE. Version April 2017. https://www.aseanshine.org/download/get/1afa34a7f984eeabdbb0a7d494132ee5
[62] Malaysia Suruhanjaya Tenaga – ST (Energy Commission). CLASP Policy Database. https://clasp.ngo/policies/malaysia-meps3

| Group | Type | Power Rating (W) | Minimum Efficacy (lm/W) | Reference Standard & Additional Requirements |
|---|---|---|---|---|
| **Self-ballasted single-capped lamps for general lighting service** | CFL | < 9 | 46 | i) the performance testing standards shall be in accordance with MS IEC 60969<br>ii) the endurance parameters tested shall be not less than 80 % of the initial lumen output value and the failure rate of not more than 10 % of sample population after 2 000 h operation. |
| | | ≥ 9 to < 15 | 52 | |
| | | ≥ 15 to < 25 | 55 | |
| | | ≥ 25 | 62 | |
| **Single-capped fluorescent lamps for general lighting service** | Non-integrated CFL and circular fluorescent lamps | < 10 | 46 | i) the performance testing standards shall be in accordance with MS IEC 60901;<br>ii) the endurance parameters tested shall be not less than 80 % of the initial lumen output value and the failure rate of not more than 10 % of sample population after 2 000 h operation. |
| | | ≥ 10 to < 19 | 55 | |
| | | ≥ 19 to < 27 | 59 | |
| | | ≥ 27 | 70 | |
| **Self-ballasted lamps for general lighting service (types as defined in MS IEC 60061-1)** | G13 | NA | 75 | i) the performance testing standards shall be in accordance with MS 62612 (P);<br>ii) for LED lamps shall be tested for 6 000 h according with to MS 62612 (P), with minimum 70 % of the initial lumen output value and the failure rate of not more than 10 % of sample population;<br>iii) the endurance parameters for testing as with i), shall be not less than 80 % of the initial lumen output value and the failure rate of not more than 10 % of sample population after minimum 1 000 h operation; and |
| | GU10 | NA | 50 | |
| | E27 or B22d | NA | 60 | |
| | E14 | NA | 60 | |

### 5.3.2 Singapore

Singapore has a technology-neutral MEPS requiring power be at the maximum of the value returned from a single formula, $0.24\sqrt{\phi} + 0.0103\phi$ where $\phi$ is the luminous flux.[63] This technology-neutral MEPS covers incandescent lamps between 25-200 W, CFL lamps up to 60 W, and LED bulbs up to 60 W and translates to approximately 53 lm/W for common residential luminance of 850 lm/W. In addition, Singapore has lifetime requirements for the above lamps. For linear fluorescent and linear LED lamps Singapore has lifetime requirements only, and no MEPS.

### 5.3.3 Philippines

Philippines has developed and enforced mandatory comparative labeling for various lighting products since 2003.[64] Currently, MEPS and comparative labeling for CFL is specified in PNS 2050-2:2015, single-capped fluorescent lamps in PNS 2050-1-2:2006, and double-capped linear fluorescent lamps in PNS 2050-1-1:2007.

Lighting MEPS have been enforced since 2007, requiring CFLs between 2-60 W to meet efficacy between 40-65 lm/W. In addition to the efficacy requirement, average lifetime in hours is provided in the labeling, rated at 50% failure according to the specified standard test conditions. LFL lamps between 10-65 W are required to meet MEPS requirements ranging from 60-83 lm/W.[65] The MEPS level enforced in the Philippines is illustrated in Figure 45 for CFLs and Figure 46 for LFLs.[66]

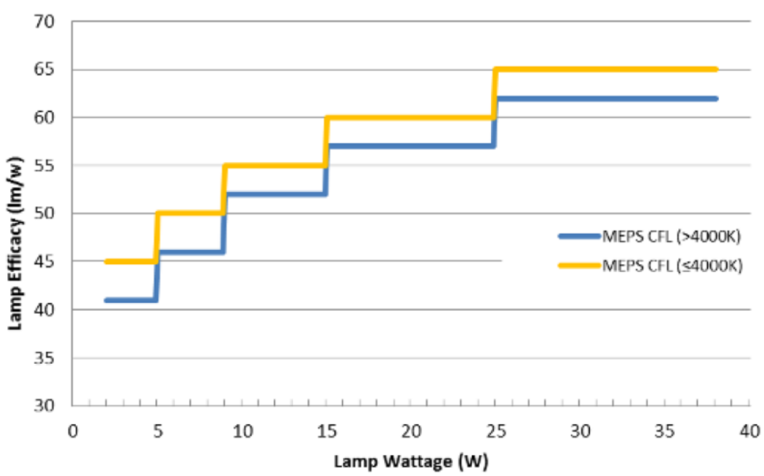



*Figure 45: Philippines CFL MEPS in PNS 2050-2:2007*

[63] Singapore National Environment Agency. Household Sector – MEPS. https://www.nea.gov.sg/our-services/climate-change-energy-efficiency/energy-efficiency/household-sector/minimum-energy-performance-standards
[64] ASEAN Regional Efficient Lighting Market Assessment – UN Environment Programme. IIEC. 2016. https://www.lites.asia/files/otherfiles/0000/0469/Regional_efficient_lighting_market_assessment_in_ASEAN_annex-included_3Nov2016.pdf
[65] Policy Database. CLASP, https://clasp.ngo/policies/philippines-label7
[66] ASEAN Regional Efficient Lighting Market Assessment – UN Environment Programme. IIEC. 2016. https://www.lites.asia/files/otherfiles/0000/0469/Regional_efficient_lighting_market_assessment_in_ASEAN_annex-included_3Nov2016.pdf

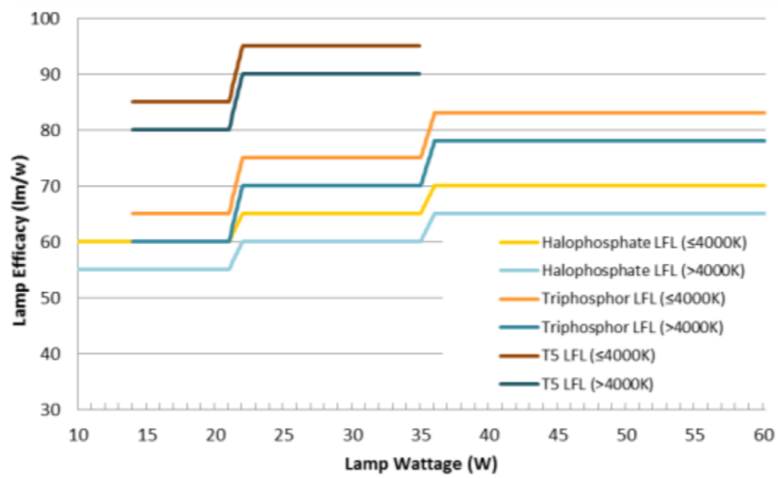



*Figure 46: Philippines LFL MEPS in PNS 2050-1-1:2007 Amendment 1:2013*[67]

### 5.3.4 Thailand

Thailand has established a range of lighting policies from mandatory MEPS for self-ballasted CFL and double-capped fluorescent lamps, voluntary MEPS for single-capped CLFs and ballasts for fluorescent lamps, to voluntary labeling programs named Energy Label No. 5 at specified values for these aforementioned lighting products, luminaries for T5 and T8 LFLs, and LED lamps.[68]

The Electricity Generating Authority of Thailand has been promoting energy efficiency for lighting projects through this long-standing labeling scheme which started in 1996 with CFLs, and most recently updated to be made effective in early 2019 at updated levels for CFLs and LEDs.[69] Applicable MEPS levels and minimum requirements for Energy Label No. 5 labeling for CFLs, LFLs, and LEDs are illustrated in Figure 47, Figure 48, and Figure 49 respectively.[70]

[67] Philippines Department of Energy. PNS 2050-1-1:2007 Amendment 1:2013. http://www.opac.dti.gov.ph//DocumentFolder/pages%20from%20pns%202050-1-1%20amd%201-2013.pdf
[68] Policy Updates Relating to Energy Efficient Lighting in Thailand. A. Asawutmangkul. Department of Alternative Energy Development and Efficiency. Lites Asia. Feb 2016. https://www.lites.asia/files/otherfiles/0000/0440/Bangkok_February_2016_Day_1_Session_2_Policy_update_Thailand.pdf
[69] Thailand - New Energy Efficiency Label for Lighting Products. UL. 2019. https://www.ul.com/news/thailand-new-energy-efficiency-label-lighting-products
[70] ASEAN Regional Efficient Lighting Market Assessment – UN Environment Programme. IIEC. 2016. https://www.lites.asia/files/otherfiles/0000/0469/Regional_efficient_lighting_market_assessment_in_ASEAN_annex-included_3Nov2016.pdf

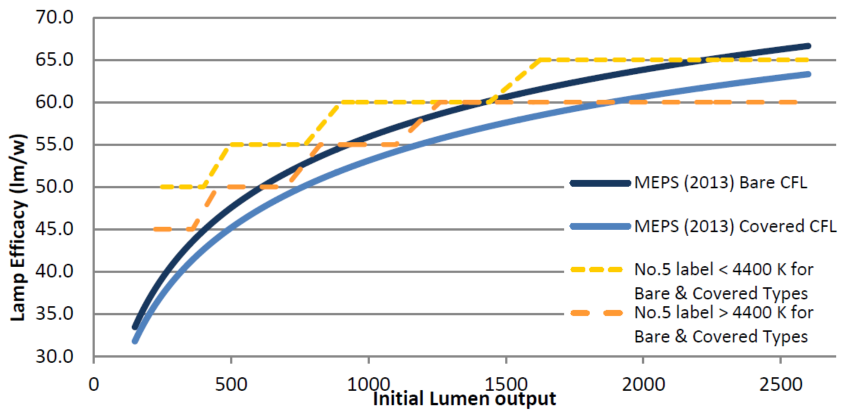



*Figure 47: Thailand CFL MEPS in TIS 2310-2556 (2013) and EGAT Manual of EE Labeling Program*

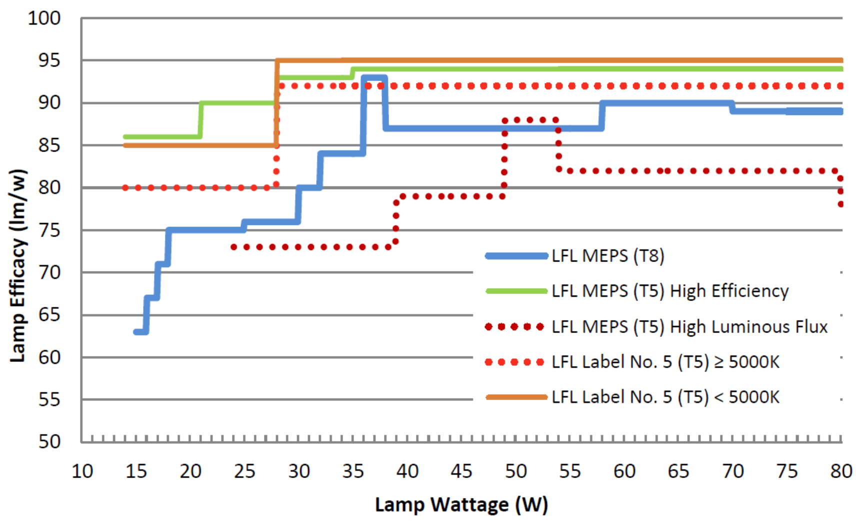



*Figure 48: Thailand LFL MEPS in TIS 2309-2556 (2013) and EGAT Manual of EE Labeling Program for Fluorescent Lamps*

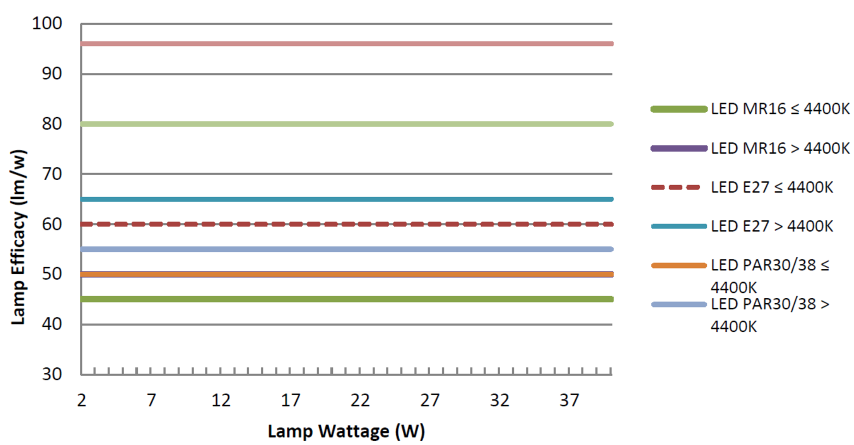



*Figure 49: Thailand LED minimum requirement for Energy Label No. 5 labeling*

### 5.3.5 Vietnam

Vietnam is another country in ASEAN that has been enforcing energy efficiency lighting policies for an extensive period. MEPS for CFLs was first introduced in 1999, and the level was recently updated in 2015. In 2013, additional MEPS levels were released for LFLs and ballasts for fluorescent lamps. Current MEPS levels applicable for CFLs and LFLs in Vietnam are illustrated in Figure 50 and Figure 51, respectively.[71]

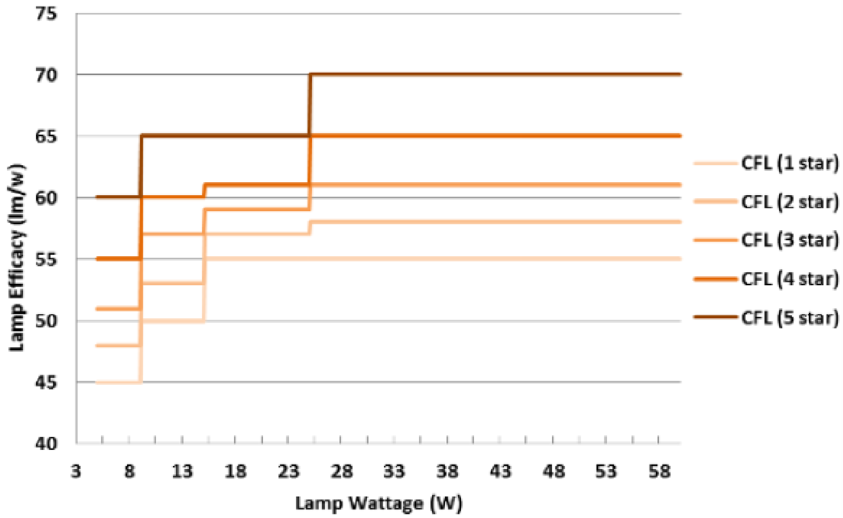



*Figure 50: Vietnam CFL MEPS in TCVN 7896:2015*

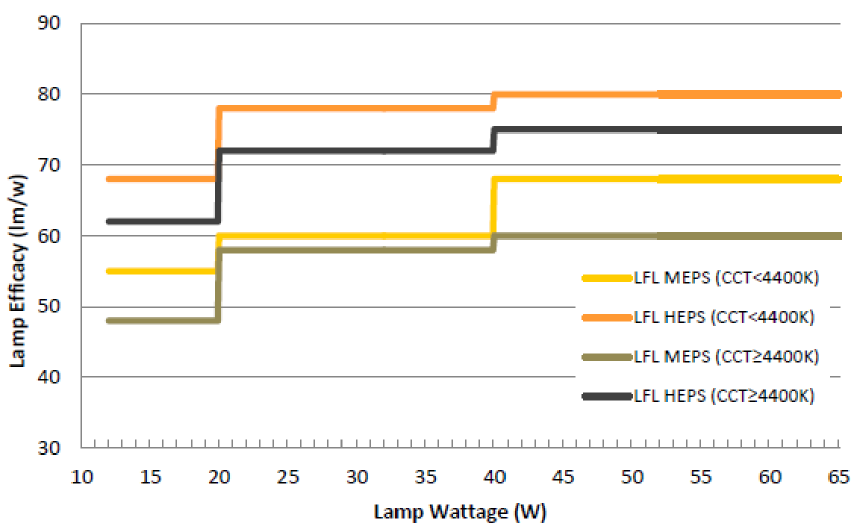



*Figure 51: Vietnam LFL MEPS in TCVN 8249:2013*

[71] ASEAN Regional Efficient Lighting Market Assessment – UN Environment Programme. IIEC. 2016. https://www.lites.asia/files/otherfiles/0000/0469/Regional_efficient_lighting_market_assessment_in_ASEAN_annex-included_3Nov2016.pdf

## 5.4 International Comparison

### 5.4.1 European Union

The leading economy in lighting policy today is the European Union, which in 2019 passed an ambitious technology neutral MEPS with efficacies above 90 lm/W for the most common residential lamps at 850 lm/W, and higher for commercial lamps. These requirements will be in force in 2021. These stringent lighting regulations are expected to bring annual electricity savings of 93 TWh by 2020, which is above the energy consumption of Croatia and is equivalent to avoided annual emissions of 35 million tonnes of $CO_2$.[72]

### 5.4.2 South Africa

South Africa is also in the process of adopting ambitious technology neutral requirements at 90 lm/W for most residential and commercial lamps. The South African and European requirements are shown in Figure 52 along with performance of lamps that CLASP has gathered from Australia, China, Korea, Indonesia and Singapore.

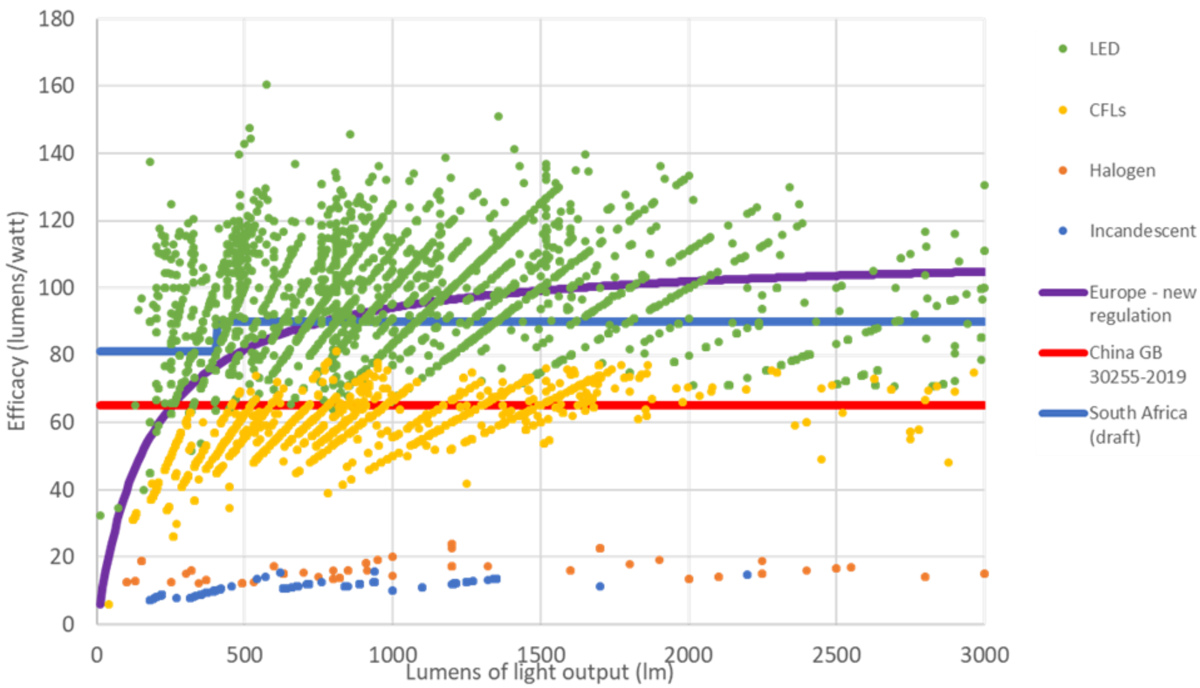



*Figure 52: EU, China, and South Africa (draft) MEPS relative to the performance of hundreds of lamps sold around the world.*

[72] European Commission. Lighting – Energy labeling and ecodesign requirements. https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/energy-efficient-products/lighting_en

### 5.4.3 Incandescent Ban

In addition to MEPS, many countries around the world have banned incandescent lamps for general service lighting applications either totally or partially, or enacted programs to exchange inefficient lamps with efficient LEDs, such as India's Unnat Jyoti by Affordable LEDs for All (UJALA) program, further detailed in **Appendix F**.

