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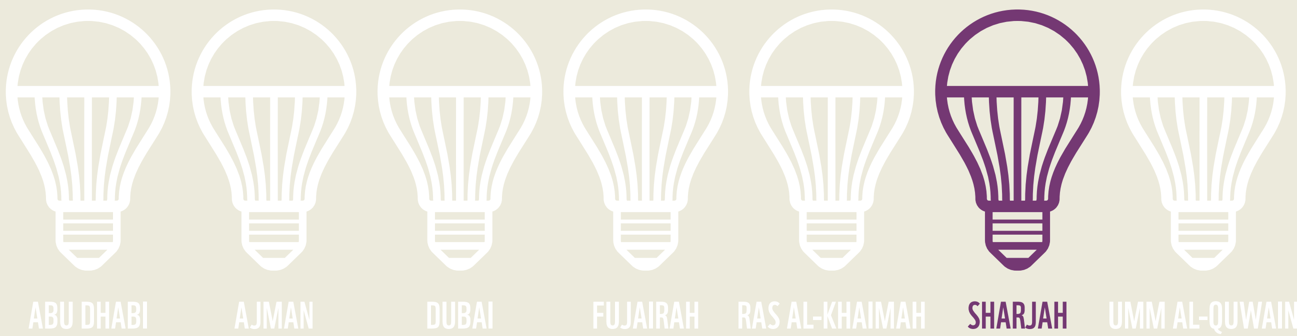

BENEFITS OF EFFECTIVE IMPLEMENTATION OF THE UAE'S LIGHTING REGULATION

UNITED ARAB EMIRATES
MINISTRY OF ENVIRONMENT & WATER

هيئة البيئة - أبوظبي
Environment Agency - ABU DHABI

هيئة الإمارات للمواصفات والمقاييس
Emirates Authority For Standardization & Metrology

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This summary has been published under the esteemed leadership of the Ecological Footprint Initiative Partners. The text has been prepared by EWS-WWF and RTI.

About Emirates Wildlife Society in association with WWF (EWS-WWF)

Emirates Wildlife Society is a national (UAE) environmental non-government, non-profit organisation that works in association with WWF, one of the world's largest and most respected independent conservation organisations. EWS-WWF has been active in the UAE since 2001 and has initiated and implemented several conservation and education projects in the region. The mission of EWS-WWF is to work with people and institutions within the UAE and the region, to conserve biodiversity, tackle climate change and reduce the ecological footprint through education, awareness, policy, and science-based conservation initiatives.

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About the UAE Ecological Footprint Initiative:

The Ecological Footprint Initiative (EFI) was launched in 2007 through a partnership between: the Ministry of Environment and Water, Environment Agency – Abu Dhabi, EWS-WWF and the Global Footprint Network, transforming the UAE from a country with one of the highest per capita Ecological Footprint per capita the world, to one with some of the most advanced Ecological Footprint science. From 2007-2011, the Ecological Footprint Initiative succeeded in verifying the UAE footprint, identifying the breakdown of the footprint by sector and developed a scientific scenario-modelling tool for decision makers that assesses the impact of different policies to reduce the country's footprint by 2030. In 2012, the partnership welcomed the Emirates Authority for Standardization and Metrology which worked on developing energy efficiency standard for domestic lighting. The Ecological Footprint Initiative continues to verify the UAE's Footprint, and finding solutions to manage the country's Footprint.

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Dr. Mathis Wackernagel, President of the Global Footprint Network

This Emirate-level summary is one of a set of seven summaries titled “Benefits of Effective Implementation of the UAE’s Lighting Regulation”, which outlines the benefits of the “UAE Lighting Regulation on Indoor Products” (December 2013) for every emirate in the UAE compared to the whole country. The successful implementation of the “UAE Lighting Regulation on Indoor Products” (Dec 2013) is highly dependent on the actions taken within every emirate. It is for this reason these summaries have been developed, to ensure decision makers from utility companies, municipalities, environmental authorities, customs bodies, academia, and interested members of the public take effective action to implement the regulation and ensure the UAE can achieve the full potential of the regulation.

This summary provides details on the context of the lighting regulation for the UAE, the baseline for the Emirate, the savings for the Emirate from an energy, financial, and environmental perspective, and finally a description of how the lighting regulation is implemented and governed.

Acknowledgements

We begin by thanking the partners of the Ecological Footprint Initiative (EFI), Ministry of Environment and Water in the UAE and the Environment Agency – Abu Dhabi (EAD), the Emirates Authority for Standardisation and Metrology (ESMA) and the Global Footprint Network (GFN) for continuously supporting the efforts of the EFI. In particular we are very grateful to our sponsors EAD and the Regulation and Supervision Bureau Abu Dhabi (RSB), who funded this research and made it possible. Finally, we are also grateful to all of our Steering Committee members for their continued guidance and support.

The successful partnership of the EFI highlights the importance of conducting locally relevant science-based research to support policy making. In particular, the close collaboration with ESMA resulted in using the RTI technical volume (the basis of the summary set) as supporting documents to develop the “UAE Regulation for Lighting Products”, which was approved by the UAE Cabinet and HH Sheikh Mohamed bin Rashid Al Maktoum, Prime Minister of the UAE and Ruler of Dubai, in December 2013.

The “Benefits of Effective Implementation of the UAE Lighting Regulation” Emirate-level summary set has been prepared by Research Triangle Institute International (RTI International) for EWS-WWF. We specifically thank Mr. Hazem Qawasmeh and Dr. Michael P Gallagher of RTI International for their efforts and effective collaboration with us while drafting the summaries.

