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SUCCESSFUL IMPLEMENTATION OF FIRST EVER MINIMUM ENERGY PERFORMANCE STANDARDS (MEPS) AND LABELS FOR ENERGY EFFICIENT LED LIGHTING IN PAKISTAN

INTRODUCTION

Pakistan, located in South Asia, is the sixth most populous country in the world (with some 230 million inhabitants) and it is the fastest urbanizing nation in the region. Pakistan has rapidly become a developing country, and in parallel with population growth, energy consumption has gradually risen giving place to an increasing energy crisis.

There is a significant gap between electricity demand and generation capacity, with 29% of the population still lacking full access to reliable electricity, especially in rural areas (54% access rate)[1]. Pakistan also ranks as one of the countries with the highest occurrences of power blackouts, which can last eight to 10 hours in urban areas, while rural areas can face load shedding of up to 18 hours a day[2].

Despite energy access challenges, the low rates of electricity consumption per capita (500 KWh/capita, about one-sixth of the world average[3]) and the long-standing power blackout issues which have serious impacts on the industrial and commercial activities, Pakistan has registered an outstanding recent increase in electricity consumption, with a total of 111 TWh in 2017 (an increase of 270% since 1990), and total CO_2 emissions of 183 Mt in 2017 (a 226% increase from 1990)[4]. Energy is currently the largest contributing sector in Pakistan's emissions profile, responsible of nearly 46 percent of total emissions, and indicated as a top priority in the country´s Nationally Determined Contribution (NDC). This share is expected to grow significantly in the near future. Current levels of consumption, added to an annual growth rate of 9%[5] and the tremendous potential of the country for further growth and expansion, will certainly trigger a growth in energy consumption and consequently, higher carbon emissions.

The objectives for increasing energy access, reducing the gap between energy supply and demand, and CO_2 emission reduction can be largely achieved through the full market transformation to already available, more intelligent, energy efficient lighting, such as light-emitting diodes (LEDs). Energy efficient lighting can be an integral component in delivering fair and equitable energy access to the country's citizens but will also provide substantial environmental and financial savings.

According to the UNEP-United for Efficiency (U4E) Country Saving Assessment for the Pakistani lighting market[6], transformation to more energy efficient lighting systems through the implementation of minimum energy performance standards (MEPS) will result in estimated annual savings of

1 million tons of CO_2 emissions from avoided **burning of fossil fuels**,

1.2 TWh of electricity savings, and...

over **$120 million savings** in **electricity costs** by 2030

1 *Energy Progress Report, Tracking SDG7.* https://trackingsdg7.esmap.org/country/pakistan

2 *Mehmet Efe Biresselioglu, Muhittin Hakan Demir. "Preferences of household energy use in Pakistan. Findings from a national survey", 2019.*

3 *International Energy Agency (IEA). 2018.* https://www.iea.org/countries/pakistan

4 *Ibid*

5 *"Energy Efficiency Roadmap for Pakistan", WorldBank Group*

6 *Pakistan Savings Policy Assessment.* https://united4efficiency.org/country-assessments/pakistan

Behind this premise, and in line with Pakistan´s NDC commitments to reduce its emissions by 20%, and the approval of the National Energy Efficiency and Conservation (EE&C) Bill by the National Assembly in February 2016 to strengthen Pakistan's institutions and accelerate the procedures and mechanisms for the effective conservation and efficient use of energy in the country, the USD $7.4 million USD GEF project "*Delivering the Transition to Energy Efficient Lighting in Residential, Commercial, Industrial, and Outdoor Sectors*" was formally launched in February 2019.

The project, through the U4E team of experts, provides technical assistance to the *National Energy Efficiency and Conservation Authority* (NEECA) from the Ministry of Energy (Power Division) in the promotion, demonstration, deployment, and transfer of innovative high efficiency and usage-controlling lighting technologies. Multiple other local institutions participate of the project, including the *Pakistan Standards and Quality Control Authority* (PSQCA), which is the national standardization body, and the *Pakistan Council for Scientific and Industrial Research* (PCSIR) in its role of accredited organization in charge of electronic testing facilities, as well as local manufactures and their associations, universities and academic institutions and U4E technology partners.