One illustrative example is China, which started phasing out incandescent lamps in 2011, with lamps above 15 W banned since 2016.[73] ASEAN countries that have enforced banning of incandescent include:

- Malaysia: Full ban since 2014[74]
- Singapore: Stringent MEPS with a further revision in force in 2023[75]
- Philippines: Full ban since 2010[76]
- Vietnam: Ban above 60 W since 2013[77]

[73] China's Lighting Market. HKTDC Research. 2019. https://research.hktdc.com/en/article/MzA3ODg1MTU1
[74] Malaysia Association of Water and Energy Research. Incandescent Bulbs Phase-Out (GLS) Programme: Are Malaysians Short-Changed? http://www.awer.org.my/?pgid=home&cid=243
[75] Singapore National Environment Agency. All Light Bulbs Sold In S'pore To Be Minimally Of LED Efficiency Level From 2023. 2018. https://www.nea.gov.sg/media/news/news/index/all-light-bulbs-sold-in-s-pore-to-be-minimally-of-led-efficiency-level-from-2023
[76] ADB Blogpost. Hasnie. 2015. https://blogs.adb.org/blog/my-small-victory-energy-efficiency-philippines
[77] Vietnam Ministry of Industry and Trace. CLASP Policy Database. https://clasp.ngo/policies/vietnam-label13

# 6 Test Procedure and Testing Capability

## 6.1 Testing Procedure in Draft Regulation

The current labeling program for CFLs references SNI IEC 60969:2009 Ballast lamps for general lighting services - Performance requirements, which specifies the testing of power, luminance, and other characteristics of CFLs. This test standard is also referenced by the draft regulation for CFLs

The Ministry of Energy and Mineral Resources has not drafted a decree concerning the Minimum Energy Performance Standard for LED Lighting. However, the intention is to base the performance testing on SNI IEC 62612:2016 on self-ballasted LED lamps for general lighting service with supply voltage > 50 V - Performance Requirements. This SNI standard is a revision of SNI IEC/PAS 62612:2013 on self-ballasted LED lighting for general lighting services - Performance Requirements.

## 6.2 ASEAN SHINE Lighting Harmonization

As mentioned in Section 5.3, ASEAN countries are harmonizing lighting efficiency policy, including MEPS and testing. The recommendations have been included in a Regional Policy Roadmap, including the following test standards. Countries shall adopt these test methods by 2022.[78]

a. CIE S025 (testing of photometric requirements) and IEC 62612 (testing of functional performance requirements) for non-directional Light Emitting Diode lamps,
b. CIE S025 (testing of photometric requirements) for double-capped linear Light Emitting Diode lamps (linear fluorescent replacements), and
c. CIE 084 (testing of photometric requirements) and IEC 60081 (testing of functional performance requirements) for double-capped Linear Fluorescent Lamps.

## 6.3 Additional Testing Requirements

In addition to the above tests, CLASP would recommend efficacy and other tests for incandescent and halogen lamps, which would support a technology-neutral regulation. These are specified in IEC 60064 Tungsten filament lamps for domestic and similar general lighting purposes - Performance requirements or CIE 84 Measurement of Luminous Flux.[79]

In addition to these three tests, CLASP recommends additional test standards be included or referenced in the regulation to either asses the characteristics of the lamp and determine if it is covered by the regulation; determine its lifetime and other performance parameters; or determine its health and safety parameters. A complete list of standards referenced in the draft South African technology neutral lighting regulation are listed in Table 22, below.

*Table 22: Relevant test standards and compliance certification*

| Metric | Lamp Type | Standard | Compliance Certification (for suppliers) |
|---|---|---|---|
| Luminous Efficacy [lm/W] | All | Calculated See below for (measured luminous flux / measured power) | Sample of 10 units. The arithmetical mean of the calculated luminous efficacy of the 10 units shall not be less than required level. |

[78] ASEAN SHINE, "Harmonization of Energy Performance Standards for Lighting: A Regional Policy Roadmap," https://www.aseanshine.org/download/get/bf8229696f7a3bb4700cfddef19fa23f
[79] Alternatively, since any efficacy requirement that reflects current performance available in the market (50, 65, or 80 lm/W) would eliminate general service incandescent and halogen lamps, it may be administratively simpler to just ban these types of lamps rather than reference additional tests.

| Metric | Lamp Type | Standard | Compliance Certification (for suppliers) |
|---|---|---|---|
| Luminous flux in [lm] | Incandescent / Halogen | IEC 60064<br>CIE 84 | Sample of 10 units. The arithmetical mean of the measured luminous flux of the 10 units shall not be less than 92.5% of the rated luminous flux and the measured luminous flux of each individual lamp of the sample shall not be less than 90% of the rated luminous flux |
| | CFL | IEC 60969<br>CIE 84 | |
| | LED | IEC 62612<br>CIE S025 | |
| Power in [W] | Incandescent / Halogen | IEC 60064<br>CIE 84 | Sample of 10 units. The arithmetical mean of the measured power of the 10 units shall not exceed 107.5% of the rated power, and the measured power of each individual lamp of the sample shall not exceed 110% of the rated power. |
| | CFL | IEC 60969<br>CIE 84 | |
| | LED | IEC 62612<br>CIE S025 | |
| Standby Power | Connected LED lamp | IEC 63103 | Sample of 10 units. The measured standby power of each individual lamp of the 10 units shall not exceed the required level by more than 100 mW. |
| Fundamental Power Factor | LED | IEC 62612 | Sample of 10 units. The measured displacement factor of each individual lamp of the sample shall not be less than the required level minus 0.05. |
| Color Rendering Index (CRI) | LED | IEC 62612<br>CIE S 025<br>CIE 13.3 | Sample of 10 units. The measured CRI of each individual lamp of the sample shall not be less than the required CRI-$R_a$ level minus 3 |
| Correlated color temperature (CCT) | LED | IEC 62612<br>CIE S025<br>CIE S015 | Sample of 10 units. For each individual lamp of the sample, the measured CCT shall conform to the industry standard tolerances contained in the IEC standards used for testing. |
| Luminous flux maintenance factor | CFL | IEC 60969 Annex D | Sample of 10 units. For each individual lamp of the sample, the measured luminous flux maintenance factor shall conform to the industry standard tolerances contained in the standards used for testing. |

| Metric | Lamp Type | Standard | Compliance Certification (for suppliers) |
|---|---|---|---|
| | LED | European Lifetime Test for LED Lamps | The determined XLMF% of the sample following the test in Annex B shall not be less than $X_{LMF, MIN}$%.[80] |
| Survival Factor | LED | European Lifetime Test for LED Lamps | Sample of 10 units. At least 9 light units of the test sample must be operational after completing the endurance test in Annex B. |
| Short-term Flicker indicator (PstLM) | LED | IEC TR 61547-1 | Sample of 10 units. For each individual lamp of the sample, the measured intrinsic[81] $P_{st}^{LM}$ of the 10 units shall not be more than the required level plus 5%. |
| Stroboscopic effect Visibility Measure (SVM) | LED | IEC TR 63518 | Sample of 10 units. For each individual lamp of the sample, the measured intrinsic SVM of the 10 units shall not be more than the required level plus 5%. |
| EMC emissions | All | CISPR15 | |
| EMC immunity (including voltage surge and dip) | All | IEC 61547 | |
| Harmonics | All | IEC 61000-3-2 | |

[80] There is no tolerance associated with this metric as it is a fixed requirement and it is up to the manufacturer to declare an $L_{70}B_{50}$ value to meet it.
[81] Intrinsic performance is where test is conducted with a stable mains voltage without fluctuations.

## 6.4 Existing Test Facilities and Capabilities

Respondents from test labs SUCOFINDO and P3TKEBT shared that the testing equipment and procedure for LED lighting would be similar with those for CFL Lighting; there is no need for additional resources, facilities or testing time. The representatives of the two testing facilities also shared that their existing lighting performance testing facilities were currently under-utilized.

The list of test facilities, along with information on their respective performance testing capacity for CFL lighting, is shown in Table 14 below. B2TE, B4T, Baristand, and P3TKEBT are government facilities. Sucofindo is a state-owned enterprise; while Qualis is a private company.

*Table 23. Lighting performance testing capacity*

| Test Laboratory | KAN Accreditation | Monthly Capacity |
|---|---|---|
| **Balai Besar Teknologi Konversi Energi (B2TKE)** | LP-096-IDN | 500 |
| **Balai Besar Bahan dan Barang Teknik (B4T)** | LP-007-IDN | 200 |
| **Balai Riset dan Standardisasi Industri (Baristand)** | LP-213-IDN | 800 |
| **Pusat Penelitian Pengembangan Teknologi Ketenagalistrikan, Energi Baru, Terbarukan, dan Konservasi Energi (P3TEK - EBTKE)**[82] | LP-364-IDN | 300 |
| **Sucofindo** | LP-024-IDN | 5,400 |
| **Qualis** | LP-708-IDN | 400 |
| **Total** | | 7,600 |

[82] Estimated duration for testing is 45 minutes per light bulb; 30 minutes for conditioning and 15 minutes for actual testing, as reported by P3TEK-EBTKE

# 7 Policy Analysis Methodology

To support EBTKE in formulating effective energy conservation regulations, CLASP used the findings from this market study to evaluate the currently drafted MEPS level and labeling policies and alternate policy options. CLASP used a lighting stock model specifically developed for Indonesia to estimate the impacts of different regulations across the residential, commercial, and outdoor lighting sectors, taking into account the different lighting technologies and the ongoing transition from legacy technologies to LED.

Energy impacts are expressed in terms of the reduction in final national energy consumption due to more efficient lamps as well as in terms of avoided $CO_2$ emissions resulting from reduced electricity consumption. In this analysis, CLASP evaluated the impacts to consumers as well as impacts at the national level for selected policy scenarios. Additionally, CLASP estimated the impacts to the manufacturers by calculating the number of models that would be eliminated from the market under more stringent MEPS.

## 7.1 Baseline Analysis

The average wattage of lamps on the Indonesian market is shown in Table 24. The average wattage and luminance for CFLs is based on the information provided by manufacturers to EBTKE through the suppliers' declaration of conformity (SDoC) and is weighted by the number of units for each model (models with higher sales are weighted more heavily). For all other lamp types, the average wattage and luminance are based on data found in retail and online by PwC and CLASP, so the number of units for each model is unknown (all models are weighted equally).

To estimate these, CLASP took the average wattage of models within 50% of the typical specifications listed in Table 25. For example, 7 W is the average wattage of LED models between 333 lm and 1000 lm (666 lm +/- 50%). CLASP focused on this narrower slice of the market to avoid the impact of higher-luminance and higher-wattage models that would otherwise skew the average, but which may not be commonly used. These were included in the commercial sector.

Finally, for some less common product types or sectors, either luminance or wattage data was not available, in which case CLASP used typical values based on its international experience.

*Table 24: Estimated average wattage of lamps on the Indonesian market*

| Lamp Technology | Power Rating (W) | | |
|---|---|---|---|
| | Residential | Professional | Outdoor |
| **Incandescent** | 55 | 80 | 80 |
| **Halogen** | 50 | 73 | 73 |
| **CFL** | 11 | 24 | 24 |
| **LFL** | 30 | 30 | 30 |
| **Mercury Vapor** | 70 | 80 | 220 |
| **High Pressure Sodium** | 80 | 80 | 150 |
| **Metal Halide** | 80 | 80 | 150 |
| **LED** | 7 | 21 | 70 |

*Table 25: Typical luminance for each technology and application*

| Lamp Technology | Typical luminous flux (lm) | | |
|---|---|---|---|
| | Residential | Professional | Outdoor |
| **Incandescent** | 666 | 2,000 | 2,000 |
| **Halogen** | 666 | 2,000 | 2,000 |
| **CFL** | 666 | 2,000 | 2,000 |
| **LFL** | 2,000 | 2,000 | 2,000 |
| **Mercury Vapor** | 7,000 | 7,000 | 7,000 |
| **High Pressure Sodium** | 7,000 | 7,000 | 7,000 |
| **Metal Halide** | 7,000 | 7,000 | 7,000 |
| **LED** | 666 | 2,000 | 7,000 |

Finally, the wattages for each lamp type were multiplied by the usage assumptions described in Section 7.1, below, as well as 10% ballast losses for LFL and HID (mercury vapor, high pressure sodium, and metal halide) lamps. The resultant unit energy consumption in kWh/yr appears in Table 26, below.

*Table 26: Estimated average unit energy consumption of lamps on the Indonesian market*

| Lamp Technology | Unit Energy Consumption (kWh/yr) | | |
|---|---|---|---|
| | Residential | Professional | Outdoor |
| **Incandescent** | 153 | 208 | 336 |
| **Halogen** | 139 | 189 | 305 |
| **CFL** | 31 | 63 | 102 |
| **LFL** | 92 | 86 | 139 |
| **Mercury Vapor** | 214 | 229 | 1,016 |
| **High Pressure Sodium** | 244 | 229 | 693 |
| **Metal Halide** | 244 | 229 | 693 |
| **LED** | 19 | 54 | 294 |
| **Shipment-weighted Average** | **58** | **99** | **319** |

## 7.2 Model Inputs and Assumptions

CLASP's analysis estimates the impacts of implementing policies that improve energy efficiency of new equipment by calculating the difference between a business-as-usual scenario (i.e., no policies implemented) and a policy scenario (i.e., higher MEPS or Best Available Technology). The model uses a bottom-up approach, based on a stock model and sales forecasts considering first purchase (increase in number of households and ownership levels) and replacement of retired lamps.

In the model, total energy consumption is estimated per year for the stock in use under each policy scenario, based on the average unit energy consumption of each lamp type. A MEPS requirement will decrease that energy consumption relative to the baseline. It

CLASP used the following data inputs and assumptions to estimate the impacts under different scenarios:

- Annual lamps sales data and forecasts from 2020 to 2030 were modeled based on increases in stock (3.5% for residential, the income growth rate; 5% for professional and outdoor, the GDP growth rate), and the replacement of retiring legacy lamps with LED technology to effect a full transition to LED by 2030.
- Residential lamps are used on daily average for 7.6 hours per day, based on CLASP's 5000-household residential end-use survey. Professional usage is assumed at 10 hours, and outdoor usage at 11.5 hours. However, professional usage only occurs on weekdays, not weekends, which reduces the average usage to 7.1 hours per day.
- Lamp lifetime depends on technology, sector, and usage, as outlined in Table 27.

*Table 27: Mean lamp lifetimes used in the model (the time until 50% of the lamps have been retired)*

| Lamp Technology | Residential Lifetime | | Professional Lifetime | | Outdoor Lifetime | |
|---|---|---|---|---|---|---|
| | Hours | Years | Hours | Years | Hours | Years |
| **Incandescent** | 800 | 0.3 | 1,000 | 0.3 | 1,000 | 0.2 |
| **Halogen** | 2,000 | 0.7 | 2,000 | 0.8 | 2,000 | 0.5 |
| **CFL** | 6,000 | 2.2 | 6,000 | 2.3 | 6,000 | 1.4 |
| **LFL** | 16,500 | 5.9 | 18,000 | 6.9 | 18,000 | 4.3 |
| **Mercury Vapor** | 20,000 | 7.2 | 20,000 | 7.7 | 20,000 | 4.8 |
| **High Pressure Sodium** | 22,000 | 7.9 | 24,000 | 8.5 | 24,000 | 5.2 |
| **Metal Halide** | 17,000 | 6.1 | 18,000 | 6.5 | 18,000 | 4.1 |
| **LED** | 15,000 | 5.4 | 30,000 | 11.5 | 30,000 | 7.1 |

- Electricity price of 1,467.28 IDR/kWh, equivalent to 0.10 USD/kWh was applied, based on the most recent price for non-subsidized tariff for the R-1 residential class, published by PLN for the year of 2019.
- Transmission and distribution (T&D) losses at 9.51%, as published in PLN's annual statistics report for the year of 2018.
- $CO_2$ emissions factor of 0.807 kg/kWh was applied, from PLN.[83]
- The standard year or year when policy is implemented is set at 2020.

[83] PLN Bantah PLTU Jadi Penyebab Polusi Jakarta. (2019, August 3). Retrieved from https://nasional.republika.co.id/berita/pvnraa377/pln-bantah-pltu-jadi-penyebab-polusi-jakarta

- Consumer discount rate of 6.1%, national discount rate of 6.5% and real income growth rate of 4.0% from World Bank for 2018.
- Population and urbanization data from United Nations, namely from the 2017 revisions of the World Population Prospects dataset from the Department of Economic and Social Affairs, Population Division.
- UEC values were calculated based on the assessment discussed in the previous section.
- The exchange rate used for conversion to and from IDR and USD was 14,124.50 IDR/USD.
- HID and linear fluorescent fixtures include an additional 10% ballast losses.

The specific inputs used for the modeling are shown in the table below.