We are grateful to all stakeholders that contributed with data and technical expertise to make these summaries robust and locally relevant. These include but are not limited, to The Ministry of Environment and Water, Environment Agency – Abu Dhabi, The Emirates Authority for Standardisation and Metrology, Regulation and Supervision Bureau – Abu Dhabi, The Middle East Lighting Association, Department of Municipal Affairs - Abu Dhabi, The Executive Affairs Authority - Abu Dhabi, The Urban Planning Council - Abu Dhabi, Abu Dhabi Water and Electricity Authority, Dubai Carbon Centre of Excellence, Dubai Electricity and Water Authority, Dubai Statistics Centre, Federal Electricity and Water Authority, Fujairah Municipality Health Department, Masdar Institute, Ministry of Economy, Ministry of Public Works, National Bureau of Statistics, and Sharjah Electricity and Water Authority.

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INTRODUCTION AND BASELINE

Emirates Authority for Standardisation and Metrology (ESMA) and key strategic partners of the UAE's Ecological Footprint Initiative[1] (EFI) have recently announced the introduction of a new indoor lighting regulation in the UAE. The regulation was endorsed on December 31, 2013 by UAE Cabinet of Ministers as Decision Number 34 of 2013, under the title "UAE Regulation for Lighting Products". The objective of the lighting regulation is to reduce energy consumption in the household while minimizing negative impacts on the UAE economy, environment, and human health. To this end, it is very important to understand the economic, environmental, health, and social implications of the lighting regulation for residents, businesses and governmental agencies[2].

The regulation will see the introduction of safe, high quality and energy efficient lighting products to the UAE market, as well as the phasing out of low quality, inefficient lighting products. These measures will reduce energy consumption that will cut carbon emissions and result in financial savings for residents, businesses and the government.

This summary report presents the technical, economic, and achievable potential assessment for the development of residential lighting regulation for the Emirate of Sharjah in comparison with the UAE. Annual impacts in terms of energy savings, financial benefits to households, subsidy reductions for governments, and environmental impacts are estimated for the currently existing stock of residential buildings and lighting characteristics.

6%
OF ENERGY CONSUMPTION IN HOUSEHOLDS IS FROM LIGHTING

United Arab Emirates – Context

Table (1) summarizes the residential lighting electricity consumption by Emirate. Total electricity consumption for residential lighting for the baseline year of 2011 was estimated to be 2,442 GWh. For comparison purposes, the table also shows the estimated population and number of residential housing units for the baseline year of 2011. Historical population data from 1996 to 2005 were used to estimate average growth rates from 2010 to 2020 to be an average of 5.6%.

Table (1): Baseline Electricity Consumption by Emirate

Emirate	2011 Population	Number of Housing Units	Total Lighting Electricity Consumption, GWh
Abu Dhabi	3,672,279	635,864	861
Dubai	1,567,552	392,122	604
Sharjah	1,433,480	301,919	357
Ajman	388,329	74,478	98
Umm Al-Quwain	157,511	28,286	52
Ras Al-Khaimah	884,280	167,605	327
Fujairah	594,997	92,456	143
Total	**8,698,429**	**1,692,730**	**2,442**

Source: (RTI, 2012a)

In order to characterize electricity consumption for residential lighting, available data were used to define several residential housing unit numbers and typologies and identify consumption per housing unit type. These were assessed in 2011, (the baseline year) using available data on the numbers, types, and characteristics of residential housing units from the National Bureau of Statistics (NBS) website. Results and distribution are listed within Table (5) and depicted in Figure (3).

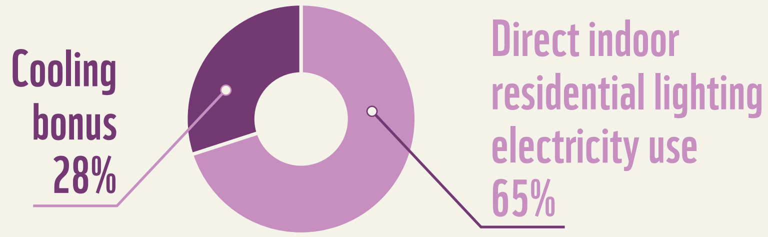


Figure (1): Annual Saving Contribution due to Improved Residential Lighting

Switching to energy efficient light bulbs could save **65%** of the electricity consumed by lighting.

Annual technical potential for energy savings by switching to energy efficient lamps (EELs) for the UAE is estimated to be 2,046 GWh based on the 2011 population. This represents a 5% reduction in residential energy consumption and a 2.9% reduction in total electricity consumption. The savings are comprised of a 65% reduction in direct indoor residential lighting electricity use and a 28% cooling bonus due to reduced air conditioning demand. The cooling bonus reflects reducing air conditioning use associated with avoided heat produced by incandescent lamps, and further reducing natural gas consumptions for power generation and its associated GHG emissions.

92% of these savings is attributed to removing incandescent light bulbs from households.

Currently, incandescent lamps account for the overwhelming majority of lighting energy usage, totalling 78%. Within the incandescent lamps, 60-watt lamps represent the bulk of the energy consumption. Compact Fluorescent Lamps (CFLs) account for approximately 8% of the lighting energy consumption, with 14-watt CFLs (the equivalent of a 60-watt incandescent) representing the largest share. Linear Fluorescent Lamps (LFLs) and halogens account for approximately 7% each, with minimal penetration of Light Emitting Diodes (LEDs). The distribution of technologies across all the emirates is displayed in Table (2).