DEVELOPMENT OF MINIMUM ENERGY PERFORMANCE STANDARDS (MEPS)

Following the U4E Integrated Policy approach, one of the cornerstone objectives of the project is the development of a national efficient lighting policy and strategy which contains a regulatory framework for MEPS and labelling. MEPS are a combination of policy measures, which define the minimum efficiency levels and quality criteria which products must satisfy to be sold in the local market, thereby offering a highly cost-effective option for removing inefficient products from the market. Robust MEPS represent the foundation to ensure the success of any energy efficient product transition strategy.

Establishing the appropriate level for MEPS is critically important. **This should set ambitious energy and quality performance criteria to have a real positive impact on the market, while still being realistic and applicable.** To be realistic, MEPS should contribute to transform the market in a progressive way with reasonably priced products available in the market. To be applicable, they should take into account the capability of local manufacturers and retailers to meet the specified levels. Therefore, it is key that a collaborative approach is taken to the discussion for MEPS development, engaging a wide range of stakeholders, including government institutions and local manufactures and their associations. For this purpose, several in-person and virtual consultation workshops took place in Karachi and Islamabad during 2019 and 2020 where more than 90 stakeholders from the public and private sector participated to agree on the technical criteria for the lighting MEPS policy. This included representatives from importers and manufacturers, such as Phillips and Osaka (representing 45% of the market share), Neolux Lighting, Fiam Lighting, Lumilux Lighting Pakistan, K-Electric, Unilux Lighting Pakistan and NEECA. The meetings focussed on capturing all points of view and reaching an agreement regarding:

- The scope of lighting sources to be included in the regulation.
- The criteria to be covered by the regulation and the performance levels.
- A proposal for a labelling scheme.

LED MEPS Formulation Consultative Workshop on 18 October 2019.
The event included a dedicated session on Green Finance and Gender Mainstream

A key input for the development of the lighting MEPS proposal was the Lighting Market Assessment developed by NEECA, which gathered data through a detailed local market survey. The main results from the study showed that **LED technologies have a major penetration in the Pakistani lighting market.** Their market share reaches 55% for the domestic, tertiary and industrial sector, followed by tubular lamps (23%) and CFLs (21%) (Figure 1). Lighting LED products (bulbs and tubes) and spare parts for their further local assembly, are mainly imported from China, reaching more than 32 million units in 2017. In the domestic sector, LED lighting accounts for nearly 70% of all lighting units, showing a very important acceptance of this technology by the residential user. LED lighting is less widely used in the commercial sector, which is dominated by T8 fluorescent tubes (tube lights), mainly 36 watts (48 inches or 120 cm). In the industrial sector, LED lighting is the predominant technology, with 48% of the market share, although more than half of the light sources are still incandescent or discharge sources. These findings are summarized in Figure 2.

The assessment results also indicated that **domestic LED product durability is less than four years – a lifetime four times shorter than average LED bulbs.** In the case of commercial LED lights, the weighted average life is of 2.25 years, around 3,200 operation hours, and in the industrial sector, lifetime is 2.5 years, around 3,500 operation hours. These lifetimes are even shorter than for the domestic sector and are not aligned with high quality LED products in other countries that can reach 25,000 hours.