*Table 28: Summary of key inputs.*

| Data | | Residential Lighting (850 lm) | Professional Lighting (2000 lm) | Public Street Lighting (7000 lm) | Validation |
|---|---|---|---|---|---|
| Product Lifetime (years) | | LED<br>15,000 hrs.<br>~5 years<br><br>CFL<br>6000 hrs<br>~2 years<br><br>Incandescent<br>800 hrs.<br>0.3 years | LFL<br>18,000 hrs.<br>~7 years<br><br>LED<br>30,000 hrs.<br>~12 years | LED<br>30,000 hrs.<br>~7 years<br><br>HPS<br>22,000 hrs<br>~5 years. | Validation from GAMATRINDO on generic operational hours and lifetime across technologies for typical lamps in residential, web research for lifetime values. |
| Stock in 2019 (million units) | | 334 | 324 | 27 | Residential stock model validation by GAMATRINDO, inputs later revised per CLASP's household survey.<br><br>Annual shipments estimated per modeling methodology captured in Appendix E |
| Annual Shipments (million units) | 2016 | 142 | 110 | 5.94 | |
| | 2017 | 125 | 95.8 | 4.43 | |
| | 2018 | 109 | 83.3 | 4.65 | |
| | 2019 | 88.1 | 68.7 | 4.75 | |
| | 2020 | 100 | 72.8 | 4.71 | |

| Data | | Residential Lighting (850 lm) | Professional Lighting (2000 lm) | Public Street Lighting (7000 lm) | Validation |
|---|---|---|---|---|---|
| | 2021 | 102 | 69.8 | 4.98 | |
| | 2022 | 101 | 67.9 | 5.45 | |
| | 2023 | 97.5 | 67.5 | 5.91 | |
| | 2024 | 93.1 | 67.7 | 6.15 | |
| | 2025 | 89.5 | 67.4 | 6.21 | |
| | 2026 | 87.4 | 66.9 | 6.30 | |
| | 2027 | 86.6 | 66.9 | 6.49 | |
| | 2028 | 85.8 | 66.1 | 6.79 | |
| | 2029 | 86.0 | 64.6 | 7.20 | |
| | 2030 | 90.9 | 66.0 | 7.69 | |
| Unit Energy Consumption (kWh/year) | Baseline | 58 | 99 | 319 | Includes all lamps in sector, not just the most common (e.g., includes linear fluorescents used in residential).<br><br>Under a technology neutral 80 lm/W MEPS, incandescent and CFL eliminated from the residential market, but incandescent continues to be used in professional sector for poultry/bakery applications. |
| | EBTKE Technology-specific requirements (38 lm/W for typ. CFL; 50 lm/W for LED) | 58 | 99 | 319 | |
| | CLASP Recommended **Technology Neutral** Requirement (80 lm/W; 130/lm for outdoor) | **23** | **93** | **259** | |

# 8 Policy Options and Results

CLASP evaluated several options for lighting MEPS levels. First, CLASP reviewed its technology- CLASP recommended level of 80 lm/W (130 lm/W for street lighting), which would accelerate the transition to efficient LED. In addition, CLASP reviewed the current EBTKE draft regulation that has efficacy requirements below 40 lm/W for typical 15 W CFL lamps as well as the proposal by lighting manufacturers to set a requirement of 50 lm/W for LEDs.

## 8.1 Technology Neutral Recommendation from CLASP

The current and proposed CFL regulation applies only to CFLs typically used in the residential sector. There is a separate regulation for LED lamps. Similarly, the ASEAN SHINE harmonized lighting requirements focus on LED lamps (though linear fluorescent lamps are also included). In contrast, CLASP's proposal would apply to all lamps intended for general lighting service, regardless of technology, meeting the following four criteria:

1. Input voltage type and voltage range (AC or DC, voltage and frequency);
2. Quantity of light emitted (lumens);
3. x,y chromaticity coordinates falling within a defined area in colour space (x,y); and
4. Lamp having one of a specific type of base (types specified).

A 'technology neutral' scope allows for the substitution of different technologies, encourages innovation and the introduction of new products, and stimulates the market to evolve to more energy-efficient products. The scope of coverage is critical, to ensure that technologies are not inadvertently omitted and become loopholes. Consider the technologies shown in the table below. All of these technologies are capable of producing light when installed into a screw-base, mains-voltage socket, but all have differences in efficacy, lifetime, colour rendering and costs to purchase and run the lamp, as shown in Table 29 (see Appendix G for an in-depth description of the four common general lighting service technologies).

*Table 29: Examples of Non-Directional Household Lamps, Screw-Base, Mains-Voltage*

| Characteristic | Incandescent | Halogen | Compact Fluorescent | Light Emitting Diode Lamp |
|---|---|---|---|---|
| |  |  |  |  |
| **Efficacy** | 8-15 lm/W | 11-18 lm/W | 55-65 lm/W | 60-160 lm/W |
| **Lifetime** | 1000-1500 hrs | 2000-3000 hrs | 6000-12,000 hrs | 15-30,000 hrs |
| **Color rendering index** | 100 | 100 | 70-90 | 70-95 |
| **Cost to buy*** | $ | $$ | $$ | |
| **Cost to run*** | $$$$$ | $$$$ | $$ | $ |

All four technologies are manufactured and distributed globally, although in any one market, some technologies may be more common than others. If, however, a regulation were developed that was technology-specific and applied to only one of the four technologies, it could very easily have a distorting effect on the market, whereby the regulated product becomes more expensive due to redesign and compliance certification costs, causing end-users to shift to one of the other three technologies.

Furthermore, by applying to the entire market and targeting the worst performers, this approach generates higher energy reductions. Compare a technology neutral approach that eliminates inefficient halogens and incandescent, with a technology specific one that only focuses on further increasing the efficacy of already-efficient LEDs.

### 8.1.1 Technology Neutral Exclusions

When setting a broad, technology-neutral scope of coverage, certain products may fall into coverage which were not intended to be regulated. For this reason, an exclusion list is developed which explicitly names and defines products that are not part of the regulation. These 'special purpose' lamps and lighting systems should still be covered by safety standards and regulations, but they should not be subject to the quality and performance requirements.

These lamps typically are used in applications such as agriculture, air-traffic control, healthcare, animal-care, photocopiers and so-on. They may not have more energy-efficient alternatives that could replace them, thus these specific (and deemed to be important by policymakers) applications would no longer be supplied with lamps, creating an impact through their unintentional phase-out due to the regulation.

The following text is an extract from the exclusions section of the draft South African lighting regulation:

*The following lamps are exempted from the energy efficiency and functional performance requirements of this compulsory specification:*

- *a) the primary purpose of the light is not general illumination and the product packaging is prominently marked as such, e.g. but not limited to:*
  - *I. emission of light as an agent in chemical or biological processes (other than human visual perception), e.g. but not limited to:*
    - *polymerization,*
    - *ultraviolet light used for curing/drying/hardening,*
    - *photodynamic therapy,*
    - *horticulture,*
    - *food service,*
    - *medical applications,*
    - *aquarium,*
    - *animal care, and*
    - *anti-insect products;*
  - *II. image capture and image projection, e.g. but not limited to:*
    - *camera flashlights,*
    - *photocopiers, and*
    - *video projectors;*
  - *III. signaling, e.g. but not limited to:*
    - *railway-signaling,*
    - *marine signaling,*
    - *road-signaling and traffic control, and*
    - *air traffic-signaling and airfield lamps;*
- *b) the spectral distribution of the light is adjusted to the specific needs of particular technical equipment, in addition to making the scene or object visible for humans, e.g. but not limited to:*

- *studio lighting,*
- *performance special effects lighting, and*
- *theatre lighting;*

c) *the scene or object lit requires special protection from the negative effects of the light source, e.g. but not limited to:*
- *lighting with dedicated filtering for photosensitive patients, and*
- *lighting with dedicated filtering for photosensitive museum exhibits;*

d) *lighting is required only for emergency situations, e.g. but not limited to:*
- *emergency lighting luminaires;*

e) *requiring ambient temperatures above 120°C and this exemption only applies to incandescent and halogen lamps with the following characteristics:*
- *an overall length of maximum 60 mm,*
- *a rated power of maximum 25 W,*
- *a base type of E14 or B15, and*
- *a rated luminous flux of maximum 225 lm; and*

f) *lamps for national measurement standards.*

### 8.1.2 Illustrations

CLASP proposal is illustrated relative to the efficacy distribution of residential lamps in Figure 53, but it would also apply to professional lamps and street lighting.

Figure 56 show the requirements relative to the efficacy of models currently in the market, as reported to EBTKE through Suppliers' Declaration of Conformity (SDoC) in 2019.

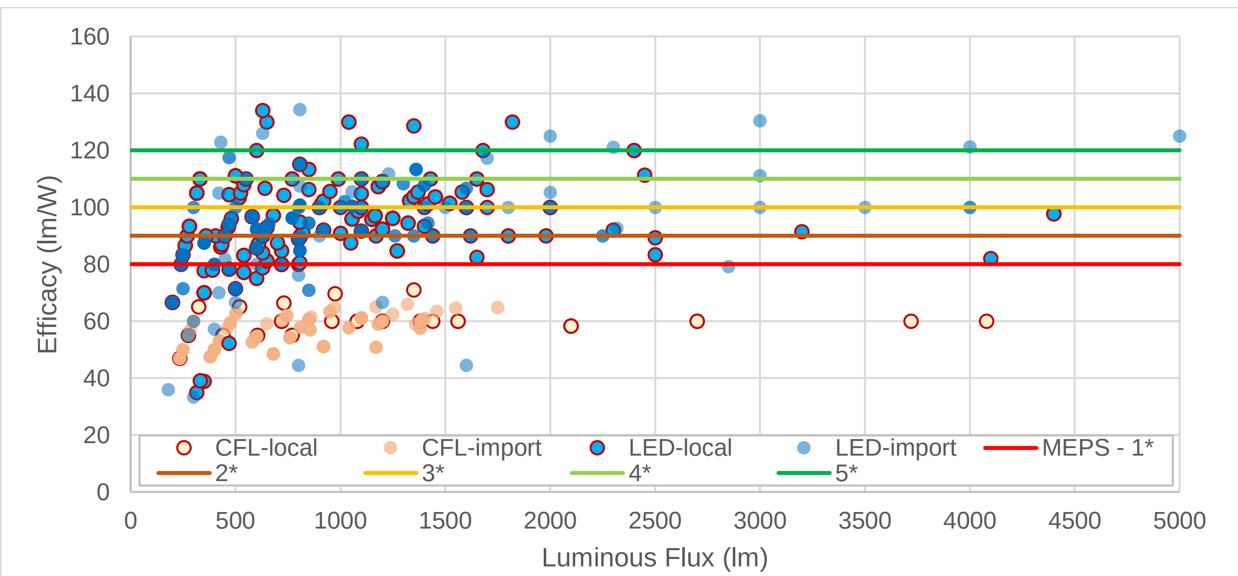



*Figure 53: CLASP recommended MEPS requirements compared to residential and professional lamp characteristics found in the market.*

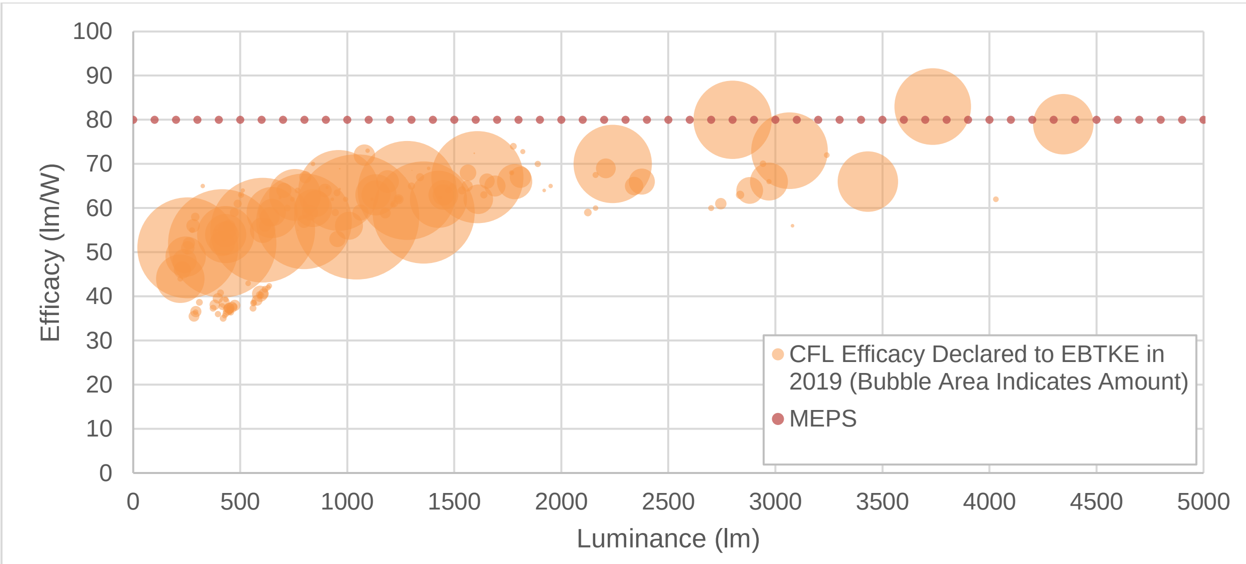



*Figure 54: CLASP recommended MEPS requirements compared to CFL lamp characteristics reported to EBTKE through Suppliers' Declaration of Conformity (SDoC) in 2019*

While the European Union has adopted requirements that are above 90 lm/W for most household and professional lamps (Figure 55), and even higher efficacies are available on the Indonesian market, CLASP is proposing 80 lm/W as an initial requirement that establishes a technology-neutral lighting MEPS without excessively increasing prices. Furthermore, 80 lm/W is the requirement proposed for ASEAN SHINE harmonization across Southeast Asia by 2023. Adopting the CLASP recommended level would allow Indonesia to lead the region by meeting its commitment ahead of schedule.

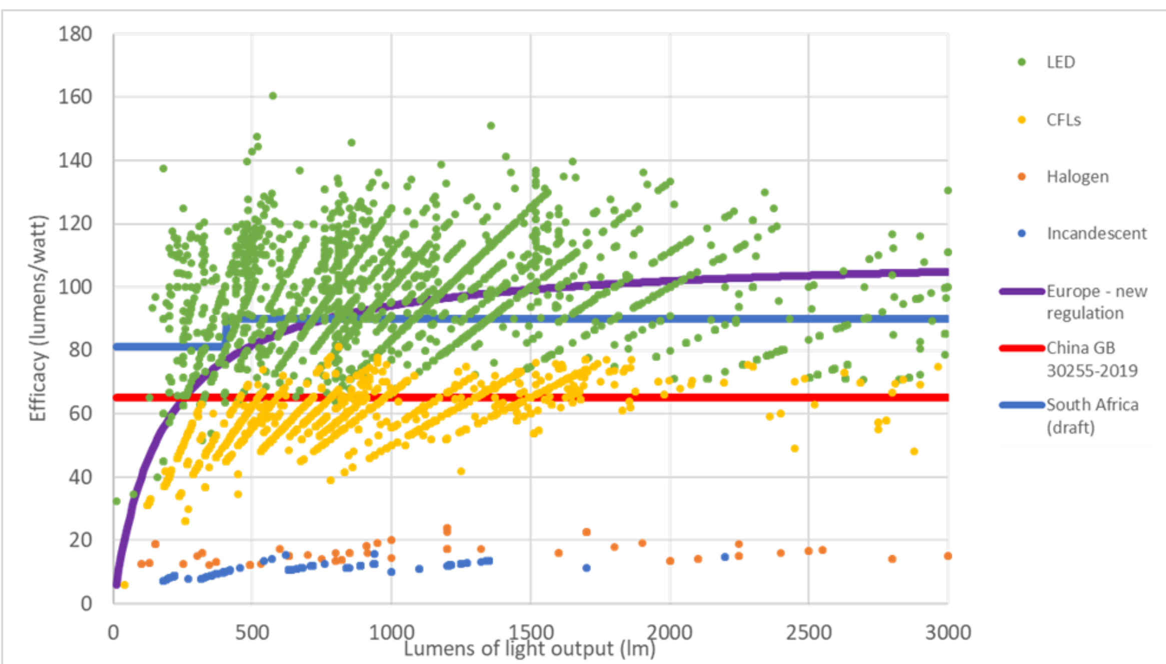



*Figure 55: Comparison of international lighting policies compared to efficiency of products available in Australia, China, Korea, Indonesia and Singapore*

### 8.1.3 Street Lighting

For street lighting, the previously discussed Ministry of Transport procurement specification requires an efficacy of 100 lm/W. This specification has been used broadly, such that most new street lighting in Indonesia has already transitioned to LED, with HID continuing to be used for replacement. CLASP recommends adopting a MEPS of 130 lm/W to take advantage of recent efficacy improvements and reduce the energy consumption of these long-lived lamp types.

## 8.2 Technology-specific Lighting Policies Under Consideration by EBTKE

In addition, EBTKE is considering technology-specific requirements for CFLs and LEDs that are incrementally more stringent than those proposed in the draft regulations, as shown in Table 30 and Table 31.

*Table 30. CFL requirements under consideration by EBTKE*

| Power (Watt) | Efficacy Value (lm/W) | | | | |
|---|---|---|---|---|---|
| | 1 Star | 2 Star | 3 Star | 4 Star | 5 Star |
| **≤ 8** | ≥34 | ≥44 | ≥54 | ≥64 | ≥74 |
| **> 8 - 15** | ≥38 | ≥48 | ≥58 | ≥68 | ≥78 |
| **> 15 - 25** | ≥42 | ≥52 | ≥62 | ≥72 | ≥82 |
| **> 25 - 60** | ≥46 | ≥56 | ≥66 | ≥76 | ≥86 |

*Table 31. LED requirements under consideration by EBTKE*

| Efficacy Value (lm/W) | | | | |
|---|---|---|---|---|
| 1 Star | 2 Star | 3 Star | 4 Star | 5 Star |
| **≥50** | ≥80 | ≥95 | ≥110 | ≥125 |

Figure 56 shows the draft CFL MEPS (1-star requirement) relative to the efficacy of CFL models currently in the market, as reported to EBTKE through Suppliers' Declaration of Conformity (SDoC) in 2019.[84] As can be seen, the draft requirements would affect very few models, and even fewer units sold: the models with the highest numbers of units, as reported by manufacturers, are all above the line.

In fact, 99% of the total units reported by manufacturers meet the requirements, such that the average efficacy would not change significantly. If the 1% of units that do not meet the EBTKE MEPS under consideration were to be redesigned to just meet them (e.g., a 14 W CFL is redesigned to increase its efficacy from 35 lm/W to the 38 lm/W), the average efficacy increase from 61.18 lm/W without the standard to 61.19 lm/W with the standard.

[84] The total number of units reported in 2019 (129 million) is much higher than in 2018 (9 million) or 2017 (28 million), so it is possible it also includes models sold in these prior years.