Table (2): Estimated Number of Residential Lamps and Consumption Distribution by Emirate

Emirate	Number of Lamps	Annual Electricity Consumption, GWh/yr				
		Incandescent	CFL	Lin. Fluor.	Halogen	LED
Abu Dhabi	30,088,887	664.8	70.7	63.4	61.1	0.6
Dubai	12,508,381	469.9	49.6	44.1	39.6	0.4
Sharjah	11,176,973	277	29.3	26.4	24.6	0.2
Ajman	21,121,452	76.4	8.1	7.1	6.6	0.1
Umm Al-Quwain	4,940,484	41	4.3	3.4	3.2	0
Ras Al-Khaimah	1,769,724	258.2	26.9	21.3	20.1	0.2
Fujairah	3,420,584	112.6	11.8	9.7	9.3	0.1
Total	**85,026,485**	**1899.9**	**200.7**	**175.4**	**164.5**	**1.6**

Source: (RTI, 2012a)

1 Ecological Footprint Initiative partners are: Ministry of Environment and Water (MoEW), Environment Agency Abu Dhabi (EAD), ESMA, Global Footprint Network (GFN), and EWSWWF. The EFI is sponsored by EAD and the Regulation and Supervision Bureau (RSB) Abu Dhabi.

2 Data and information utilized for this research has been generated locally. Original reports; namely Baseline Assessment Report, Assessment of Technical, Economic, and Achievable Potential Report, Sustainability Impact Assessment Report and Policy and Regulatory Framework Report are available online for further information. http://uae.panda.org/

Figure (2) shows the distribution of energy savings by lamp type for the country, when the new regulation is implemented. If all lamps being phased out by the regulation were replaced with compact fluorescent lamps (CFLs), the total energy savings would be 2,046 GWH per year (see Table 3). The elimination of incandescent lamps accounts for 92% of the savings. The elimination of inefficient halogen lamps accounts for 7% of the savings and the elimination of low-efficiency CFLs from the market accounts for the remaining 1% of the savings.

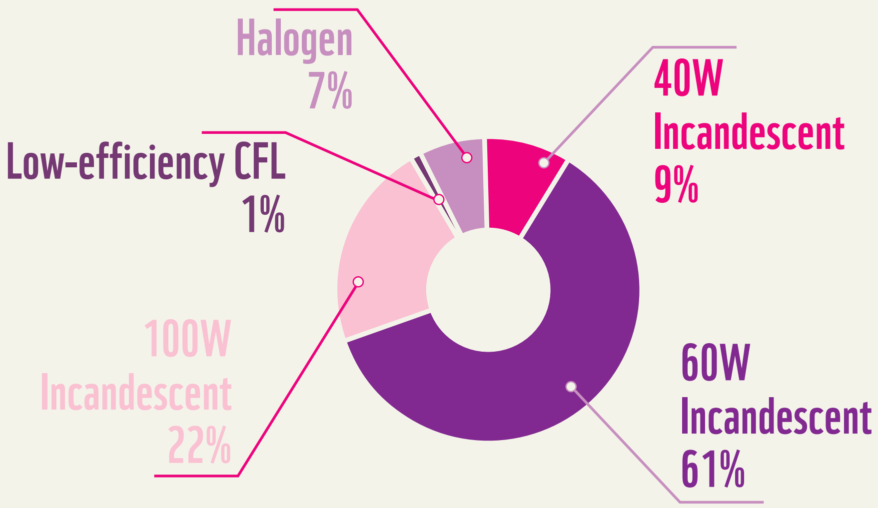


Figure (2): Potential Energy Savings by Lamp in UAE

Lighting usage rates used in the analysis are a significant determinant of the energy, economic, and environmental impact estimates. The analysis uses a relatively conservative estimate of approximately 3 hours per day based on a study conducted by the U.S. Department of Energy[3]. Under this conservative scenario, the total social benefits are estimated to be approximately AED 668 million per year after full adoption of EELs. The household sector benefits are estimated to be AED 459 million per year after full adoption of EELs. In addition to household benefits, subsidy reductions to the government are estimated to be AED 216 million per year.

Table (3): Incremental Annual Social Benefit by Technologies Phase-Out (AED 1,000)*

Technologies Phased Out	Total Annual Energy Savings (GWH)	Annual Increase in Lamp Expenditures	Annual Household Savings from Reduced Electricity Bills	Annual Government Savings from Subsidy Reduction	Full Annual Social Benefits
Incandescents	1,875	2,268	420,840	198,072	616,644
Halogens	151	3,097	33,967	15,868	46,738
Low-efficiency CFLs	20	2,048	4,473	2,104	4,530
Total	**2,046**	**7,413**	**459,280**	**216,044**	**667,911**

Source: (RTI, 2012c)

* Calculated savings are based on the conservative scenario assuming 3 hour usage of the light bulbs per day

3 The U.S. DOE study provides the most comprehensive data on residential lighting usage. The data appear to be the best available at the present time because they apply to all lamps within a room, include data for a broader set of room types, and differentiate between housing unit type. Similar detailed local data is non-existent.

Emirate of Sharjah – Context

Sharjah population numbers and estimates are reflected in Table (4) below and used for the emirate's baseline consumption and potential benefits. Two references[4] were obtained that provide historical data on the population of the UAE by year. But in view of the inconsistency in growth rates since 2005, the historical population data from 1996 to 2005 were used to estimate an average growth rate of 7.2% from 2010 to 2020 for Sharjah.