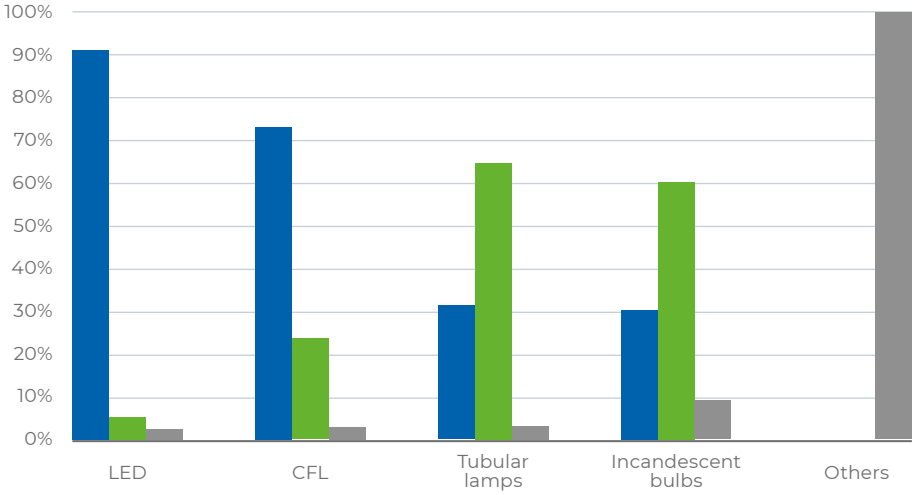

Figure 1: Pakistani Lighting Market share by Technology

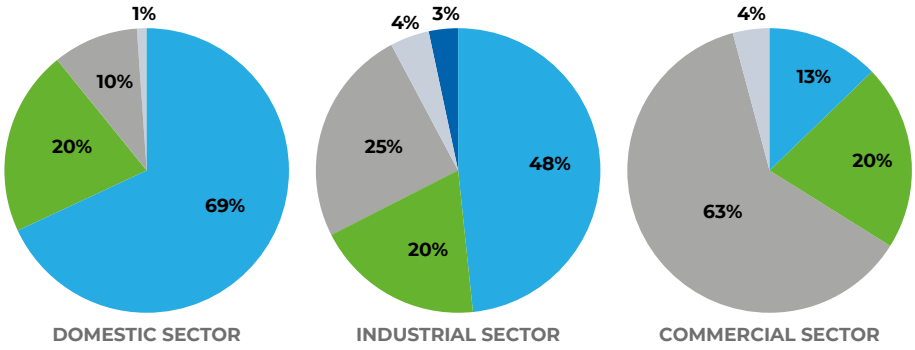

Figure 2: Pakistani Lighting Market share by Sector

In parallel, tests were carried out by the Pakistan Council of Scientific and Industrial Research (PCSIR) on a small sample of LED bulbs and tubes purchased directly from the retail shops. 7- and 12-watts LED light bulbs represented the domestic sector and samples from T8 LED tubes and LED downlights for the commercial sector. The parameters tested included power and power factor, initial flux, efficiency, colour rendering index (CRI) and correlated colour temperature (CCT) among others. The analysis showed some interesting findings. In the case of the sample for the domestic sector, the average power for each wattage was inferior to the rated power of the lamps. Although the average efficiency was acceptable, the flux deviation for the LEDs was too high: more than 200% lower for 7-watt bulbs. The results for CRI, which measures the quality of the light, were satisfactory, but the CCT average of 7,700 Kelvin was very high compared to traditional incandescent lamps (3,000 Kelvin.), producing a blueish light. This is recognized as being harmful to the retina, as a result of cellular oxidative stress, and is also suspected to be a risk factor in age-related macular degeneration.

In the sample for the commercial sector, the minimum efficacy of the LED tubes (70 lumens/watt) was lower than most of the fluorescent tubes and the average efficacy of downlights was also relatively low (60 lumens/watt) compared to traditional products on the international market. Results for CRI indicated a quality insufficient for commercial practice, for example, for distinguishing colours. In terms of CCT, the average colour temperature of 7,400 Kelvin for LED tubes was very high compared to traditional fluorescent tubes utilized in the commercial sector (4,000 to 5,000 Kelvin), repeating the same high blue component in its spectra as for the domestic case.

Against this background, **the MEPS proposal aimed to enhance the best quality LED products, for a rapid phase-out of CFL lamps and incandescent bulbs. Minimum energy performance requirements were defined and agreed for LED bulbs, LED downlights, LED tubes and LED outdoor lighting** in Pakistan based on a wide range of flux following the U4E Model Regulation Guidelines for General Service Lamp[7], the results from the market assessment and the input from the local stakeholders. These requirements are summarized in Table 1.