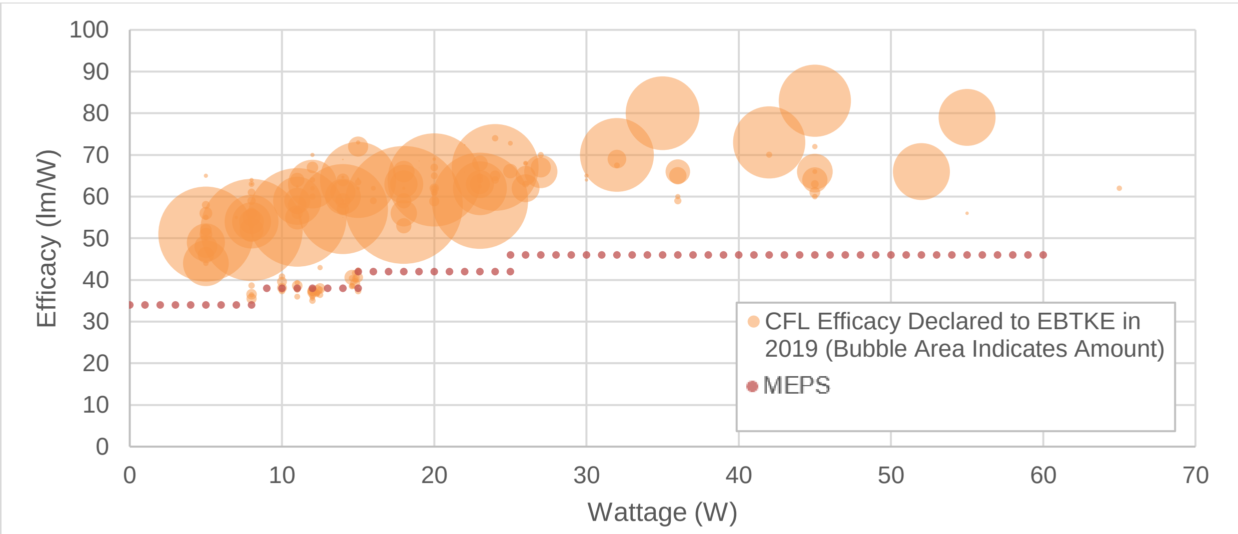



*Figure 56: CFL efficacy declared to EBTKE compared to the MEPS (1-star) requirement under consideration by EBTKE.*

For comparison, Figure 43 shows the distribution of efficacies for the CFL models found in the market and online. The average efficacy of models in the market is 57 lm/W.

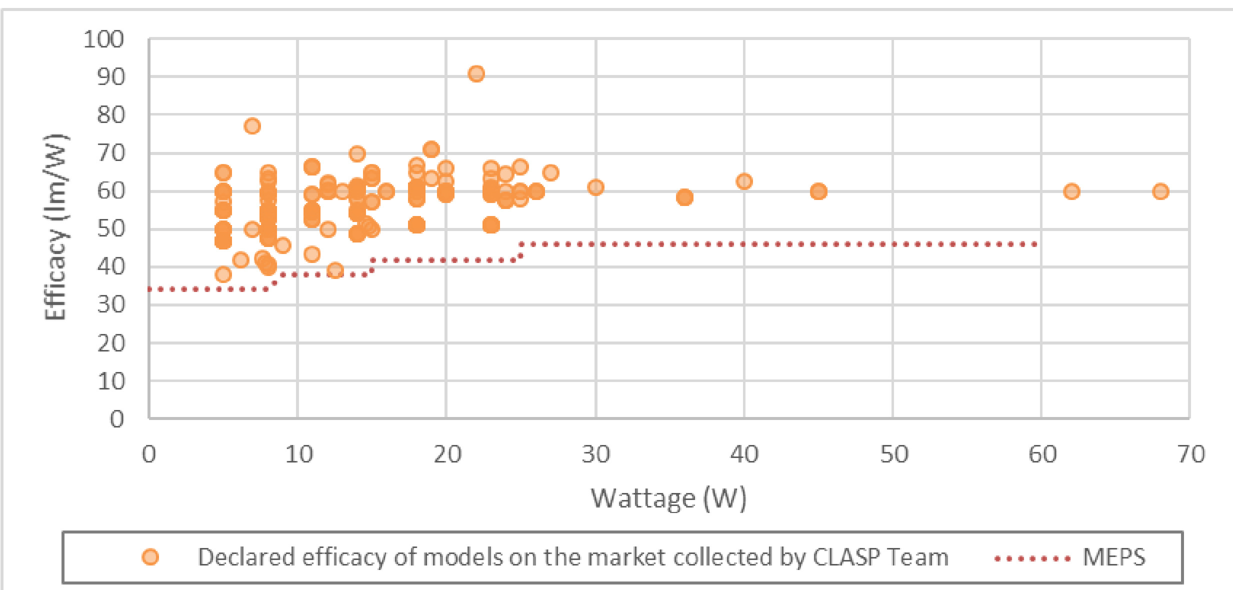



*Figure 57: Efficacy of models in the market compared to the MEPS (1-star) requirement under consideration by EBTKE. Darker circles represent more models with that efficacy and wattage.*

LED lamps are currently not regulated, so there is no data on the unit shipments of different models. CLASP therefore used the declared characteristics of models found in retail and online to estimate the range of efficiencies available in the market. Figure 57 shows the distribution of efficacies of all LED lamps, while Figure 59 shows it for LED residential lamps (mostly bulbs and including all models found in retail). Both distributions are compared to the 50 lm/W MEPS level under consideration by EBTKE.

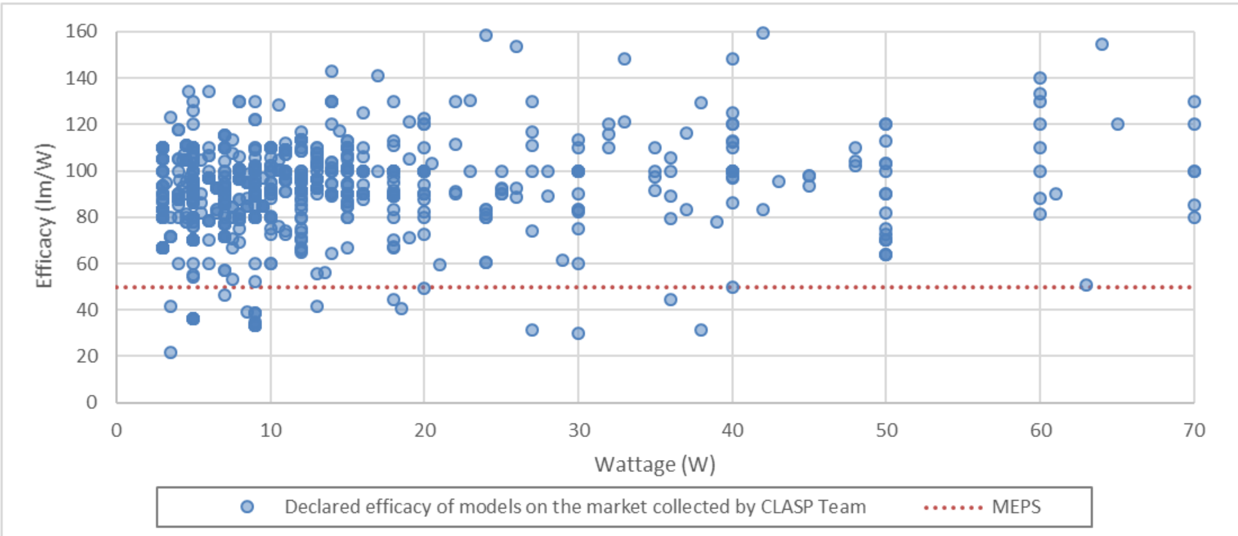



*Figure 58: Efficacy of <u>all</u> LED models in the market compared to the MEPS (1-star) requirement under consideration by EBTKE. Darker circles represent more models with that efficacy and wattage*

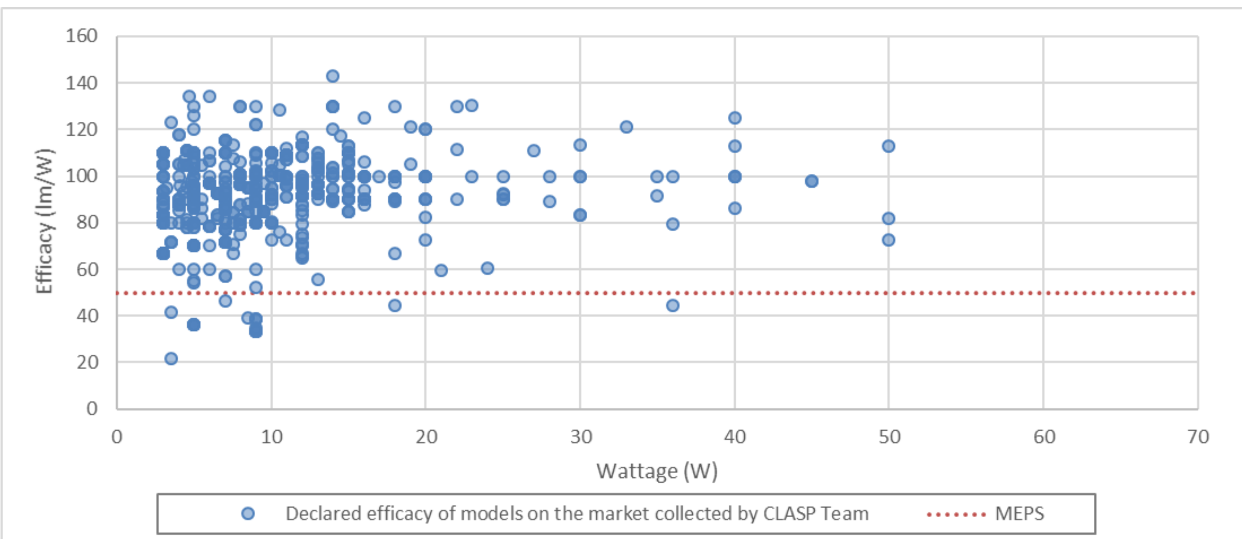



*Figure 59: Efficacy of <u>residential</u> LED models in the market compared to the MEPS (1-star) requirement under consideration by EBTKE. Darker circles represent more models with that efficacy and wattage*

As can be seen in the graphs, very few models fall below the 50 lm/W requirement under consideration. In fact, 97% of all LED lamp models can meet the MEPS, and 83% of residential LED models could do so. The average efficacy of all LED lamp models is 94 lm/W, while the average of residential LED models is 92. Once implemented, the MEPS would increase the average efficacy to 96 lm/W for all LED and to 93 lm/W for residential LED.

Finally, these requirements would not affect incandescent and halogen lamps, which continue to be imported, manufactured, and used in Indonesia. Furthermore, they would not affect linear fluorescent lamps. And finally, they would not affect streetlights. As shown above, LED lighting efficiency is above 90 lm/W; therefore, much of the savings come from shifting legacy lighting technology to LED through technology-neutral standards.

# 9 Impact Assessment

To estimate the national impacts of both sets of MEPS—the ones recommended by CLASP and the ones currently under consideration be EBTKE—CLASP calculated the energy reductions if these requirements were applied to typical fixtures for each sector and technology.[85] While the majority of lamp on the market can meet both the EBTKE and CLASP MEPS levels, the standards would nonetheless have an impact as the inefficient lamps would be redesigned to meet the efficacy levels, or replaced with LED lamps that could meet them.

For example, the average residential LED on the market between 720 and 880 lm has an efficacy of 90.78 lm/W, however, there is a range of efficacies, including lamps that do not meet the EBTKE MEPS under consideration of 50 lm/W. Once these lamps are replaced by minimally compliant ones at 50 lm/W, the average efficacy increases, but only slightly, as only 3% of LED models within the typical luminance range do not currently meet the requirements. In the case of CLASP recommended requirements at 80 lm/W, the average efficacy would increase to 92.11 lm/W, again a small change as only 16% of LED models do not meet the requirements.

Therefore, CLASP also reviewed the impact of the requirements across the range of other technologies that would be affected. In the case of the CLASP technology-neutral requirement, the 80 lm/W would apply to CFLs and residential and outdoor incandescent, where the average efficacy is much lower. These impacts are discussed in the sections that follow.

## 9.1 Impacts to Consumers

For an average consumer, the impact of the recommended CLASP MEPS would be positive, with high lifetime savings and quick paybacks. Residential stocks in 2019 broke down as follows;

- Incandescent and halogen : 35 million, or 10%
- CFL : 149 million, or 42%
- LED : 145 million, or 44%.

Furthermore, the typical prices for these lamps were;

- Incandescent : IDR 6,000
- CFL : IDR 20,000
- LED : IDR 25,000

Adopting the CLASP recommended requirement would require a shift to LED lamps, increase the stock-weighted average purchase price from IDR 20,737 to 25,000, or an increase of IDR 4,263. The payback for residential consumers in Table 32, below is approximately one month. Price data were not available for professional or outdoor lamps. As the vast majority of models already meet the MEPS requirements under consideration by EBTKE, they will have little consumer benefit.

[85] For the typical luminance ranges for each application, see

Table 25.

*Table 32: Consumer paybacks from the CLASP recommended MEPS*

| Lamp Type | Price Increase (IDR) | Annual Electricity Cost Savings (IDR) | Payback Period (years) | Lifecycle Cost Savings (IDR)[86] | Product Life (years) |
|---|---|---|---|---|---|
| **Residential** | 4,263 | 51,849 | 0.1 | 236,205 | 5.4 |
| **Professional** | N/A | 29,364 | N/A | 78,138 | 11.5 |
| **Outdoor** | N/A | 92,050 | N/A | 518,365 | 7.1 |

## 9.2 Impacts to Manufacturers

CLASP's recommended MEPS at 80 lm/W could be met by 1% of CFL models for which manufacturers provided data through the Suppliers Declaration of Conformity, representing 7% of units. For other lamp types, for which unit data are not available, CLASP's recommended MEPS could be met by the following percentages of models:

- Incandescent: 0%
- Linear Fluorescent: 0%
- LED, excluding outdoor: 81% (including 71% of locally assembled models)
- LED, outdoor: 26% (including 26% of locally assembled models)
- Since LED lamps already dominate the market, the overall pass rate across all models identified during market research is 60% (including 49% of locally assembled models)

The EBTKE MEPS under consideration would be met by 99% of CFL units, and 97% of LED models, as detailed in Section 8.2.

## 9.3 Impact at the National Level

The national impacts for the CLASP recommended MEPS at 80 lm/W for general service lighting and 130 lm/W for street lighting are summarized in Table 33 and Table 34, below. As mentioned above, the energy reductions from further improving LED efficacy through an 80 lm/W requirement are limited, as most LED lamp models already exceed this efficacy.

Furthermore, LED technology continues to improve, such that any immediate energy reductions would erode with time. Instead, most of the reductions and $CO_2$ mitigation comes from switching incandescent, halogen, and CFL lamps to 80 lm/W LED.

[86] This assumes a discount rate of 5% and the average lifetime of LEDs in each sector. During this time it would be necessary purchase incandescent and CFL lamps multiple times, further increasing the lifecycle cost savings of LED.

*Table 33. Summary of energy reduction for the CLASP recommended MEPS at 80 lm/W for general service lighting and 130 lm/W for street lighting. The limited impacts in 2030 are because all lighting is assumed to have transitioned to LED by then.*

| Lamp Technology | Energy Reduction Annual in 2030 (TWh) | | | | Energy Reduction 2020-2030 (TWh) | | | |
|---|---|---|---|---|---|---|---|---|
| | Res. | Comm. | Outdoor | Technology Total | Res. | Comm. | Outdoor | Technology Total |
| **Incandescent** | 0.0 | 0.0 | 0.0 | **0.0** | 15.4 | 0.0 | 0.0 | **15.4** |
| **Halogen** | 0.0 | 0.0 | 0.0 | **0.0** | 6.5 | 2.9 | 0.1 | **9.5** |
| **CFL** | 0.0 | 0.0 | 0.0 | **0.0** | 5.7 | 0.0 | 0.0 | **5.7** |
| **LFL** | 0.0 | 0.0 | 0.0 | **0.0** | 1.1 | 3.0 | 0.1 | **4.2** |
| **Mercury Vapor** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **High Pressure Sodium** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **Metal Halide** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **LED** | 0.0 | 0.0 | 0.6 | **0.6** | 0.0 | 0.0 | 14.0 | **14.0** |
| **Sector Total** | **0.0** | **0.0** | **0.6** | **0.6** | **28.7** | **6.0** | **14.2** | **48.8** |

*Table 34. Summary of $CO_2$ mitigation for the CLASP recommended MEPS at 80 lm/W for general service lighting and 130 lm/W for street lighting. The limited impacts in 2030 are because all lighting is assumed to have transitioned to LED by then.*

| Lamp Technology | Emissions Mitigation Annual in 2030 ($MtCO_2$) | | | | Emissions Mitigation 2020-2030 ($MtCO_2$) | | | |
|---|---|---|---|---|---|---|---|---|
| | Res. | Comm. | Outdoor | Technology Total | Res. | Comm. | Outdoor | Technology Total |
| **Incandescent** | 0.0 | 0.0 | 0.0 | **0.0** | 13.6 | 0.0 | 0.0 | **13.6** |
| **Halogen** | 0.0 | 0.0 | 0.0 | **0.0** | 5.8 | 2.6 | 0.1 | **8.4** |
| **CFL** | 0.0 | 0.0 | 0.0 | **0.0** | 5.0 | 0.0 | 0.0 | **5.0** |
| **LFL** | 0.0 | 0.0 | 0.0 | **0.0** | 0.9 | 2.7 | 0.1 | **3.7** |
| **Mercury Vapor** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **High Pressure Sodium** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **Metal Halide** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **LED** | 0.0 | 0.0 | 0.6 | **0.6** | 0.0 | 0.0 | 12.4 | **12.4** |
| **Sector Total** | **0.0** | **0.0** | **0.6** | **0.6** | **25.3** | **5.3** | **12.6** | **43.2** |

In contrast, Table 35 and Table 36 show the national impacts of technology-specific policies under consideration by EBTKE. As was the case previously, there will be no savings in 2030, as general service lighting and street lighting is expected to fully transition to efficient LED.

While PwC and CLASP did find a few typical LED lamps that would not meet the 50 lm/W regulations (e.g., a 800 lm residential lamp with efficacy of 44 lm/W), the efficacy of LED lamps is expected to improve at 2% each year, such that any energy reductions from regulating these lamps will quickly disappear.

In the case of CFLs, the savings are small because only a 1% of CFL lamp units would be affected by the MEPS, most of these with lower luminance for use in the residential sector. Other sectors or technologies would be unaffected.