Table (4): Estimated Population and Growth Rate in Sharjah (million)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Growth Rate
UAE	8.265	8.699	9.158	9.642	10.155	10.696	11.268	11.873	12.512	13.189	13.905	5.60%
Sharjah	1.337	1.443	1.537	1.648	1.767	1.895	2.031	2.178	2.335	2.504	2.685	7.20%

Source: (RTI, 2012a)

To determine the number of residential housing units by typology in base-year 2011, the data from the National Bureau of Statistics website for 2010 was scaled up using the growth rate for Sharjah. Table (5) summarizes the estimated number of housing units for 2011 that resulted from these steps with overall total housing units of approximately 301,917 in the base-year compared to 1,692,725 in UAE. Table (5) and Figure (3) also compare the energy consumption per housing unit type in Sharjah and across UAE.

Table (5): Estimated Number of Housing Units and Consumption by Typology in 2011

	UAE		Sharjah	
	Number of Housing Units	Estimated Consumption (Gwh/yr)	Number of Housing Units	Estimated Consumption (Gwh/yr)
Studio Apartment	186,095	64.48	42,088	14.58
1-Bedroom Apartment	315,781	233.64	71,418	52.84
2-Bedroom Apartment	360,801	360.84	81,600	81.61
3-Bedroom Apartment	45,138	52.05	10,208	11.77
4+-Bedroom Apartment	9,919	14.51	2,243	3.28
Small villa	65,556	125.63	7,560	14.49
Medium villa	94,552	474.4	10,904	54.71
Large villa	19,991	251.55	2,305	29.00
Part of Villa	16,016	10.71	1,528	1.02
1-Story Building	98,500	113.57	9,155	10.56
Public House	146,606	280.93	17,211	32.98
Part/ Public House	45,103	30.18	2,299	1.54
Separate Rooms	92,722	2.95	19,632	0.62
Arabic House	120,675	231.25	19,436	37.24
Others	75,270	195.1	4,330	11.22
Total	**1,692,725**	**2,441.79**	**301,917**	**357.5**

Source: (RTI, 2012a)

4 The first reference includes a summary of the population of each Emirate for each year from 1996 to 2009, obtained from the National Bureau of Statistics (NBS) website. The file identifies the source of the data as the Ministry of Economy – Central Statistics Department. The second reference for population data is entitled Methodology of Estimating the Population in UAE and was also obtained from the NBS website.

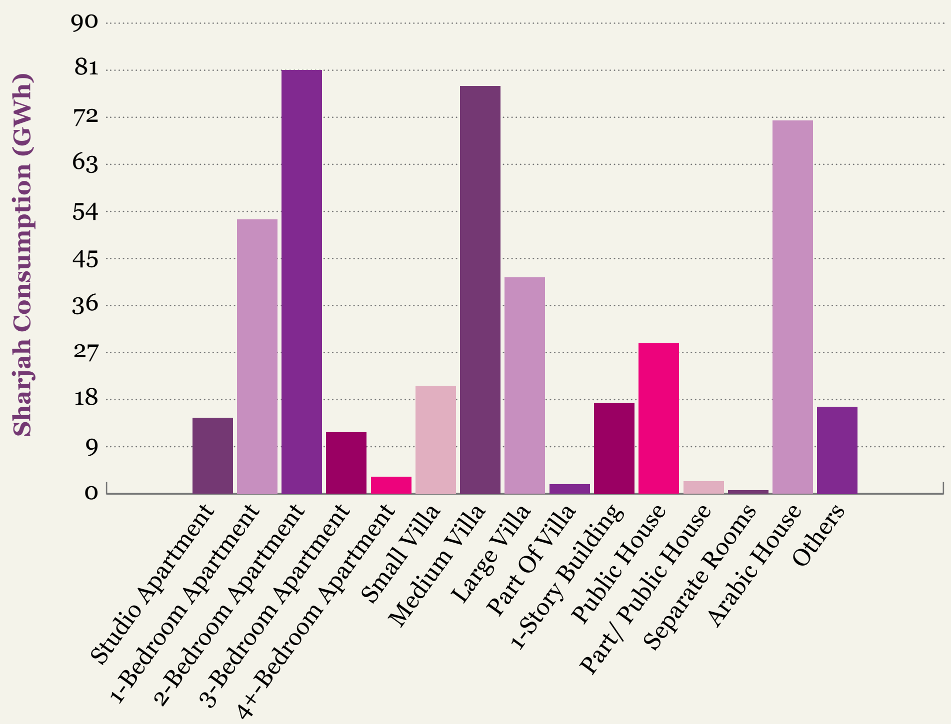


Figure (3): Estimated Consumption by Typology in 2011

SHARJAH'S ELECTRICITY CONSUMPTION FROM LIGHTING AT

15%

IS THE THIRD HIGHEST AMONGST ALL SEVEN EMIRATES

Residential lighting energy usage in the Emirate of Sharjah is estimated to be 357 GWh per year; accounting for 15% of the total residential lighting usage in the UAE (estimated to be 2,442 GWh per year). Apartments/flats account for the largest share of lighting energy usage, totalling 42%. The majority of the consumption is associated with two bedroom apartments at 23%. Incandescent lamps account for the overwhelming majority of lighting energy usage and 60-watt lamps represent the bulk of the energy consumption. Incandescent lamps account for the overwhelming majority of lighting energy usage and 60-watt lamps represent the bulk of the energy consumption.