7 *https://united4efficiency.org/resources/model-regulation-guidelines-for-conventional-consumer-light-bulbs/*

PARAMETERS	LED LAMPS	LED TUBES	LED DOWNLIGHTS	LED OUTDOOR LIGHTING
Minimum efficacy level	60 ≤ Φ < 600 : 80 lm/W 600 ≤ Φ < 1200 : 90 lm/W 1200 ≤ Φ < 3300 : 100 lm/W	2 feet : 106 lm/W 4 feet : 114 lm/W 5 feet : 116 lm/W	60 ≤ Φ < 600 : 70 lm/W 600 ≤ Φ < 1200 : 75 lm/W 1200 ≤ Φ < 3300 : 80 lm/W	100 lm/W for up to 90W, 120 lm/W for more than 90 W
Minimum rated lamp lifetime L70B50 @ 25°C	8,000 hours Till June 2021 10,000 hours July 2021 onwards*1	10,000 hours Till June 2021 12,000 hours July 2021 onwards*1	10,000 hours Till June 2021 12,000 hours July 2021 onwards*1	15,000 hours Till June 2021 20,000 hours July 2021 onwards*1
Early failure rate (maximum)	10% at 3,000 hours	10% at 3,000 hours	10% at 3,000 hours	10% at 3,000 hours
Color rendering index (CRI)	≥ 80	≥ 80	≥ 80	≥ 70
Correlated Color Temperature (CCT)	< 6,500 Kelvin Till June 2021 < 6,000 Kelvin July 2021 onwards	< 6,500 Kelvin Till June 2021 < 6,000 Kelvin July 2021 onwards	< 6,500 Kelvin Till June 2021 < 6,000 Kelvin July 2021 onwards	< 6,500 Kelvin Till June 2021 < 5,000 Kelvin July 2021 onwards
CCT tolerance	± 300 K	± 300 K	± 300 K	± 300 K
Compatibility with existing fixtures and ballasts (for tubes) and dimming compatibility (for street lighting)	—	2 feet : flux ≥ 1,000 lumens 4 feet : flux ≥ 2,200 lumens 5 feet : flux ≥ 3,200 lumens able to work on ferromagnetic ballast	—	Street lighting luminaires must be dimmable
Fundamental power factor*2 (displacement factor)	2 W < P ≤ 25 W : ≥ 0.5 P > 25W : ≥ 0.9	2 W < P ≤ 25 W : ≥ 0.5 P > 25W : ≥ 0.9	2 W < P ≤ 25 W : ≥ 0.5 P > 25W : ≥ 0.9	≥ 0.9
Voltage rating operation range	160 VAC to 250 VAC (50 Hz)	160 VAC to 250 VAC (50 Hz)	160 VAC to 250 VAC (50 Hz)	160 VAC to 250 VAC (50 Hz)
Maximum Standby Power (connected lamps or internal sensor)	< 0.5 Watt	< 0.5 Watt	< 0.5 Watt	< 0.5 Watt
Short term flicker perceptibility (PstLM)	≤ 1.0 at full load and a sinusoidal input voltage.	≤ 1.0 at full load and a sinusoidal input voltage.	≤ 1.0 at full load and a sinusoidal input voltage.	≤ 1.0 at full load and a sinusoidal input voltage.
Photobiological risk group (blue light and UV hazard)	RG0 or RG1 are allowed.	—	—	—
Warranty duration	minimum 1 year	minimum 1 years	minimum 1 years	minimum 3 years

*1 *If achievable at reasonable cost based on the registration database.*

*2 *Fundamental Power Factor: Also known as Displacement factor. Displacement (phase-shift) between the fundamental (first harmonic) current and voltage waveforms by calculating the cosine of the phase-shift angle. It is a more detailed measure to quantify the displacement of the*

Table 1: Summary of Minimum Energy Performance Standards (MEPS) for LED bulbs, LED downlights, LED tubes and LED outdoor lighting in Pakistan

The proposed MEPS were successfully approved at the 99th meeting of the Electrotechnical National Standards Committee in November 2019, and come into force from December 2020. Products placed on the market before the application date can be sold until the end of June 2021, to allow manufactures, retailers and importers a six-month period to adjust to the new regulation.

The agreed MEPS exceed the efficacy level of 35% recommended in the U4E Model Regulation Guidelines for the domestic sector and include additional performance criteria (Table 2) and also compare favorably with the European Lighting Standards (Figure 3). This reflects the high ambition of Pakistan to truly transform their market to best quality LED products and the commitment from the local stakeholders to remove obsolete and inefficient products from the market.