*Table 35. Summary of energy reduction for the MEPS under consideration by EBTKE (38 lm/W for common CFL; 50 lm/W for LED bulbs). The null impact in 2030 are because all lighting is assumed to have transitioned to LED by then.*

| Lamp Technology | Energy Reduction Annual in 2030 (TWh) | | | | Energy Reduction 2020-2030 (TWh) | | | |
|---|---|---|---|---|---|---|---|---|
| | Res. | Prof. | Outdoor | Technology Total | Res. | Prof. | Outdoor | Technology Total |
| **Incandescent** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | 0.0 |
| **Halogen** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | 0.0 |
| **CFL** | 0.0 | 0.0 | 0.0 | **0.0** | 0.01 | 0.0 | 0.0 | **0.01** |
| **LFL** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | 0.0 |
| **Mercury Vapor** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | 0.0 |
| **High Pressure Sodium** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | 0.0 |
| **Metal Halide** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | 0.0 |
| **LED** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | 0.0 |
| **Sector Total** | **0.0** | **0.0** | **0.0** | **0.0** | **0.01** | **0.0** | **0.0** | **0.01** |

*Table 36. Summary of $CO_2$ mitigation for the MEPS under consideration by EBTKE (38 lm/W for common CFL; 50 lm/W for LED bulbs). The null impact in 2030 are because all lighting is assumed to have transitioned to LED by then.*

| Lamp Technology | Emissions Mitigation Annual in 2030 ($MtCO_2$) | | | | Emissions Mitigation 2020-2030 ($MtCO_2$) | | | |
|---|---|---|---|---|---|---|---|---|
| | Res. | Comm. | Outdoor | Technology Total | Res. | Comm. | Outdoor | Technology Total |
| **Incandescent** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **Halogen** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **CFL** | 0.0 | 0.0 | 0.0 | **0.0** | 0.01 | 0.0 | 0.0 | **0.01** |
| **LFL** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **Mercury Vapor** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **High Pressure Sodium** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **Metal Halide** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **LED** | 0.0 | 0.0 | 0.0 | **0.0** | 0.0 | 0.0 | 0.0 | **0.0** |
| **Sector Total** | **0.0** | **0.0** | **0.0** | **0.0** | **0.01** | **0.0** | **0.0** | **0.01** |

# 10 Conclusion and Recommendations

This *Indonesia Lighting Market Study and Policy Analysis* provides the technical evidence to support a revision of the draft MEPS to world-leading levels that will save Indonesians money while reducing energy use and $CO_2$ emissions. Government agencies can use this information to define their efficiency baseline for lighting, quantify potential energy and GHG emissions savings in support of national energy efficiency targets or NDC commitments, and estimate other potential benefits from revising the draft S&L program requirements.

The analysis presented in this report was based on the product data for almost a thousand models from retail stores in Jakarta, Bandung, Surabaya, Makassar, Denpasar, and Medan, as well as additional ones found through manufacturer websites. Manufacturers and importers provided sales data, which CLASP supplemented with import data from government agencies BPS and INSW and United Nations Comtrade to arrive at a total market size. CLASP validated the findings with manufacturers, government officials, and other organizations during a National Workshop on November 20 and subsequent focus group discussions (FGDs).

**Currently EBTKE is developing MEPS and labeling criteria for lighting. The efficacy values in the market are approximately twice as efficient as the minimum criteria in the draft regulations.** They are also significantly below requirements in other countries in the ASEAN region, which have had requirements for five to 10 years. These MEPS requirements as currently drafted will not result in hardly any energy reductions or $CO_2$ mitigation.

Based on a review of the market, other leading requirements, and an upcoming deadline under the ASEAN SHINE program, CLASP recommends a more stringent MEPS requirement of 80 lm/W for general service lighting. A technology neutral standard at 80 lm/W would not only eliminate the least efficient LEDs and most mercury containing CFLs, but it would finally eliminate incandescent lamps. Many countries around the world, including China, have long banned these inefficient lamps, which draw over seven times as much power as today's LEDs—power which they release as heat within the building.

Eliminating these lamps would protect Indonesian consumers from dumping and save significant money. While efficient LED lamps may be four times as expensive as incandescent, their long lifetimes and energy efficiency more than justify their higher up-front cost. At an average usage of 7.6 hours per day, payback is less than a month.

Finally, moving to 80 lm/W would fulfill Indonesia's commitment under the ASEAN SHINE program, which envisions 80 lm/W MEPS for LED bulbs, linear fluorescents, and LED linear replacements, by 2023. As LED technology is continuously improving, achieving this target early would result in maximum savings.

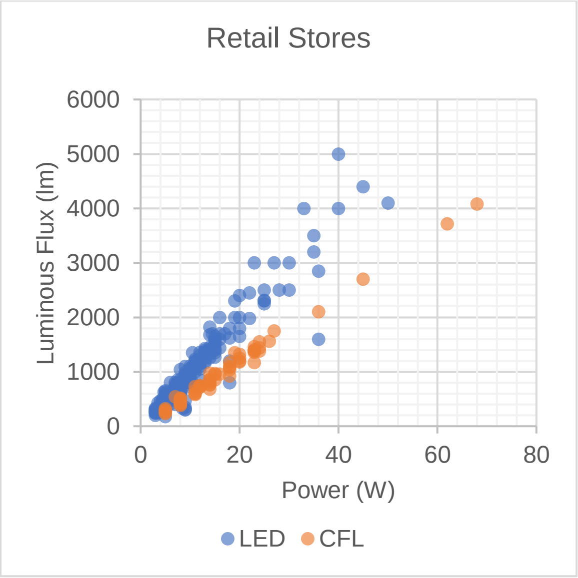
In addition, CLASP recommends building on the prior success in the street lighting sector, where the government has driven an almost complete transition from high-intensity discharge (HID) lamps to LED. While the government procurement specifications at 100 lm/W have been effective, LED technology has moved on and there is a further opportunity for energy reductions and $CO_2$ mitigation by increasing the stringency of street lighting to 130 lm/W.

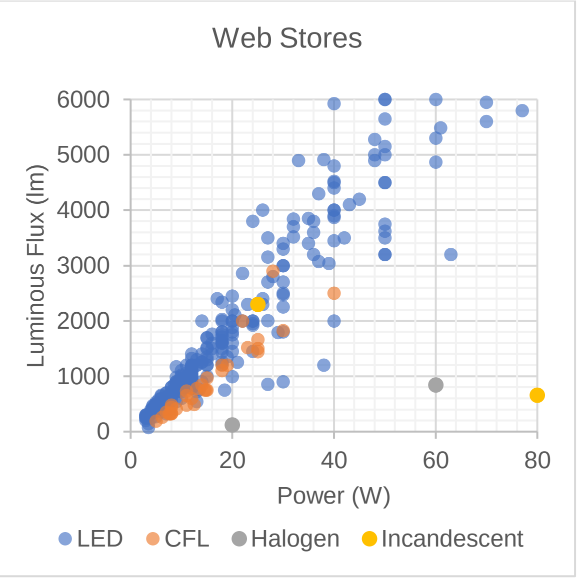
Together, these two MEPS would reduce Indonesia's energy consumption by 66 TWh 2020-2030 and mitigate over 58 MT $CO_2$. Higher star levels can encourage the purchase of even more efficient lamp models, leading to even greater reductions.

# Appendix A – Retailer Survey & Web Research Data

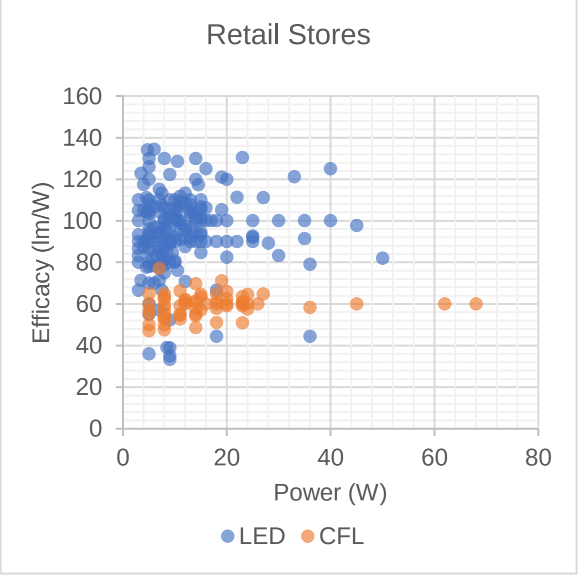
**Non-duplicate lighting products identified in retail and web stores**

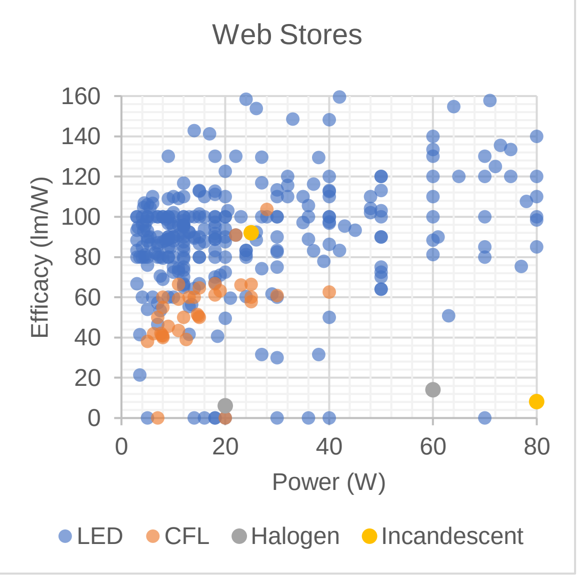
**Luminous flux and wattage**



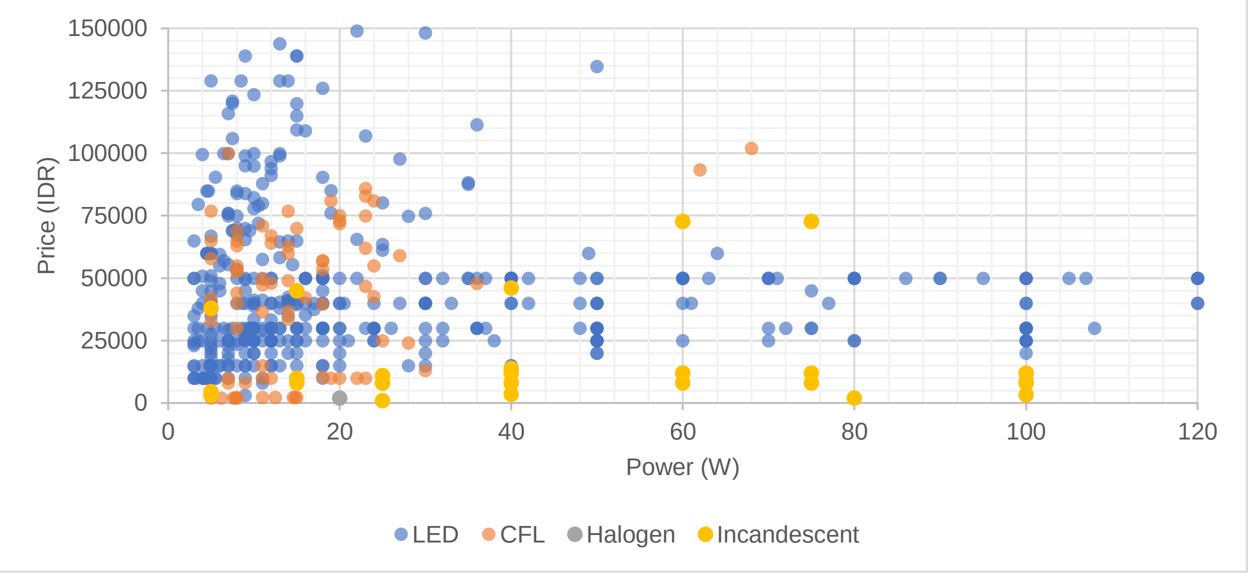




**Efficacy and wattage**



**Price and wattage**




a) Brands found in traditional retail stores

| No | Brands | Technology | Location |
|---|---|---|---|
| 1 | Cardilite | LED | Makassar |
| 2 | Javotec | LED | Makassar |
| 3 | Luften | LED | Makassar |
| 4 | Renesola | LED | Makassar |
| 5 | Opple | LED | Makassar, Surabaya |
| 6 | NVC | LED | Makassar, Medan, Surabaya |
| 7 | Megaman | LED | Makassar |
| 8 | Leuchtech | LED | Makassar, Medan |
| 9 | Fatro | LED | Makassar |
| 10 | Cahaya | LED | Makassar |
| 11 | Centralite | CFL | Makassar |
| 12 | Arashi | LED | Medan |
| 13 | Sunsonic | LED | Medan |
| 14 | Sunfree | LED | Medan |
| 15 | Surya | LED | Medan |
| 16 | Eclat | LED | Medan, Surabaya |
| 17 | Cahaya | LED | Medan |
| 18 | Morgen | LED | Medan |
| 19 | Visicom | LED | Medan |
| 20 | Sylvania | LED | Medan |
| 21 | Heles | LED | Medan |
| 22 | Mega | LED | Medan |

| | | | |
|---|---|---|---|
| 23 | Kingled | LED | Medan |
| 24 | Fujilight | LED | Medan |
| 25 | Ekonomat | LED | Surabaya |
| 26 | Chiyoda | LED | Surabaya |
| 27 | InLite | LED | Surabaya |
| 28 | Myth | LED | Surabaya |
| 29 | Brilliant | LED | Surabaya |
| 30 | Sky Holic | LED | Surabaya |
| 31 | Nerolight | LED | Surabaya |
| 32 | Hannochs | LED | Surabaya |
| 33 | Juara | LED | Surabaya |
| 34 | Vyba | LED | Surabaya |
| 35 | Focus | LED | Surabaya |
| 36 | Petir | LED | Surabaya |
| 37 | Masko | LED | Surabaya |
| 38 | Wilux | LED | Surabaya |
| 39 | Simon | LED | Surabaya |
| 40 | Meiwa | LED | Surabaya |
| 41 | Visicom | LED | Surabaya |
| 42 | Brighton | LED | Surabaya |
| 43 | Piolin | LED | Surabaya |
| 44 | Airam | LED | Surabaya |
| 45 | Intra | LED | Surabaya |
| 46 | Neko | LED | Surabaya |
| 47 | Million | LED | Surabaya |
| 48 | Badalux | LED | Surabaya |
| 49 | Toshiba | CFL | Surabaya |
| 50 | Shukaku | CFL | Surabaya |
| 51 | Leuchtech | CFL | Surabaya |
| 52 | GE | CFL | Surabaya |
| 53 | Mitsuyama | LED | Jakarta |
| 54 | Ecocity | LED | Jakarta |
| 55 | Itami | LED | Jakarta |
| 56 | Kyoku | LED | Jakarta |
| 57 | Seacamp | LED | Jakarta |
| 58 | Halopika | LED | Jakarta |
| 59 | Nero | LED | Jakarta |
| 60 | Myth | LED | Jakarta |
| 61 | Holylux | LED | Jakarta |
| 62 | Zetalux | LED | Jakarta |
| 63 | FTL | LED | Jakarta |

# Appendix B – Field Survey Methodology

An initial research based on interactions with industry experts and secondary research was taken up for the retailer market in Indonesia. From the data at hand and available resources, the below statistics of retailers in Indonesia were obtained.

*Table 37 Statistics of Retailers*[87]

| Retailer Type | Units |
|---|---|
| Electrical Shops | 72,000 |
| Building Material Shops | 15,000 |
| Mini Markets | 25,000 |
| Supermarkets | 1000 |
| Traditional Stores | 2,000,000 |

As per the above statistics, a reasonable sample size was selected (*excluding traditional stores*) to conduct retailer survey. The above statistics were considered to arrive at sample size of retailers. The sampling method is explained below.

### Proposed Sampling Methodology

The following approach was proposed for conducting the survey of retail stores in Indonesia:


[87] The data is taken from the website of Indonesian Electrical Lighting Association and the source is *'PT PLN (Persero) / Electricity State Enterprise, ESDM, Litbang Sentra Elektrik'*

### Determination of survey sample size

The survey samples were chosen to statistically represent the retail stores across the selected regions.

$$\text{Sample size } = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p(1-p)}{e^2 N}\right)}$$

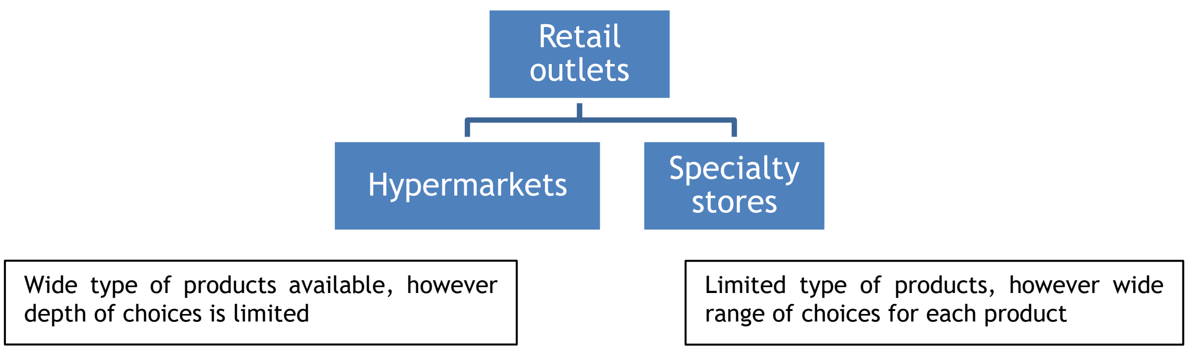
*Population Size = N, Margin of error = e, z-score = z, p is the sample proportion, e is percentage, put into decimal form.*

| Confidence/Margin of error | 9% | 7% | 5% | 3% |
|---|---|---|---|---|
| 80% | 51 | 84 | 164 | 455 |
| 85% | 64 | 106 | 207 | 576 |
| 90% | 84 | 138 | 271 | 752 |
| 95% | 119 | 196 | 384 | 1067 |
| 99% | 205 | 339 | 664 | 1843 |

As shown above, the sample size depends on the required confidence interval and the appropriate margin of error. We proposed confidence interval of 80% and a margin of error of 9%, making it a total of 51 field visits to retailers.

### Approach Selected for Selection of Retail Stores

Based on consultations with EBTKE and CLASP, the hypermarkets and specialty stores were selected for retailer survey. The approach was discussed with CLASP and EBTKE teams and the 1st phase retailer survey was conducted for Jakarta city. This was followed with retailer surveys at Bandung, Surabaya and Makassar. Also, during this time based on interviews with lighting associations (APERLINDO, GAMATRINDO) a greater dependence on imports was felt for the Eastern Indonesia (e.g. North Sulawesi, Papua, Makassar) lighting market. This region has proximity to China Australia trade route and hence there was a need identified to include it as part of the retailer survey.




Retailer surveys focused on common lighting technologies, models, wattages, brands, and retail prices supplied by lighting retailers in each country, including shopping malls/supermarkets, and specialty stores. Although the geographical coverage was limited, the findings were quite useful in understanding the lighting retail market. The retailer survey questionnaire was designed to identify number of lamp models available with each retailer. We assumed that lamp retailers would carry only models regularly sought by consumers and on-shelf availability would determine their popularity.