TECHNICAL, ECONOMIC AND ACHIEVABLE POTENTIAL ENERGY SAVINGS FOR SHARJAH

The technical, economic, and achievable potential assessment was aimed at establishing the basis and recommendations for developing residential lighting regulation for the UAE. This section portrays the energy savings and economic benefits for Sharjah residents and subsidy reductions for government.

As shown in Figure (4), the technical potential is the largest, with the economic and achievable potential being subsets of the technical potential.

Figure (4): Technical, Economic, and Achievable Potential

The technical potential is an estimate of the potential savings associated with a specific Demand-Side Management (DSM) measure, or combination of measures, assuming that the measure is technically feasible and achieves 100% penetration within the target populations. Technical potential does not take into account the cost-effectiveness or market acceptance of the DSM measures under consideration. Economic potential is a subset of the technical potential and represents what is economically cost-effective. The economic potential is intended to quantify the share of the technical potential energy savings that are economically viable from either a household or social perspective. Achievable potential is a subset of the economic potential and represents the savings and/or efficiency level that can realistically be expected.

Calculations are based on three phase-out strategies of (i) incandescent, (ii) halogen and (iii) low-efficient CFLs over a three year period. Energy savings from switching to EELs are estimated for incandescent, inefficient halogen, and low-efficiency CFL lamps and based on a conservative average use of 3 hours per day. Figure (5) shows graphically the targeted families of lamp technologies and their phase out stages in the coming three years as per the endorsed scenarios.

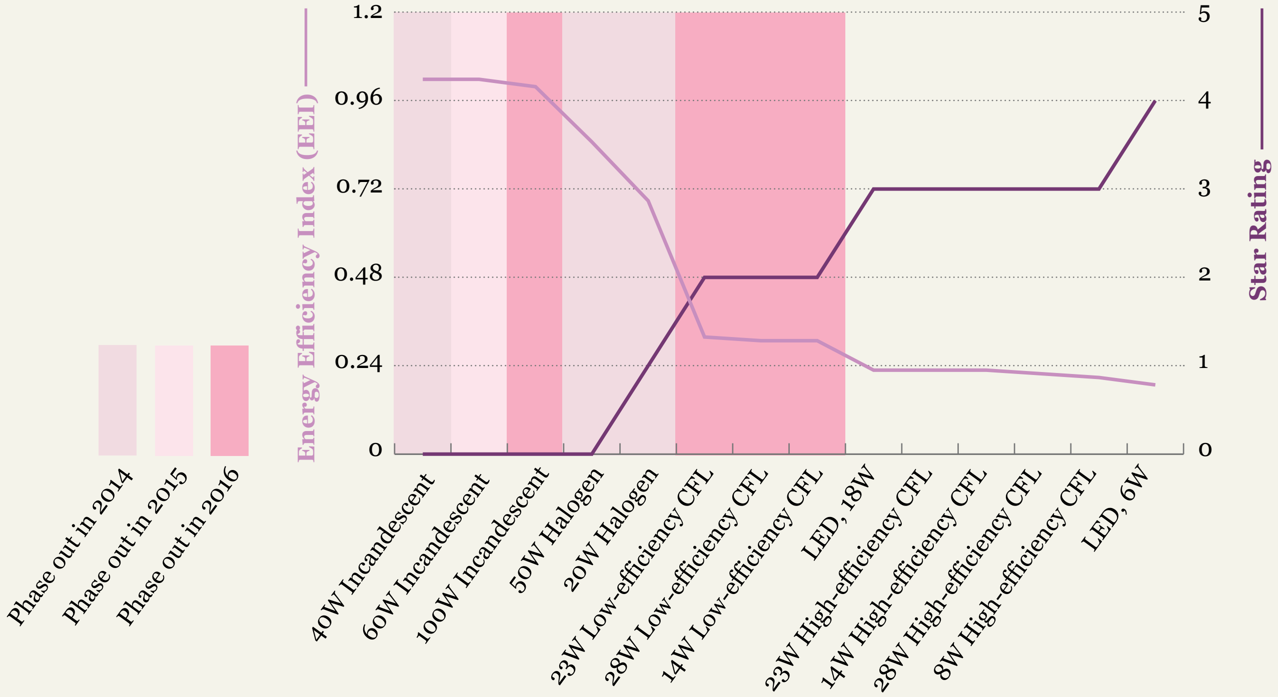


Figure (5): Phase Out of Lamp Technologies

For modelling purposes, it is assumed that all upgrades switch to high quality CFL lamps. In general, CFLs use less energy and are lower cost than other EEL options, such as LEDs. Whereas LEDs have longer life expectancies compared to CFLs, their high cost has limited market penetration in most countries.

The baseline assumes that 15% of CFLs are sub-standard (lower luminous efficacy and shorter life expectancy [RTI, 2012a]) and the removal of these low-efficiency CFLs is part of the technical potential. For high-efficiency CFLs, LFLs, and LEDs currently in use, it is assumed that there are no upgrade possibilities that should be included in the technical potential. It is assumed that the luminous efficacy of low-quality CFLs is 67% of high-quality CFLs and their average life expectancy is 3,000 hours (compared to 10,000 for high-quality CFLs).

The modelling framework was programed in the GAMS software[5] to calculate the savings under the chosen phase-out scenario. Outcomes from the model execution indicate that direct energy savings from upgrading lighting in Sharjah residential sector is estimated to be 234 GWh. Calculated for the UAE, for every 1 kWh of lighting energy saved, there is a cooling bonus of 0.28 kWh of air cooling energy, which leads to full annual technical potential savings for Sharjah of 299 GWh.