	MODEL REGULATION			PROPOSAL PAKISTAN (DOMESTIC SECTOR ONLY, LED ONLY)		
Efficacy		LFC	LED		LED	
	60 ≤ Φ < 600	50	60	60 ≤ Φ < 600	80	
	600 ≤ Φ < 1200	55	75	600 ≤ Φ ≤ 1200	90	
	1200 ≤ Φ ≤ 3300	60	80	1200 ≤ Φ ≤ 3300	110	
Fundamental Power factor	P ≤ 2W	Not applicable		same as model regulation		
	2W < P ≤ 5W	≥ 0.4		same as model regulation		
	5W < P ≤ 25W	≥ 0.7		same as model regulation		
	P > 25W	≥ 0.9		same as model regulation		
Colour Rendering Index (CRI)	≥ 80 except outdoor and industry			≥ 80 except outdoor and industry		
1000 hour early failure test	must operate after 150 minutes on and 30 minutes off for 400 cycles (*=1 000 hours on*)			5% at 1,000 hours		
Supply switching test	CFLi lamps must survive 3,000 switching cycles of 1 minute on and 3 minutes off (=50 hours)					
Short term flicker perceptibility (PstLM)	≤ 1.0 at full load and a sinusoidal input voltage.			≤ 1.0 at full load and a sinusoidal input voltage.		
Stroboscopic effect (SVM)	No criteria					
Mercury content	Compact fluorescent lamps (CFLs) for general lighting purposes that are ≤30 watts should not exceed 5 mg per lamp burner.					
Lifetime	if claimed, manufacturers shall provide evidence to the regulator that substantiates the claim according the L70F50 definition of IEC 62612.			15,000 hours at L70B50 @ 25°C		
Voltage fluctuation	No criteria			Voltage rating operation range: 160 VAC to 250 VAC		
Time to light	No criteria					
Time to reach 60% of flux	No criteria					
Color consistency	No criteria			± 300 K		
Corrolated Color Temperature	No criteria				< 6,500 Kelvin	
Photobiological risk group (blue light and UV hazard)	No criteria				RG0 or RG1 are allowed.	
Warranty	No criteria				1 year	

Table 2: Comparison between U4E Model Regulation Guidelines for general purpose lamps and Pakistan approved MEPS

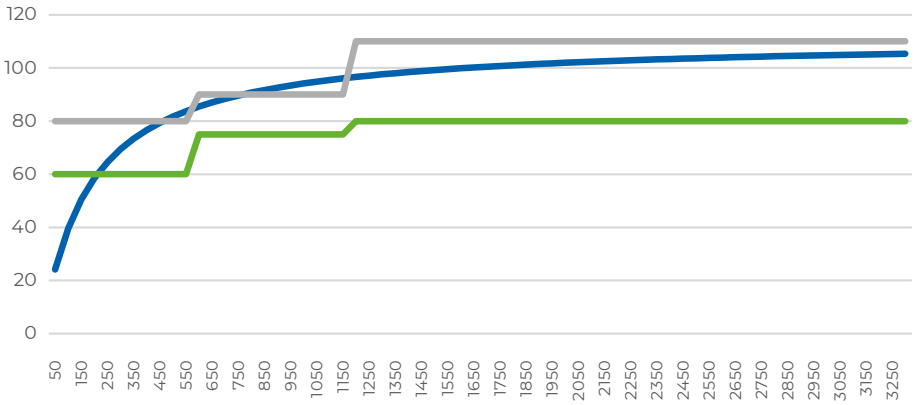

Figure 3: Comparison of approved MEPS for Pakistan against U4E Model Regulation Guidelines and European Lighting Standards - Efficacy vs Flux.

In addition to the development of the MEPS, the project also provided capacity building workshops for NEECA, and the wider public, to deliver technical training on the developed MEPS, along with information on sustainable public procurement best practices and technical recommendations to foster energy efficient lighting purchases in the public and semi-public sector.