# Appendix C – Local Manufacturing Data

a) Below is the list of all GAMATRINDO members

| S No | Members of GAMATRINDO |
|---|---|
| **1** | PT Lighting Solution – Sidoarjo, Jawa Timur |
| **2** | PT Hikari – Jakarta Barat |
| **3** | PT. Panca Aditya Sejahtera – Surabaya & Nganjuk, Jawa Timur |
| **4** | PT. Sentra Solusi Elektrindo – Sidoarjo, Jawa Timur |
| **5** | PT. Sinar Angkasa Rungkut – Surabaya, Jawa Timur |
| **6** | PT. Moradon Berlian Sakti – Dadap, Tangerang, Banten |
| **7** | PT. Global Jaya Elektronik – Cikupa , Tangerang, Banten |
| **8** | PT. Infinity Light Indonesia – Cikupa, Tangerang, Banten (no longer) |
| **9** | PT. Suke Teknologi Indonesia – Jakarta Timur (closed) |
| **10** | CV. Sentosa Electric – Cimahi, Jawa Barat |

b) Production Capacity and utilization per year in units for GAMATRINDO members in Indonesia

| No | Lamp Type | Production Capacity per Year | Utilization per Year |
|---|---|---|---|
| **1** | LED Bulb | 56,420,000 | 5,507,600 |
| **2** | LED Filament | 1,600,000 | 800,000 |
| **3** | CFL | 79,010,000 | 18,740,000 |
| **4** | Incandescent Lamp | 40,160,000 | 15,846,400 |
| | ***Total - Household Lamps*** | ***177,190,000*** | ***40,894,000*** |
| **5** | LED Tubular | - | - |
| **6** | LED Street Lamp | 60,000 | 19,000 |
| | LED Flood Light | 115,000 | 30,500 |
| | LED High/Low Bay | - | - |
| | LED Downlight | 300,000 | - |
| | Solar Home | 100,000 | 80,000 |
| | ***Total - Luminaries*** | ***575,000*** | ***129,500*** |
| *Total* | | - | ***41,023,500*** |
| | **Worth, Labor & Investment** | **2017** | **2018** |
| **7** | Worth (Rupiah) | 576,000,000,000 | 258,359,000,000 |
| | Investment (Rupiah) | 15,850,000,000 | 18,150,000,000 |
| **8** | Labor | 2,371 | 1,393 |

# Appendix D – Status of Engagements with Stakeholders

Government stakeholders and associations

| No | Agencies | Meeting/calls | Remarks |
|---|---|---|---|
| 1 | Badan Pusat Statistik | Yes | Provided data |
| 2 | Indonesia National Single Window | Yes | Provided data |
| 3 | Ministry of Transportation | Yes | Provided street light data for national roads under their management |
| 4 | PT Jasa Marga | Yes | Provided street light data for some toll roads in Indonesia, pending others |
| 5 | Jakarta city government | Yes | Provided street light data |
| 6 | Bandung city government | Yes | Provided street light data |
| 7 | Bogor city government | Yes | Provided street light data |
| 8 | Surabaya city government | Yes | Provided street light data |
| 9 | South Tangerang city government | Yes | Provided street light data |
| 10 | Tangerang city government | Yes | Provided street light data |
| 11 | Makassar city government | Yes | Provided street light data |
| 12 | Medan city government | Yes | Pending street light data |
| 13 | APERLINDO | Yes | Provided market insights |
| 14 | AILKI | Yes | Provided data for 5 members (street light manufacturers) |
| 15 | GAMATRINDO | Yes | Provided market data for members. Validation of residential stock and sales model |
| 16 | ALINDO | Yes | Provided market insights |

Key manufacturers representing more than 75 % of market share in lighting

| No | Manufacturer/Importer | Brands | Status |
|---|---|---|---|
| 1 | PT Panasonic Lighting Indonesia | Panasonic | Completed |
| 2 | PT Signify Indonesia | Philips | Completed |
| 3 | PT Honoris Industry | Hori | Completed |
| 4 | Gamatrindo members | 10++ brands | Completed |
| 5 | Hannochs | Hannochs | Partially complete |

**Key takeaways**

- Validation checks for collected data as per short questionnaire completed with Signify and Hori
- Inputs and feedback taken from GAMATRINDO on market survey findings
- Typical Product Specifications collected for all above manufacturers from web research

APERLINDO Members

| No | Manufacturer | Brands | Status | Remark |
|---|---|---|---|---|
| 1 | PT Citra Hannochs Niagantara | Hannochs, Arashi, Winova, Mitsui | Pending response on sales figures | Follow up (calls and messages) |
| 2 | PT Pancaran Indonesia | Cahaya | Contacted | No responses despite follow ups |
| 3 | PT Shukaku Indonesia | Shukaku | Contacted | No responses despite follow ups |
| 4 | PT Tjipto Langgeng Abadi | Focus | Contacted | No responses despite follow ups |

| | | | | |
|---|---|---|---|---|
| 5 | PT Golden Batam Raya / PT Prima Makmur Indonesia | Visalux | Contacted | No responses despite follow ups |
| 6 | PT Gunawan Elektrindo | Visicom | Contacted | No responses despite follow ups |
| 7 | PT Sinarmonas Industries | Sinarmonas | Contacted | No responses despite follow ups |
| 8 | PT Ningbo Global Lamp | Shinyoku | Contacted | No responses despite follow ups |
| 9 | PT Saka Agung Karya Abadi | Saka | Contacted | No responses despite follow ups |
| 10 | PT Chint Indonesia | Chint | Contacted | No responses despite follow ups |
| **11** | **PT Karya Energi Semesta** | **Letsa** | **Completed** | **Done** |
| 12 | PT Himel Indonesia | Himel | Contacted | No responses despite follow ups |
| 13 | PT Indikom Semesta Sampoerna | Nikita | Contacted | No responses despite follow ups |
| 14 | PT Artolite Indah Mediatama | Artolite | Contacted | No responses despite follow ups |
| 15 | PT Valensi Cahaya Persada | Valensi | Contacted | No responses despite follow ups |
| 16 | PT YLI Industry Indonesia | YLI | Contacted | No responses despite follow ups |
| 17 | PT Kharisma Sinarlindo Perkasa | Powerled | Contacted | No responses despite follow ups |

| | | | | |
|---|---|---|---|---|
| 18 | PT Sumber Klik Sejahtera | StarkLed | No contact details | Not listed in Yellow Pages, not registered in Telkom |
| 19 | PT Sumber Digital Media | Tanaka | Contacted | No responses despite follow ups |
| 20 | PT Jaya Eco Energi | Chikara, Jishan | Completed | Done |
| **21** | **PT Robin Litten Indonesia** | **Repro** | **Contacted** | **Refused** |
| 22 | PT Emperor Light Indonesia | Emperor | Contacted | No responses despite follow ups |
| 23 | PT Ligman Indonesia | Ligman | Contacted | No responses despite follow ups |
| 24 | PT HK Electric | Cree, Griff | Completed | Done |
| 25 | PT Holz International Technology | Holz | Contacted | No responses despite follow ups |
| 26 | PT Gloria Mandiri Perkasa | Vyba | Contacted | No responses despite follow ups |
| 27 | PT Kingled Indonesia | Kingled | Contacted | No responses despite follow ups |
| 28 | PT Omni Lumins Cemerlang | Everlight | Contacted | No responses despite follow ups |
| 29 | PT Sinar Angkasa Rungkut | Chiyoda | Completed | Done |
| **30** | **PT Solarens Ledindo** | **Solarens** | **Completed** | **Done** |
| **31** | **PT Kensign Jaya Mandiri** | **Talled** | **Contacted** | **No responses despite follow ups** |
| 32 | PT Sinko Prima Alloy ` | Elitech | Contacted – now | Done |

| | | | | |
|---|---|---|---|---|
| | | | focusing on medical equipment | |
| 33 | PT Prima Medan Lestari | Fujilight | Contacted | No responses despite follow ups |
| 34 | PT Aierdane Indonesia | Aierdane | Contacted | No responses despite follow ups |
| 35 | PT Dian Satellite Unggul | Dynalux | Contacted | No responses despite follow ups |
| 36 | Feilo Sylvania Sdn Bhd (Malaysia) | Sylvania | Contacted | No responses despite follow ups |
| 37 | PT Ecogreen Clean Teknologi | Eco Green | Contacted | No responses despite follow ups |
| 38 | PT Krisna Karya Teknik LED | Luxmenn | Contacted | No responses despite follow ups |

6 out of 39 Aperlindo members are producers. The rest are importers. In addition, there are 3 members which were part of key manufacturers and hence not included in above table.

a) Bang-Beni (products with SNI) – Additional brands

| No | Manufacturer/Importer | Brands | Status | Remarks |
|---|---|---|---|---|
| 1 | PT Boxon Nikkon Jayaindo | Nikkon | Contacted | No responses despite follow ups |
| 2 | CV Slast Indonesia | Slast | No contact details | Not listed in Yellow Pages, not registered in Telkom |
| 3 | PT Nobi Putra Angkasa | Nobi | Contacted | No responses despite follow ups |

| | | | | |
|---|---|---|---|---|
| 4 | PT LED Pro Idn | Ledpro | No contact details | Not listed in Yellow Pages, not registered in Telkom |
| 5 | PT Indo Avatar Sejati | Allumia | Contacted | No responses despite follow ups |
| 6 | PT Cipta Sinergi Asia | Ecoluxon | Contacted | No responses despite follow ups |
| 7 | PT Primamitra Abadi Sentosa | Primalux | Contacted | No responses despite follow ups |
| 8 | PT Global Persada Internusa | Camus | No contact details | Not listed in Yellow Pages, not registered in Telkom |
| 9 | PT Meval Indonesia | Meval | Contacted | No responses despite follow ups |
| 10 | PT Young Jin Indonesia | GlowOne | No contact details | Not listed in Yellow Pages, not registered in Telkom |
| 11 | PT Kawachi Lighting | Kawachi | Contacted | No responses despite follow ups |
| 12 | PT Samudera Insan Teknik | Ledicon Light | Contacted | No responses despite follow ups |

# Appendix E – Stock and Shipments Model

## Introduction

As mentioned in the body of the report, the lighting market in Indonesia is diverse, with four trade associations and many manufacturers and importers. These market players supply a variety of lighting technologies to three main sectors: residential, professional, and outdoor, which consists of both street lighting as well as area lighting (e.g., outsides of buildings and car parking). Each market player could provide a partial view and despite discussions with many of them, the team was unable to develop a unified view based solely on interviews, manufacturer or importer production data, or association statistics. Instead, the team developed a stock and shipments model that drew on all these inputs and provided a total view of the market.

## Imports

Multiple stakeholders commented that the Indonesia lighting market is primarily composed of imports, estimated at 80% of volume. The main exception is public street lighting, which is procured by the government, and is therefore limited to local production.

Therefore, CLASP started with Indonesia import statistics from three sources: the Statistics Bureau BPS, Indonesia National Single Window (INSW) trade statistics, and UN Comtrade. BPS was the most detailed, providing data over the past five years for all lamp types using 8-digit HS Codes, which differentiate between different types of lamps of a single technology (e.g., incandescent lights for general illumination versus other use) as well as whole lamps versus parts. However, BPS reported data only in terms of weight. In contrast, the INSW data were expressed in terms of units, but were not as complete or detailed (e.g., did not include shipments for incandescent lamps and only included LED shipments for the past three years).

To estimate the unit shipments, CLASP multiplied the weights reported by BPS by average weights as provided by UN Comtrade over the past five years. While it is possible to calculate average weights based on the ratio of INSW unit shipments and BPS weights, CLASP elected to use UN Comtrade weights for three reasons:

1. The UN Comtrade average weights came from a single source, rather than being calculated from two sources;
2. The UN Comtrade average weights were higher than the ratio of INSW units and BPS weights, which would result in lower unit imports and therefore a more conservative energy reduction potential; and
3. The final residential lighting stock based on the UN Comtrade average weights (339 million) better aligned with other sources of data (CLASP's residential end-use survey, which found 352 million residential lamps in use in 2019 and IIEC's 2014 estimate, which estimated 378 million residential lamps in use).

The table below shows UN Comtrade weights used in the model as well as the average weights calculated from INSW and BPS data.

| Lamp Technology | Average Weight Per Lamp (kg) | |
|---|---|---|
| | UN Comtrade (Used in Model) | Ratio of INSW Units and BPS Weights |
| **Incandescent** | 0.078 | NA |
| **Halogen** | 0.078 | NA |
| **CFL** | 0.146 | 0.114 |
| **LFL** | 0.146 | 0.126 |
| **HID** | 0.649 | 0.506 |
| **LED** | 0.184 | 0.104 |

The resultant imports by technology over the past five years are shown below.

| Lamp Technology | Imports based on BPS Weights and UN Comtrade Average Weight (units) | | | | |
|---|---|---|---|---|---|
| | 2015 | 2016 | 2017 | 2018 | 2019 |
| **Incandescent** | 35,212,865 | 49,828,253 | 36,267,602 | 25,209,530 | 16,206,915 |
| **Halogen** | 6,478,227 | 10,445,881 | 9,365,889 | 9,239,194 | 7,066,719 |
| **CFL** | 90,025,228 | 74,639,318 | 70,825,790 | 53,907,290 | 35,590,797 |
| **LFL** | 10,533,849 | 8,728,059 | 7,694,221 | 5,294,618 | 3,922,119 |
| **HID** | 458,426 | 745,765 | 561,656 | 828,133 | 540,327 |
| **LED** | 88,347,162 | 53,267,918 | 44,848,291 | 63,323,340 | 53,509,729 |
| **Total** | **231,055,756** | **197,655,194** | **169,563,449** | **157,802,105** | **116,836,607** |

## Shipments

CLASP then estimated the local production for each of the above lamp types based on the ratio of local assembly in 2018, as provided by Gamatrindo and other local manufacturers, to the 2018 imports estimated above. For lamp types for which CLASP received less than 10,000 units of local production (halogen, HID, and linear fluorescent), CLASP applied a generic ratio of 28% based on the total number of locally assembled lamps (62 million) to imports (158 million). This is consistent with stakeholder information that 20% of lighting products that are locally manufactured, while 80% are imported (20%/80% = 25%). The locally assembled totals received by CLASP and ratio of imports appear in the table below (an asterisk, "*", indicates that the generic ratio was used).

| Lamp Technology | Local Assembly in 2018 | Calculated Ratio of Local Assembly to Imports |
|---|---|---|
| **Incandescent** | 15,846,400 | 39% |
| **Halogen** | 123 | 28%* |
| **CFL** | 18,740,000 | 26% |
| **LFL** | 0 | 28%* |
| **HID** | 578 | 28%* |
| **LED** | 9,070,249 | 13% |
| **Unspecified Lamp Type** | 18,480,000 | |
| **Total** | **62,137,350** | **28%** |

These ratios were used to calculate local shipments based on the imports over all years (2012-2019). Next, CLASP divided the imports and local production by sector: residential, professional, and outdoor. The professional sector includes both professional buildings and industrial facilities, while the outdoor sector includes both public street lighting, as well as illumination outside residential, commercial, and industrial buildings, and parking garages.

The splits by sector were based on information shared by a major importer, the stock split used by United for Efficiency in the development of their global lighting model in 2019, and trade association inputs that 50% of incandescent lamps are used in the professional sector. The importer's stock split was applied to its share of the imports, while United for Efficiency's splits were applied to the remainder, with the 50% residential-professional incandescent split applied to domestic production. Finally, as the reported imports varied significantly year-to-year, the totals were smoothed by taking an average of the previous two years (mimicking warehousing). The tables below show the smoothed total shipments (imports and local assembly) for each lamp type across the three sectors over the past five years.

| Residential Total Shipments | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|
| **Incandescent** | 25,172,530 | 31,161,807 | 31,548,296 | 22,527,203 | 15,176,320 |
| **Halogen** | 4,990,514 | 7,490,131 | 8,768,129 | 8,234,084 | 7,216,536 |
| **CFL** | 76,534,095 | 66,025,527 | 58,327,130 | 50,014,211 | 35,886,040 |
| **LFL** | 2,336,250 | 3,116,543 | 2,657,096 | 2,101,571 | 1,491,252 |
| **Mercury Vapour** | 926 | 1,119 | 1,215 | 1,291 | 1,272 |
| **High Pressure Sodium** | 926 | 1,119 | 1,215 | 1,291 | 1,272 |
| **Metal Halide** | 926 | 1,119 | 1,215 | 1,291 | 1,272 |
| **LED** | 27,228,007 | 34,350,873 | 23,799,566 | 26,238,660 | 28,339,623 |
| **Total** | **136,264,172** | **142,148,237** | **125,103,862** | **109,119,603** | **88,113,585** |

| Professional Total Shipments | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|
| **Incandescent** | 25,172,530 | 31,161,807 | 31,548,296 | 22,527,203 | 15,176,320 |
| **Halogen** | 2,046,259 | 3,071,176 | 3,595,193 | 3,376,219 | 2,958,994 |
| **CFL** | 38,635,179 | 33,330,349 | 29,444,121 | 25,247,676 | 18,115,633 |
| **LFL** | 6,464,064 | 8,623,019 | 7,351,796 | 5,814,741 | 4,126,076 |
| **Mercury Vapour** | 109,635 | 132,526 | 143,887 | 152,952 | 150,605 |
| **High Pressure Sodium** | 109,635 | 132,526 | 143,887 | 152,952 | 150,605 |
| **Metal Halide** | 118,891 | 143,715 | 156,036 | 165,866 | 163,320 |
| **LED** | 26,795,595 | 33,805,342 | 23,421,602 | 25,821,960 | 27,889,557 |
| **Total** | **99,451,787** | **110,400,460** | **95,804,818** | **83,259,568** | **68,731,110** |

| Outdoor Total Shipments | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|
| **Incandescent** | - | - | - | - | - |
| **Halogen** | 35,590 | 53,415 | 62,529 | 58,721 | 51,464 |
| **CFL** | 582,487 | 502,508 | 443,917 | 380,649 | 273,122 |
| **LFL** | 255,938 | 341,419 | 291,086 | 230,228 | 163,367 |
| **Mercury Vapour** | 97,708 | 118,109 | 128,234 | 136,313 | 134,221 |
| **High Pressure Sodium** | 97,708 | 118,109 | 128,234 | 136,313 | 134,221 |
| **Metal Halide** | 88,452 | 106,920 | 116,086 | 123,399 | 121,505 |
| **LED** | 3,724,323 | 4,698,608 | 3,255,371 | 3,588,997 | 3,876,373 |
| **Total** | **4,882,204** | **5,939,088** | **4,425,457** | **4,654,620** | **4,754,273** |

## Stock Accumulation

Finally, CLASP accumulated the total shipments (both imported and locally manufactured) by technology and sector to estimate the current stock. Once in service, lamps were retired and removed based on a logistic *s*-curve that depended on their lifetime and usage. Lifetime is defined as the number of hours of operation after which 50% of the lamps would be retired and depends primarily on technology but also on the sector in which the lamp is used. Professional and outdoor lamps of a given technology tend to be longer lived then their residential counterparts. The lamps' usage depends primarily on sector, with residential lamps typically used for 7.6 hours per day, professional lamps used for 7.1 hours (10 hours during workdays and 0 hours during weekends), and outdoor for 11.5 hours.