5 The model is essentially a multidimensional linear program that accounts for every lamp in the UAE. Each lamp in the baseline is assigned a series of attributes that determine its location and tariff rate, operating characteristics (hours/year), energy consumption (watts), price (AED), life expectancy (hours), and potential for EEL upgrade. Based on these characteristics, the model calculates the total lighting electricity consumption and the electricity savings under different lighting upgrade scenarios.

Table (6): Potential Total Energy Savings from Lamp Replacement in Gigawatt-hours (GWh).

Total Energy (Savings (GWh	Cooling (Bonus (GWh	Direct Energy (Savings (GWh	Lamp Phase Out
273	59	59	Incandescent
23	5	5	Halogen
3	1	4	Low-efficiency CFL
299	**65**	**64**	**Total**

Source: (RTI, 2012b)

Energy savings can materialize over the time period of 13 to 48 months after the publication of the regulation, given the life span of existing lighting products. As described in the Baseline Assessment report, an estimated 50.1% of existing lamps in the UAE are currently incandescent and represent approximately 90% of potential savings.

Figure (6) shows the energy savings potential by lamp type in Sharjah. In line with UAE-wide data, incandescent lamps account for 91% of the energy savings, with 60-watt incandescent accounting for 60%. Even though low-efficiency CFLs represent only 1% of the energy savings, the elimination of these low-efficiency lamps has a significant impact on achievable potential.

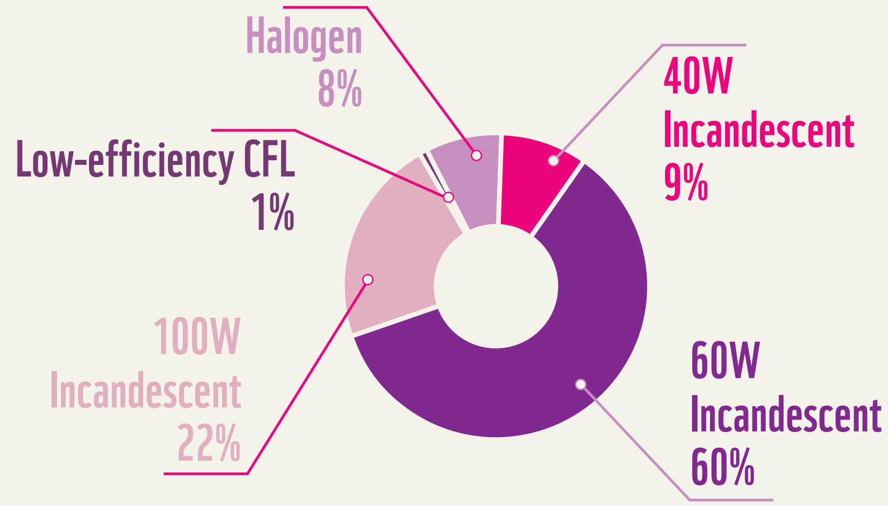


Figure (6): Potential Energy Savings by Lamp in Sharjah

Households using incandescent lamps may need to purchase more than one lamp per year, but the ones using CFLs will need to purchase fewer lamps per year because of the longer life expectancy of CFLs. As a result, over their entire lifetimes, 8-watt and 14-watt high-efficiency CFLs are actually less expensive than their corresponding 40-watt and 60-watt incandescent lamps.

Household Savings from Lower Electricity Bills

REPLACING A 60 W INCANDESCENT WITH A 14 W CFL WILL SAVE **AED 112** IN SHARJAH

Tariff rates vary by Emirate and by nationality. Thus, replacing an incandescent lamp in Sharjah has a different impact on a household's electricity bill compared to replacing an incandescent lamp in Abu Dhabi or in other Emirates. In 2009, the Sharjah Electricity and Water Authority (SEWA) increased its non-National residential tariff from 20 to 30 fils/kWh. The residential tariff structure for Sharjah is presented in Table (7) and accounted for within the analysis

Table (7): Sharjah (SEWA) Residential Tariff (fils/kWh)

Category	SEWA Residential Tariff (fils/kWh)
Nationals	7.5
Non-Nationals	30

Source: (RTI, 2012b)

Table (8) shows the average annual net benefits for individual lamps replaced by the nationals and non-nationals alike in Sharjah, and annual net benefits for the UAE. For example, replacing a 60-watt incandescent with a 14-watt CFL will yield an average net savings of AED 112 per lamp in Sharjah, compared to AED 1,553 in the UAE.

Table (8): Annual Net Benefit by Lamp in Sharjah and UAE (AED Saved per Lamp per Year)

Original Lamp Type	Replacement	Sharjah (AED/lamp/yr)	UAE (AED/lamp/yr)
40W Incandescent	8W High-efficiency CFL	23	237
60W Incandescent	14W High-efficiency CFL	112	1552.8
100 W Incandescent	23W High-efficiency CFL	38.5	595.9
14 W Low-efficiency CFL	8W High-efficiency CFL	0.2	1.65
23W Low-efficiency CFL	14W High-efficiency CFL	2.4	29.3
28W Low-efficiency CFL	23W High-efficiency CFL	0.3	3.3
20W Halogen	6W LED	2.3	25.7
50W Halogen	14W High-efficiency CFL	15.2	169.3

Source: (RTI, 2012b)

Net savings are the benefits from reduced electricity bills minus the increase in lamp expenditures. The annual increase in lamp expenditures is the change in the individual annualized lamp expenditures summed over all the replacement lamps. Calculations showed that incremental annual expenditures from moving to EELs are relatively small compared to the electricity bill savings. On average, for every AED 1 invested in EELs in Sharjah, AED 50 is saved on the electricity bill. The majority of the savings are realized during the 13–24 month period that corresponds to the replacement of incandescent lamps. Reductions in emissions associated with power generation will directly parallel the timing of energy savings.