Invitation to the virtual training on minimum energy performance standards (MEPS) and standard public procurement (SPP) for LED lighting in Pakistan on 2 July 2020

DEVELOPMENT OF ENERGY LABELLING SCHEMES

Following MEPS regulation, energy-labelling is an essential instrument to ensure the smooth implementation and maximum impact of the standards by clearly and consistently conveying the level of efficiency of the products to the end users. Energy efficiency labels allow users to make informed purchasing choices, but also can serve as a basis for implementing other instruments and incentives (e.g. financial schemes, rebates and subsidies) and thus, accelerate the pace of market evolution and adoption of new technologies.

In the case of Pakistan lighting products, a mandatory 5-star label was proposed for the four categories:

LED bulbs, tubes, down-lighters and street lighting/ outdoor lighting. The label star rating considers 1 Star as the lowest level, but it is still compliant with the minimum MEPS requirements. Having one label scheme, with one set of fixed values applicable to all LED products, simplifies its implementation by manufacturers, while also reducing the work for local authorities in charge of market surveillance.

The star levels are determined based on the lighting luminous efficacy – the ratio of the luminous flux output in lumens and the power of the light source or luminaire in watts. The levels proposed for Pakistan are shown in Table 3.

FLUX (LM)	60 ≤ Φ < 600	600 ≤ Φ < 1200	1200 ≤ Φ
1 star*	≥ 80 lm/W	≥ 90 lm/W	≥ 100 lm/W
2 stars**	≥ 90 lm/W	≥ 100 lm/W	≥ 110 lm/W
3 stars***	≥ 100 lm/W	≥ 110 lm/W	≥ 120 lm/W
4 stars****	≥ 110 lm/W	≥ 120 lm/W	≥ 130 lm/W
5 stars*****	≥ 120 lm/W	≥ 130 lm/W	≥ 140 lm/W

Reference: ϕ is the flux in lumen (lm) of the lamp or luminaire of power expressed in Watt (W).

Table 3: Energy performance star levels.

This is an important improvement compared to current energy labels in the country. In May 2016, Pakistan introduced its first ever energy labelling scheme – a voluntary label for electric fans, with three stars levels. A comparison of the new energy label for lighting products and the energy label for fans is shown in Figure 4).

Figure 4: Comparison between Fans energy labels and Pakistan Energy Label Design for LED Lighting Products

As part of this first labelling scheme, NEECA also specified that each efficient label certified electric fan should carry a highly secured NEECA security sticker, affixed by the manufacturer near the energy label. **This security sticker provides a unique QR code, revealed by scratching off the surface of the sticker, which the user can send for instant digital verification using mobile phone SMS services.** These security stickers are provided for all certified applicants by NEECA at the cost of Pak Rs. 7.0 per label (about US$0.07).

The energy labelling scheme for lighting products, will also require manufacturers to affix a NEECA provided security sticker with a unique security scratch code on all lighting products that carry the 5-star Energy Label. An example of this security sticker is shown in Figure 5.

Figure 5: NEECA security sticker for LED lighting products and its official presentation during the Project Steering Committee in January 2020 in Islamabad.L

The Government of Pakistan has been committed to spreading the message to its citizens on the benefits of LED lighting and energy efficient labels, using communication campaigns to encourage broad public acceptance and help modify user behaviour. A wide range of communication and outreach activities have taken place from the start of the project, including lectures by U4E technical experts and NEECA energy officers at academic institutions (such as the NED University of Engineering and Technology in Karachi, Qaid e Azam University Islamabad and Peshawar University of Engineering and Technology), radio and television broadcasts, and digital campaigns on social media with videos and informative brochures. These resources provide useful information on the benefits of the switch to LED lighting, tips and recommendations for a more conscious use of lighting products and energy conservation, and the date of enforcement for the upcoming MEPS regulation with the corresponding levels. Examples of some of the communications materials are shown in Figure 6.

Figure 6: Examples of materials from the NEECA communication campaign to foster LED lighting in Pakistan

ABOUT UNITED FOR EFFICIENCY

United for Efficiency (U4E) is a global initiative led by UN Environment (UNEP), funded by the Global Environment Facility (GEF), and supported by and array of leading companies, expert organizations and public entities with a shared interest in transforming global markets for lighting, appliances and equipment to more energy efficiency alternatives, saving all electricity consumers, including government, $ Billions at the same time.

To learn more about United for Efficiency's work and tools, please visit www.united4efficiency.org

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