An example stock accumulation table for residential incandescent lamps appears below. Similar tables were developed for each technology and sector.

| | | | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Stock | 20,335,769 | 28,350,862 | 28,507,608 | 28,822,932 | 32,369,721 | 34,623,846 | 30,537,401 | 23,808,217 |
| | Stock | % inst. | 57% | 33% | 15% | 6% | 2% | 1% | 0% | 0% |
| 2012 | 20,335,769 | 57% | 20,335,769 | - | - | - | - | - | - | - |
| 2013 | 28,350,862 | 33% | 11,713,426 | 16,637,436 | - | - | - | - | - | - |
| 2014 | 28,507,608 | 15% | 5,441,655 | 9,583,182 | 13,482,771 | - | - | - | - | - |
| 2015 | 28,822,932 | 6% | 2,216,144 | 4,452,017 | 7,766,092 | 14,388,680 | - | - | - | - |
| 2016 | 32,369,721 | 2% | 848,692 | 1,813,108 | 3,607,859 | 8,287,896 | 17,812,166 | - | - | - |
| 2017 | 34,623,846 | 1% | 316,996 | 694,346 | 1,469,320 | 3,850,272 | 10,259,828 | 18,033,084 | - | - |
| 2018 | 30,537,401 | 0% | 117,277 | 259,346 | 562,689 | 1,568,044 | 4,766,363 | 10,387,077 | 12,876,605 | - |
| 2019 | 23,808,217 | 0% | 43,234 | 95,949 | 210,171 | 600,496 | 1,941,127 | 4,825,479 | 7,416,939 | 8,674,822 |
| 2020 | 21,643,834 | 0% | 15,917 | 35,371 | 77,756 | 224,292 | 743,372 | 1,965,202 | 3,445,655 | 4,996,707 |
| 2021 | 19,479,450 | 0% | 5,857 | 13,022 | 28,664 | 82,980 | 277,658 | 752,592 | 1,403,262 | 2,321,299 |
| 2022 | 17,315,067 | 0% | 2,155 | 4,792 | 10,553 | 30,590 | 102,723 | 281,102 | 537,391 | 945,361 |
| 2023 | 15,150,684 | 0% | 793 | 1,763 | 3,883 | 11,262 | 37,869 | 103,997 | 200,722 | 362,034 |
| 2024 | 12,986,300 | 0% | 292 | 649 | 1,429 | 4,144 | 13,942 | 38,338 | 74,260 | 135,224 |
| 2025 | 10,821,917 | 0% | 107 | 239 | 526 | 1,525 | 5,130 | 14,115 | 27,376 | 50,028 |
| 2026 | 8,657,533 | 0% | 39 | 88 | 193 | 561 | 1,888 | 5,194 | 10,079 | 18,443 |
| 2027 | 6,493,150 | 0% | 15 | 32 | 71 | 206 | 694 | 1,911 | 3,709 | 6,790 |
| 2028 | 4,328,767 | 0% | 5 | 12 | 26 | 76 | 255 | 703 | 1,365 | 2,499 |
| 2029 | 2,164,383 | 0% | 2 | 4 | 10 | 28 | 94 | 259 | 502 | 919 |
| 2030 | 925,497 | 0% | 1 | 2 | 4 | 10 | 35 | 95 | 185 | 338 |

## Results

The resultant stock for 2019 appears for each sector in the table below. Given typical wattages for each type of lamp (e.g., 67 W incandescent, 9 W LED), the residential stock would consume 15% of residential energy consumption, while the commercial stock would consume 17% of commercial electricity consumption.

| Lamps in Use (Stock) | Residential | Professional | Outdoor | Total Indonesia |
|---|---|---|---|---|
| **Incandescent** | 23,808,217 | 24,109,198 | - | **47,917,415** |
| **Halogen** | 11,273,303 | 4,741,549 | 70,248 | **16,085,101** |
| **CFL** | 139,864,018 | 74,832,500 | 767,423 | **215,463,942** |
| **LFL** | 13,782,323 | 42,211,884 | 1,162,671 | **57,156,878** |
| **Mercury Vapour** | 8,330 | 1,020,936 | 645,805 | **1,675,071** |
| **High Pressure Sodium** | 8,738 | 1,059,482 | 697,045 | **1,765,265** |
| **Metal Halide** | 7,461 | 1,004,548 | 513,523 | **1,525,532** |
| **LED** | 145,479,400 | 174,721,748 | 22,754,638 | **342,955,787** |
| **Total** | **334,231,791** | **323,701,845** | **26,611,354** | **684,544,990** |

And below, it appears as a fraction of the total lamps in each sector.

| Stock Share by Technology and Sector (Read Down) | Residential | Professional | Outdoor |
|---|---|---|---|
| **Incandescent** | 7% | 7% | 0% |
| **Halogen** | 3% | 1% | 0% |
| **CFL** | 42% | 23% | 3% |
| **LFL** | 4% | 13% | 4% |
| **Mercury Vapour** | 0% | 0% | 2% |
| **High Pressure Sodium** | 0% | 0% | 3% |
| **Metal Halide** | 0% | 0% | 2% |
| **LED** | 44% | 54% | 86% |
| **Total** | **100%** | **100%** | **100%** |

## Forecasts

Finally, to forecast the stock and shipments through 2030, CLASP used the following assumptions on stock growth rate: 3.5% for residential (income growth) and 5% for professional and outdoor (GDP growth). However, to avoid a sudden jump in forecast shipments, the stock growth rate was adjusted slowly to reach this target growth rate: each year, the stock growth rate was calculated as the average of the long-term growth rate, above, and the growth rate the year before. As a result, the above rates were not achieved until approximately 2025 (residential and professional growth was initially lower, while outdoor growth was initially higher).

The total stock in each year was increased by the growth rate for that year; however, the stock of each lamp technology would vary as follows:

1. The stock of all non-LED legacy technologies would fall by 1/11. This fraction reflects the ongoing LED transition, and assumes that it will be complete by 2030.
2. The LED stock increases to make up the difference between the present year stock, the new increased stock, and the declining stock of non-LED legacy technologies.

Once the stock of each lighting technology was calculated for the forecast year, the shipments for the year were calculated as the difference between the previous year's stock, the current year's stock, and any retirements in that year.

# Appendix F – International Case Study of UJALA Scheme

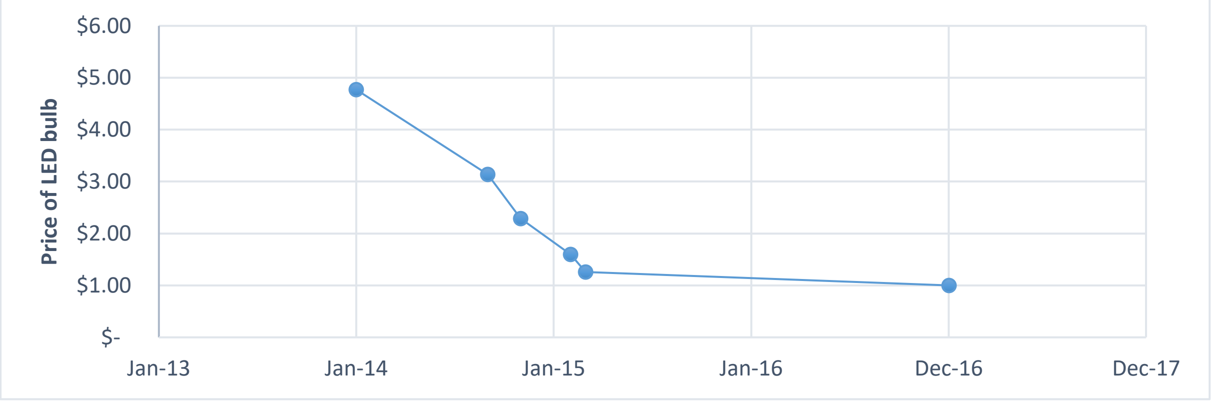
The Government of India launched a zero-subsidy nationwide domestic lighting replacement program in January 2015, to promote LEDs in the Indian residential sector called Unnat Jyoti by Affordable LEDs for All (UJALA).[88] This program was implemented by Energy Efficiency Services Limited (EESL), a publicly owned energy services company. The ultimate purpose of the program was to reduce the cost of LED bulbs in India, thereby increasing their market penetration, driving out inefficient lighting technologies from the market, and reducing energy consumption. As of 16 April 2020, UJALA's live national dashboard boasts an impressive 362 million light bulbs distributed across 120 cities, and 1,634 million LEDs sold by the industry by January 2020.[89]

The most important barrier for uptake of LED lamps in the country was their high price when compared to other technologies, including CFL. To overcome this challenge, EESL adopted a demand aggregation strategy to reduce the effective price of LED bulbs through economies of scale. EESL aggregated the demand from various parts of the country and procured large quantity of LED bulbs through an open tendering mechanism and selected the technically qualified bidder on a least cost basis.

EESL bought LED bulbs in bulk from manufacturers through many rounds of competitive bidding. The sheer volumes and long-term contracts incentivized the manufacturers to drop the bid price from Rs. 310 per LED bulb in the first round to as low as Rs. 38 in later rounds. Distribution was planned via retail networks (including e-commerce sites such as Amazon.in), special kiosks, and institutional networks (less important over time). EESL also directly to consumers, bypassing the retail supply chain and further bringing down the final distribution price. As a result, the current price of LED bulbs under UJALA is Rs. 70, about half of the price of LED bulbs available in shops. There is no subsidy from the government or the electric distribution companies (discoms).

Through this strategy, the effective price of 7 W LED bulbs was reduced from USD 4.77 in Jan 2014 to USD 1.26 in Mar 2015. In Jan 2017 the prices dropped further to approximately USD 1. Also, by end of 2017, EESL introduced 9 W LED bulbs at this price.

*Price drop for LEDs in India (case study)*




Along with price reduction, EESL adopted an innovative method called "On Bill Financing (OBF)", in which consumers are provided LED bulbs at an upfront payment of USD 0.167 and the remaining amount was deducted from their electricity bills over a span of 12 months on average. This led to greater market acceptability of LED bulbs and led to a complete market transformation of the lighting market in India.

[88] EESL & IEA, "India's UJALA Story – Energy Efficient Prosperity", 2017, https://www.eeslindia.org/content/dam/doitassets/eesl/pdf/programmes/UJALA/UJALA_Case_Studies_1.pdf
[89] India Ministry of Power, "National UJALA Dashboard - EESL", accessed May 27, 2020, https://www.ujala.gov.in/.

EESL also conducted innovative marketing campaigns to create public awareness. According to market research, the India LED lighting market is projected to grow at a CAGR of 23.6% during 2019-2025.

### Impacts on Manufacturers and Consumers

Through the UJALA program, significant bulk demand volume was created. Local manufacturers were able to cost-effectively invest in local assembly lines, gaining better profit as compared to importing. Manufacturers were also provided a streamlined distribution network through EESL, which significantly reduced transportation costs. EESL also paid up-front to ease cash flow burden for small manufacturersand took the lead to advertise LEDs at the national level.

Based on a study conducted by Prayas Energy Group (PEG) Pune, despite these incentives, the manufacturers' response was not uniform. Some were enthusiastic and made significant investments in assembly lines; others decided to withdraw as the price went down with successive aggressive bidding. PEG states that the number of bidders was high in the initial bidding phases, involving local manufacturers (those that sell their products domestically and those that generally export), and importers of light bulbs from China. Despite this fact, preference was given to locally manufactured LED bulbs.[90]

All LED products procured by the government and for government schemes must have 50% of the components manufactured domestically.[91] EESL issued a list of bidding requirements for the online tendering. Through these requirements, EESL ensured that only financially established suppliers that had ISO-certified facilities in India can participate and allowed only high-quality LEDs to be procured. The bulbs must have at least three star certification from BEE and come with a three-year replacement warranty for technical damages (excluding physical damages).[92]

From the eligible bidders, EESL then selected up to 5 the winners through online reverse auctions. The bidder with the lowest price would secure a contract for at least 30% of the total quantity, the bidder with the second lowest price with a contract for at least 25%, the third lowest with at least 20%, and so on until the fifth lowest would obtain at least 10%. A consortium of Micro, Small and Medium Enterprises (MSMEs) registered with the National Small Industries Corporation (NSIC) would be allocated with the reserved 20% of the total quantity.[93] Bidding requirements also apply to MSMEs, in which NSIC was held responsible in assuring all conditions of the contract were met.

A few big companies did not participate in the program at all and took a different approach to increase production capacity based on market demand outside the UJALA program. These companies distinguished themselves from the brands being sold under the UJALA program, marketing higher quality products. These products were also priced competitively against LEDs offered through the program. Despite these contrasting responses, many small manufacturers formed consortiums to pool resources and enable more competitive bidding. As the result, a number of small-scale LED manufacturing hubs have been established in Maharashtra, Delhi, Uttar Pradesh and Haryana.

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[90] Prayas Energy Group, "Understanding the impacts of India's LED bulb programme, "UJALA", August 2017, 14, https://www.prayaspune.org/peg/publications/item/354-understanding-the-impacts-of-india-s-led-bulb-programme-ujala.html

[91] Ministry of Electronics and Information Technology, India, "Policy for Preference to Domestically Manufactured Electronic Products in Government Procurement. Notification No. 33 (3)/2013-IPHW)", 2013, http://www.keralapost.gov.in/Downloads/DMEPS.pdf

[92] Energy Efficiency Services Limited, "Detailed Invitation for Bids (IFB) for Design, Manufacture & Supply of Self-ballasted 9 Watt LED Bulbs on Pan- India basis, with 3 Years' Warranty & Other Related Works. NIT/Bid Document No.: EESL/06/2016-17/Supply-9W LED Bulbs/1617039.", 2016a, https://eesl.eproc.in/ProductEESL/publicDash

[93] Prayas Energy Group, "Understanding the impacts of India's LED bulb programme, "UJALA", August 2017, 50, https://www.prayaspune.org/peg/publications/item/354-understanding-the-impacts-of-india-s-led-bulb-programme-ujala.html

Currently, there are about 300 registered companies selling LED bulbs in India.[94] However, only 10 to 11 of these companies own 70% of national LED market share. ELCOMA, the manufacturing association, has about 60 registered members.[95] There are about 176 different assembly units in India, a third of them in the Delhi National Capital Region (NCR). In addition to local manufacturing, the industry still imports LED bulbs from about 50 units located in China.

UJALA has significantly contributed to increased consumer awareness of LEDs. In a consumer survey involving 1,029 participants across Pune, Lucknow, and Puduchery, about 39% households in Pune and 50% in Lucknow learned about LEDs through the program. The survey also showed that over half of the households would not have bought LED bulbs if not for the program. The primary reason cited for buying LED bulbs was the reduction in the electricity bill. Nearly one-third of the households in Pune bought LED products under the UJALA program because of the lower price, whereas only few households cited 'good for environment' as their primary reason for buying LED bulbs.[96]

### Impacts at the National Level

1. Reduction in annual household electricity bills by about 15%, equivalent to over 16 billion INR
    - Equivalent to the gross domestic product (GDP) of Mumbai
2. $CO_2$ emissions mitigation of 3 Mt/yr
    - Equivalent to the annual emissions of one 500 MW coal fired power plant or removing 2.7 million cars from the road per year
3. India became the second largest LED market globally at 21.4 billion INR in annual revenues[97]
    - 10x market growth within 5 years, and significant increase in local manufacturing from 3 million LED bulbs in 2013 to 62 million in 2015 (ELCOMA)
    - Significant increase in LED penetration in residential lighting, from 0.1% in 2014 to 15% in 2014 (ELCOMA)
    - Achieved one of the fastest LED price reductions in the world—rapidly advanced public acceptance and product availability in the Indian market
    - Established high quality by including three-year warranty requirement

Although the program missed its 2019 target of replacing 770 million inefficient lamps with LEDs, UJALA remains a successful example of market transformation through demand aggregation, mass awareness, and bulk procurement. Moving ahead, the program will be aimed toward lower income households and small commercial establishments who still purchase incandescent bulbs. A possible approach is to reemphasize on-bill financing.

Half of the demand for LED bulbs in India is still generated through the UJALA program. To ensure LED distribution carries on through the existing vast network of dealers and retailers across India, EESL has to execute a gradual exit strategy. Otherwise, a sudden termination of the program could result in a sharp drop in demand and a price increase.

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[94] Bureau of Indian Standards – BIS, "Registered Products with BIS", accssed March 30, 2017, http://crsbis.in/BIS/listregmfr.do
[95] Electric Lamp and Component Manufacturers of India - ELCOMA, http://elcomaindia.com/listing
[96] Centre for Policy Research, "India's LED Lighting Story.", accessed May 27, 2020, https://cprindia.org/news/6527
[97] EESL & IEA, "India's UJALA Story – Energy Efficient Prosperity", 2017, https://www.eeslindia.org/content/dam/doitassets/eesl/pdf/programmes/UJALA/UJALA_Case_Studies_1.pdf

# Appendix G – Overview of the Four Common General Lighting Service Lamp Technologies

## Incandescent and Halogen Lamp

Originally developed in the late 1800's, incandescent lamps produce light by passing electrical current through a tungsten metal wire (i.e., "filament") which is suspended in an inert atmosphere inside a glass bulb. The electric current causes the metal wire to heat up so much that it produces visible and non-visible (infrared) light. The infrared light output can be felt as 'heat' being emitted from the lamp, and more than 95% of the energy consumed by the light is emitted as non-visible (infrared) light.

Halogen lamps are an innovation that was introduced in the 1960's as an improvement over incandescent lamps. Halogen lamps offer slightly better efficacy and longer lamp life. These lamps contain a small quantity of halogen (iodine or bromine) inside a filament capsule which re-deposits evaporated tungsten back onto the filament, preventing the blackening of the filament capsule and increasing the lamp lifetime.

**Advantages of incandescent and halogen**

- Low first cost
- High color rendering index (Ra=100)
- No control gear needed
- Easily dimmed
- Universal operating position

**)isadvantages of Incandescent and halogen**

- Low efficacy (lots of wasted electricity in the form of heat)
- Short lifetime, incandescent typically 1,000 hours; halogen typically 3,000 hours
- High running costs (i.e. electricity use)
- High operating temperature
- Only available in low color temperature (CCT of 2600K – 3200K)

The following table provides a summary of some of the key features of incandescent and halogen general lighting service lamps.

*Table G1. Incandescent and halogen lighting typical performance specification*

| Characteristic | Typical Incandescent Lamp | Typical Halogen Lamp |
|---|---|---|
| Luminous efficacy range | 8-15 lm/W | 11-18 lm/W |
| Lamp lifetime | 1000-1500 hr | 2000-3000 hr |
| Color rendering index (Ra) | 100 | 100 |
| Correlated color temperature | 2600-2800 K | 2800-3200 K |
| Dimmable? | Yes | Yes |

## Compact Fluorescent Lamp

Compact fluorescent lamps (CFLs) are direct retrofits for incandescent and halogen lamps and have been marketed in the past as an energy-efficient alternative to these lamps. The CFL lamp incorporates an electronic ballast into the base of the lamp and has a phosphor-lined glass tube. An electrical arc is struck between the tube's electrodes, causing electrons to collide with the mercury vapor atoms. This results in the emission of ultraviolet (UV) light, which in turn stimulates the phosphor coating to emit visible light. CFLs were developed in the 1970s and are essentially a miniaturized version of a linear fluorescent lamp system. Compared to incandescent lamps, CFLs use about 75 percent less electricity while producing the same amount of light. CFLs also last six to eight times longer, with a typical lifetime of 6,000 to 12,000 hours.