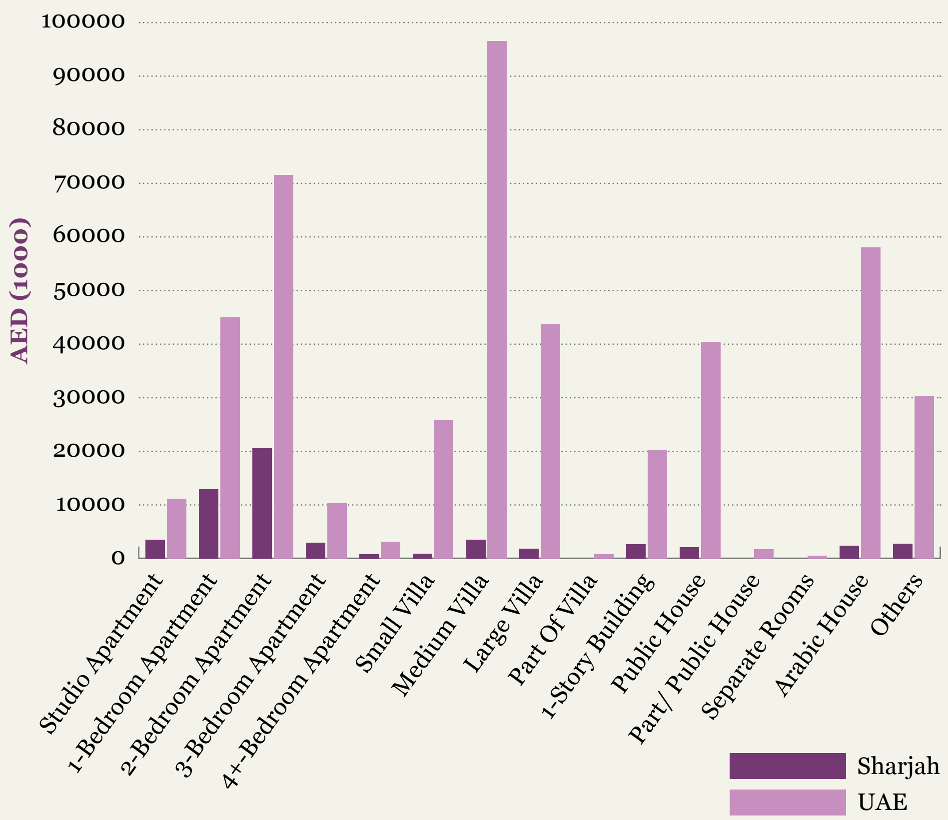
AED 57 MILLION THE REDUCTION IN ELECTRICITY BILLS IN THE HOUSEHOLD SECTOR OF SHARJAH

On aggregate, Sharjah households will realize significant savings on their electricity bills at AED 57 million, as shown in the following Table (9) and Figure (7).

Table (9): Annual Household Electricity Bill Savings by Typology by Emirate for All Lamp Replacements (AED 1,000)

Type of Housing Unit	Sharjah	UAE
Studio Apt.	3,495	11,105
1-BR Apt	12,905	44,945
2-BR Apartment	20,538	71,528
3-BR Apartment	2,969	10,342
4+-BR Apartment	825	3,085
Small Villa	924	25,810
Medium Villa	3,455	96,512
Large Villa	1,823	43,758
Part of Villa	67	785
One-story Building	2,663	20,315
Public House	2,103	40,414
Part of Public House	100	1,707
Separate Rooms	175	543
Arabic House	2,375	58,011
Others	2,749	30,339
Total	**57,166**	**459,280**

Source: (RTI, 2012b)



AED 41.5 MILLION

THE GOVERNMENT OF SHARJAH'S SAVINGS FROM REDUCED SUBSIDIES

Figure (7): Annual Household Electricity Bill Savings by Typology in Sharjah for All Lamp Replacements (AED 1,000)

Government Savings from Lower Subsidies

It is common knowledge that current tariff rates do not cover the full cost of power generation and that the provision of electricity is subsidized. Electricity subsidies provided by the government are defined as the difference between the full cost of power generation and the revenue received by the distribution companies through electricity tariffs.

Sharjah government is set to save an estimated 41.5 million AED annually in energy subsidy from Energy Efficient Lighting.

Table (10): Net Household, government and social Benefit in Sharjah (AED 1,000)*

	Technical and Economic Potential (GWh)	Annual increase in Lamp Expenditure	Annual Savings from Reduced Electricity Bills	Annual Government Savings from Subsidy Reduction	Net Annual Household Savings	Full Annual Social Benefits
Sharjah	299	1,143	57,166	41,533	55,988	97,521
UAE	2,046	7,413	459,280	216,044	451,867	667,911

Source: (RTI, 2012b)

* Calculated savings are based on the conservative scenario assuming 3 hour usage of the light bulbs per day.