The main issue with CFLs today is that they contain mercury, which is a very dangerous elemental chemical that is a neurotoxin in humans and causes environmental damage to flora and fauna alike. If CFLs are not collected in a responsible manner at the end of life, they could emit that mercury into the environment, and result in poisoning of soil and water run-off from a municipal landfill. UN Environment convened countries around the world and has established the Minamata Convention in an effort to phase-out the use of mercury in all applications, including lighting. CFLs currently have an exemption from the convention, and that exemption is under review.

Finally, it is important to note that CFLs are no longer being invested in. This technology has since been supplanted by LED technology, and thus industry has stopped innovating and improving CFL lamps. They are still sold, but sales are in decline and efficacy and quality will not improve compared to what's in the market today.

**Advantages of CFLs**

- Low running costs
- High efficacy
- Long operating life
- Good to very good color rendering
- A wide range of color temperatures

**Disadvantages of CFLs**

- Contains mercury
- Frequent switching can shorten life
- Dimming is difficult / needs a special ballast
- R&D investment has stopped; not expected to improve in quality or performance

*Table G2. Compact fluorescent Lamp typical performance specification*

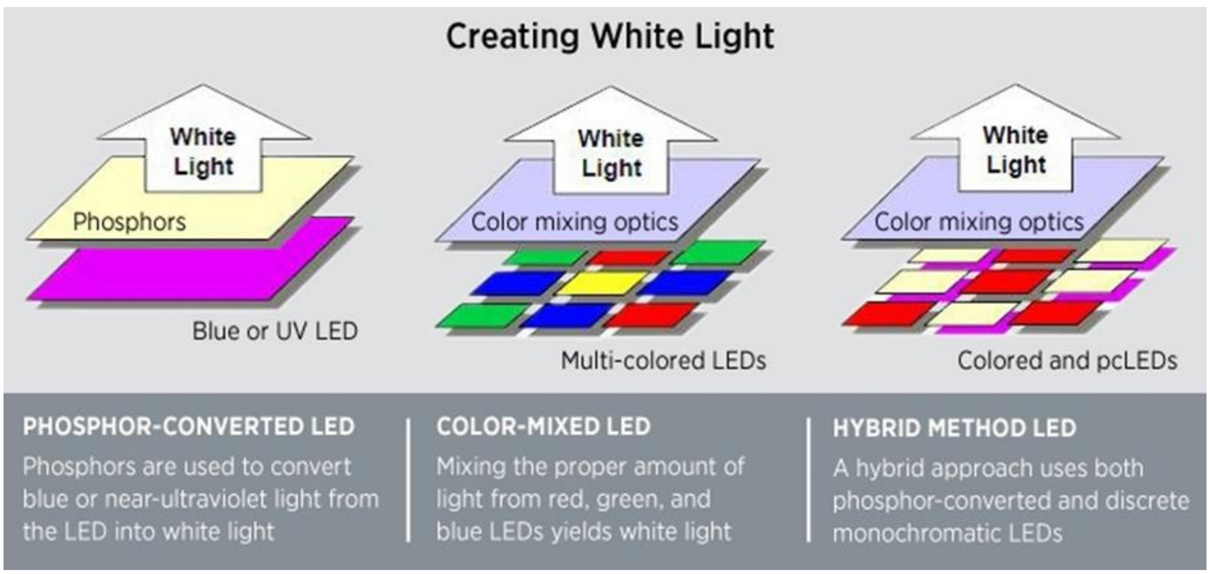
| Characteristic | CFL Typical Quantity |
|---|---|
| Luminous efficacy range | 55-65 lm/W |
| Lamp lifetime | 6000 – 12,000 hr |
| Color rendering index (Ra) | 70-90 |
| Correlated color temperature | 2500-6500 K |
| Dimmable? | Yes, if it has a dimmable ballast |

## Light Emitting Diode Lamp

Light emitting diode (LED) lamps are replacements for all other general service lamps. They are expanding their market share in general illumination applications all over the world, driven by the combination of improvements in LED technology and reductions in price. Market forces are driving a significant market expansion of LED technology, which readily replaces traditional light sources with more efficient and better performing LED technology.

There are many positive attributes of LED lamps, including that they are compact, have long life, resist breakage and vibration, offer their best performance in cold operating environments, instantly turn-on to full brightness, and can be dimmable. Depending on the drive circuit and LED array in a particular light source, LED lamps can also be adjusted to provide different coloured light or colour temperatures of white.

Unlike incandescent and fluorescent lamps, LEDs do not naturally produce white light. Instead, LEDs emit nearly monochromatic light – blue, green, amber, red – any colour is possible, depending on the chemistry of the LED substrate. White-light LEDs are therefore made in one of three ways, as depicted by the following illustration. The first, and most common today, is the phosphor-converting blue LED. This system starts with a blue LED that emits light through a phosphor that degrades some of the light from the blue wavelengths into green, yellow and red wavelengths, which mixes together with the blue emission to produce white. Another approach is to arrange monochromatic LEDs together so that the combination of the blue, green, amber and red wavelengths blend together to produce white. A third approach is to combine the phosphor-converting LEDs with coloured LEDs, in a type of hybrid approach. These three general ways of producing white light from LEDs are depicted in Figure G1.




Source: US Department of Energy, 2014

*Figure G1. Producing white light with light emitting diodes (LEDs)*

The individual LED chips are then arranged on a circuit board and assembled with a driver and housing to produce a lamp – as depicted in the following figure. In this illustration, phosphor-converting LEDs (which appear as yellow when they are off because of the yellow phosphor) are mounted on a circular heat sink inside the lamp. The heat sink conducts away the heat generated by the LEDs while they are producing light, and then the photons (light) emitted from the LEDs is projected into the spherical white plastic dome of the lamp.

*Figure G2. Cut-away view of an A-type LED Lamp*

LEDs are highly energy-efficient when measuring light output for watts of electricity input. In the market today, the most efficacious LED lamps are 200 lumens per watt, with products including linear LED tubes, streetlights and non-directional A-type LED lamps. This is more than three times the energy performance of a compact fluorescent lamp (CFL) and over 15 times more efficient than an incandescent lamp.

As the technology continues to evolve in the coming years, efficacy will improve, and costs decline. LEDs offer the potential to produce high-quality white light with unprecedented energy-efficiency. For countries choosing to phase-out incandescent lamps and jump straight to LED, the electricity savings for consumers will be more than 85 percent, without compromising light quality and while enjoying much longer service life.

The figure below from the US Department of Energy shows the historic and projected performance improvement for LED packages under specific operating conditions. [98] LED packages are the LED light sources that are used in lamps and luminaires) and are already very efficient. Their performance varies significantly with the operating temperature of the LED and the electrical current density. As of today, LEDs are operating with efficacies of 220 lumens per watt, under favorable conditions. The grey-shaded bars show the potential for further improvement with phosphor-converted blue or violet LEDs (PC-LED), and with four or more primary emitters in the color-mixing (CM) LED systems which blend together red, yellow, green, blue LEDs (CM-LED (RYGB) Neutral).

[98] Solid-State Lighting, 2017 Suggested, Research Topics, Office of Energy Efficiency and Renewable Energy, US Department of Energy, September 2017. Link: https://www.energy.gov/sites/prod/files/2017/09/f37/ssl_suggested-research-topics_sep2017.pdf

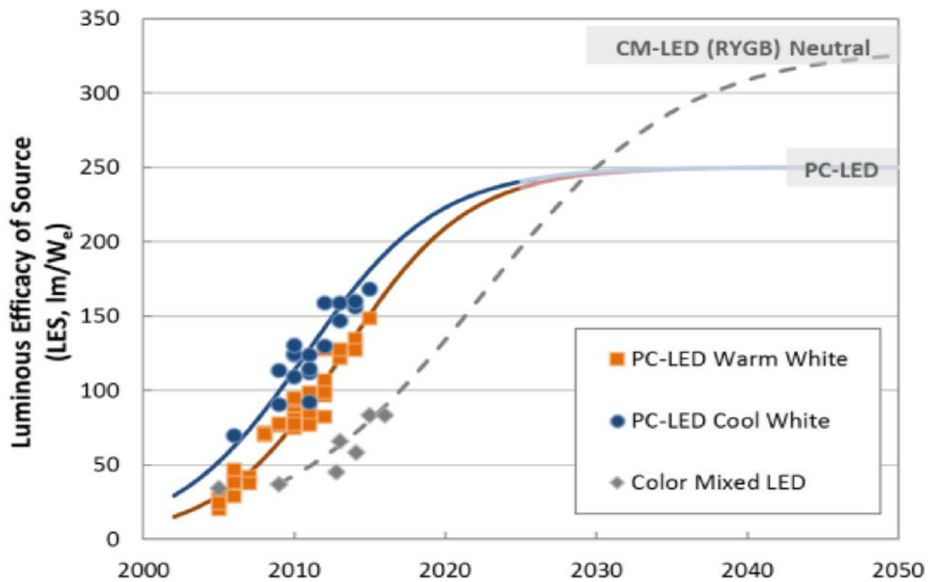



*Figure G3. Efficacies of commercial LED packages measured at 25°C and 35 A/cm² current density*

The trend for increasing efficacy also means that consumers get more and better-quality light at lower running costs. That is, the higher energy-efficiency of the LED sources translate into lower energy bills and greater reductions in $CO_2$ emissions. Figure shows average global retail price of a LED and CFL replacement lamp for a 60W incandescent. LED costs fall rapidly, then slow in 2017, reaching near parity with CFLs in 2019/2020. Actual LED pricing in a given country may vary from these levels, but the overall trend is such that LEDs are now about the same – or in some cases cheaper – than CFL lamps. Ultimately the price of LED lamps in any given country will depend on the volume of imports, local market conditions and consumer demand.

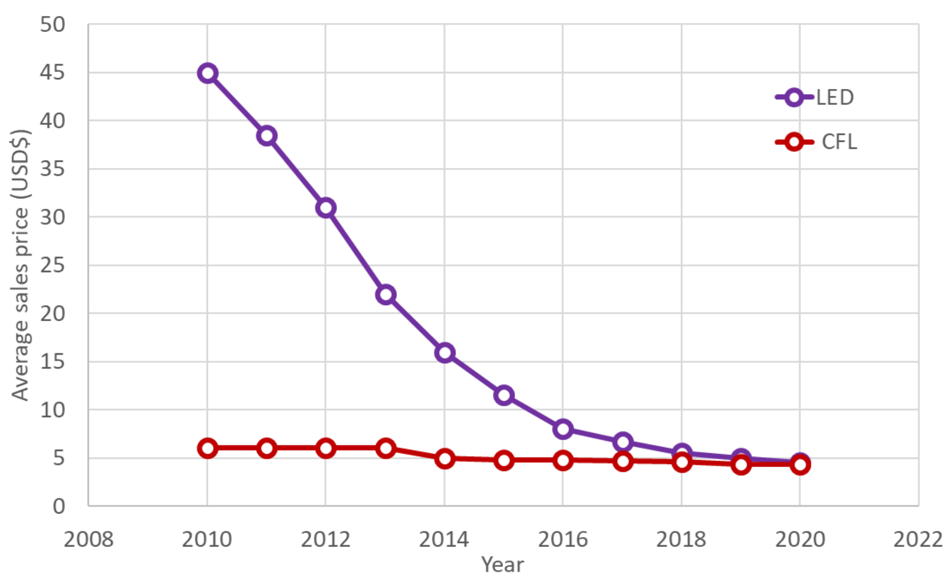



*Figure G4. LED vs. CFL Retail Price for a 60W replacement lamp*[99]

[99] Memoori research, 2014. http://www.allledlighting.com/author.asp?section_id=3271

**Figure G5** depicts some examples of the thousands LED products available on the market today. From left to right, (a) a frosted non-directional household lamp, (b) a clear non-directional LED filament lamp, (c) a directional (or “spot”) light, (d) LED tubular lamps to replace fluorescent tubes, and (e) a surface mounted dedicated LED luminaire. There are also LED street lights, flood lights, high-bay replacements, many other luminaires and technologies offered in the dynamic LED lighting market.

(a) (b) (c) (d) (e)

*Figure G5. Images of some examples of LED lamps and an LED luminaire*

**Advantages of LED Lamps**

- Highest efficacy light sources available in the world, and continuing to improve
- Lowest running costs
- Very long operating life – typically more than 15,000 hours
- High flux in a small package - good for optical control
- Can offer excellent color rendering
- Instant on, instant re-strike, dimmable
- Contains no mercury

**Disadvantages of LED Lamps**

- Driver required for operation
- Higher relative first costs, but costs are rapidly decreasing
- Needs good thermal design because waste heat is conducted, not radiated (this is reducing with increasing efficacy of LEDs)

*Table G3. Light emitting diode (LED) lighting typical performance specification*

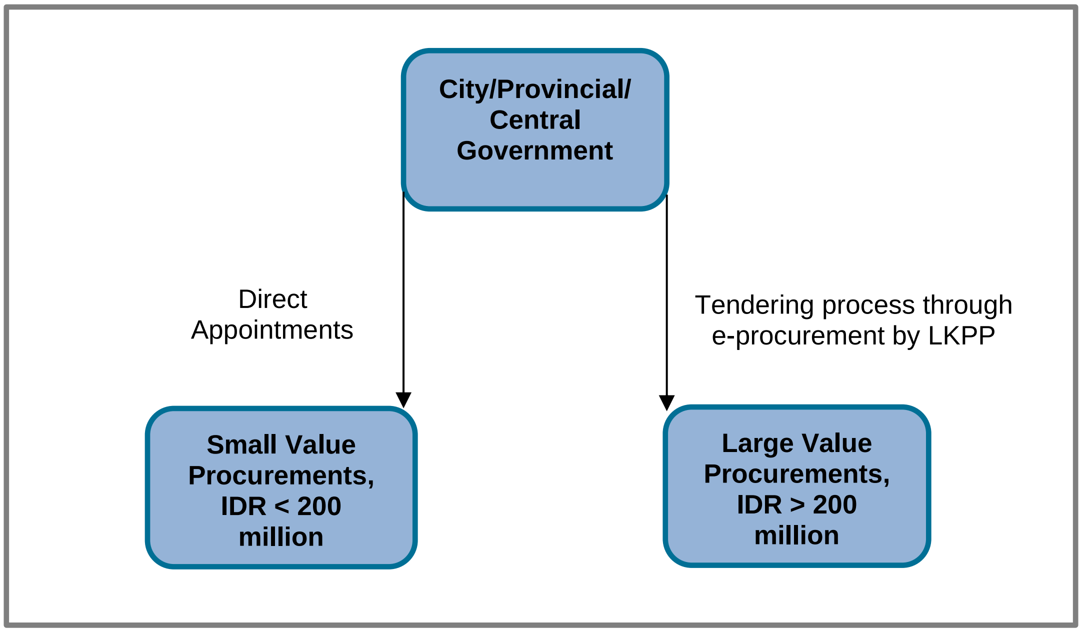
| Characteristic | LED Lamp<br>Typical Quantity |
|---|---|
| Luminous efficacy range (initial) | 50-160 lm/W |
| Lamp lifetime | 15,000 – 30,000 hr |
| Color rendering index (Ra) | 70-95 |
| Correlated color temperature | 2700 - 6500 K |
| Dimmable? | If dimmable driver |

# Appendix H – National Picture of Street Lighting in Indonesia

Indonesian government launched Smart Street Light Initiative (SSLI) in 2014 under the NAMA (Nationally Appropriate Mitigation Actions) to replace conventional street lighting systems with energy efficient technologies in urban areas. On account of this, all new procurements aim to replace conventional street lighting with efficient LED systems.

Each of the 34 provinces in Indonesia is responsible for procurement and replacement of street lights for provincial roads, city government for city roads, Ministry of Transportation for national roads, and Jasa Marga for toll roads. The procurement of street lights takes place as shown below.[100]

*Street Light Procurement at Government level*




The conventional tendering process of city governments was to procure lowest cost products. The procurement specification prior to 2014 did not take life cycle cost into account and therefore resulted in procurement of less energy efficient HPS (High Pressure Sodium) lamps. Since 2014, existing HPS street lights have been replaced with LEDs. In 2014, around 92% of the street lights operated by the provincial government of Jakarta were HPS lamps. Presently, 98% have been replaced with LED luminaires.[101]

Also, while international agencies had undertaken some pilot projects, municipalities did not have sufficient budget nor access to financing for citywide LED retrofit programs. However, after the new Public Private Partnership (PPP) Presidential Regulation 38/2015[102], energy conservation projects at the city level have seen an increase in bankability, including the possibility of alternative financing. This regulation allowed for several PPPs to be bundled and carried out under a single procurement process. It also allowed selection of a project proposed by private sector-based energy services company to procure street lights based on life cycle cost.[103]

[100] Based on interviews with provincial (Jakarta) and city (Bandung, Surabaya, Bogor) governments' procurement departments.
[101] Panggih Sudarmono et al 2018 J.Phy.: Conf.Ser.1022012021
[102] New PPP regulation provides number of incentives leading to business entities to develop commercial areas to support revenue streams
[103] Asian Development Bank "LED Streetlighting Best Practices", April 2017

One example was a collaboration between ADB, state owned utility PLN and Ministry of Energy and Mineral Resources (MEMR). Through the LED Municipal Streetlight and PLN Substation Retrofit Project, the two municipalities Semarang and Batang realized energy savings of 50%.

**Technologies in Street Lighting**

*Typical Wattages in 'Street Lighting' across locations*

| Province/City level | Technologies | Typical LED Wattages | Typical HPS Wattages |
|---|---|---|---|
| **Jakarta** | HPS, LED, Smart LED | 40W, 90W and 200W | N/A |
| **Bogor** | HPS, LED | 10W, 20W, 30W, 40W, 90W, 100W and 120W | 70W, 150W, 250W, 400W, 1000W and 2000W |
| **Surabaya** | HPS, LED | 40 W, 90 W, 120 W, and 200 W | N/A |
| **Bandung** | LED | 70W (other values need to be confirmed) | N/A |
| **South Tangerang** | LED | 40 W, 90 W, and 120 W | N/A |
| **Tangerang** | LED, HPS | 10 W, 27 W, 40 W, 55 W, 60 W, 80 W, 90 W, 120 W | 70 W, 100 W, 125 W, 250 W |
| **Makassar** | LED | 10 W, 40 W, 90 W, 120 W | N/A |

- Since 2014, in Jakarta, 98% of the HPS street lights have been replaced with LED luminaires, followed by 92% in Surabaya and 64% in Bogor
- New installations of street light units at Jakarta, Surabaya and Bandung are analyzed below. New street light installations depend upon the infrastructure development rate of the city, rate of expansion of municipal roads and also the budget. All new installations were based on LED luminaires and not HPS.

*New vs. Existing Installations in 2018*