SUSTAINABILITY IMPACT ASSESSMENT

Energy Efficient Lighting will generate core benefits to the UAE that span several areas of fiscal, environmental, and social sustainability. Many benefits are directly related to energy, demand, and fuel savings or economic (monetary) benefits. However, there are other benefits, such as environmental improvement or reputational impacts that may not be completely monetized.

The environmental impacts are analysed using a Life Cycle Analysis (LCA) framework that provides a technique for assessing the environmental aspects of a system through each life-cycle phase: raw materials acquisition, production, distribution use, and disposal. Figure (8) illustrates the key phases of the LCA process for lighting technologies, which encourages planners and decision makers to consider the environmental aspects of lighting technologies, including activities that occur outside of the traditional framework, such as amount of waste generated or potential environmental impacts of technologies.

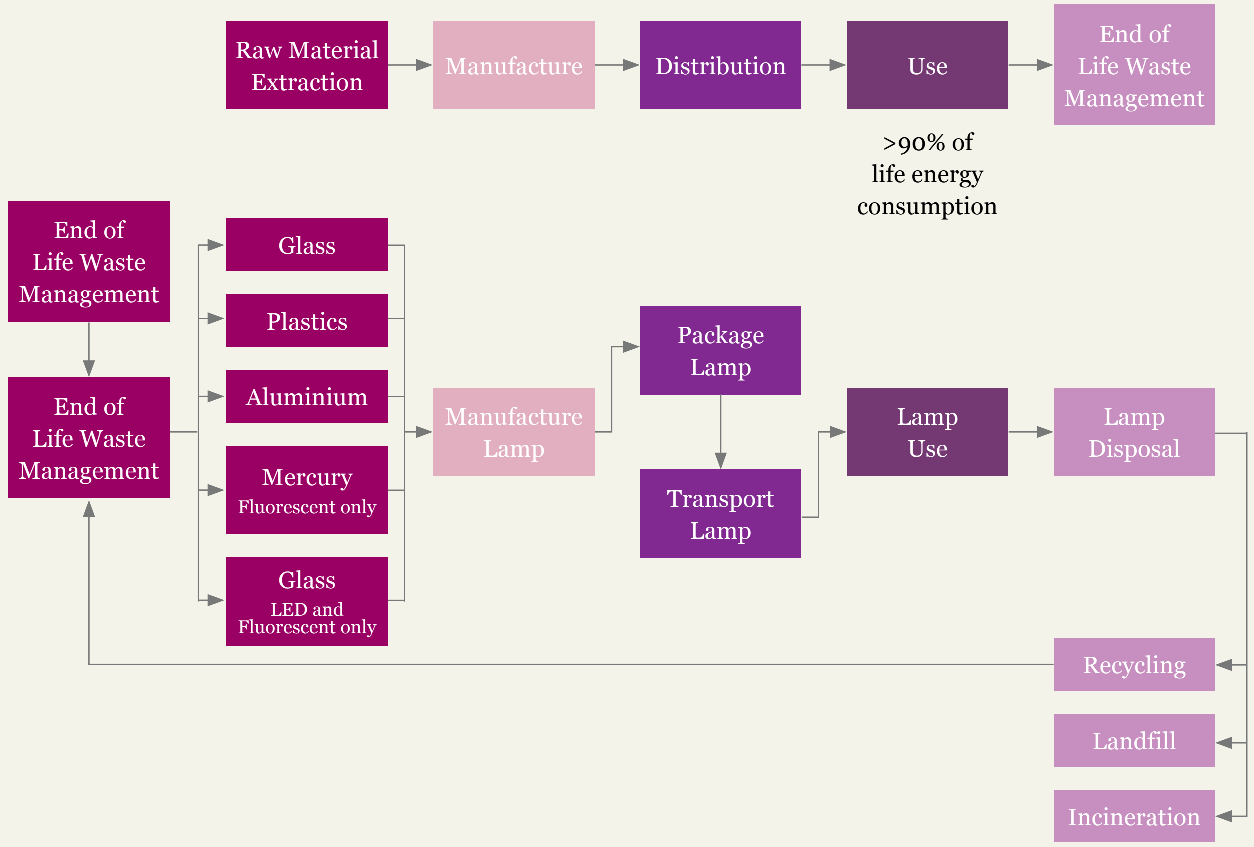


Figure (8): Life Cycle Processes and Stages for Lighting Technology

The most significant phase in the life cycle above is the use phase, which is found to account for 90–99% of the total life-cycle energy consumption (i.e., total energy used to manufacture, illuminate, and discard lamps). Manufacturing and end-of-life phases also use energy and have similar energy- related impacts associated with them but to a lesser extent compared with the use phase.

Energy consumed during the use phases of incandescent lamps is significantly greater than CFLs, LFLs, and LEDs. Both LEDs and LFLs exhibit the lowest energy impact and hazardous waste generation, whereas halogens and incandescent bulbs exhibited the highest impact. CFLs show a similar energy impact as LEDs and LFLs but result in more hazardous waste generation.

Compared to other EELs, LEDs and LFLs show the lowest energy consumption and the lowest hazardous waste generation

The study indicates that employing EEL technologies in residential lighting situations was found to be roughly four times more energy efficient than the use of incandescent lamps and over twice as energy efficient as using halogen lamps. The results indicate that the elimination of nearly all incandescent lamps in residential homes would have the most beneficial impact on climate change; contributing to a reduction in global warming potential.

Similar to the energy and GHG assessment results, the majority of NOx, SOx, and PM savings are realized through the conversion of incandescent lamps to EELs. These savings have the potential to reduce air quality issues and their related effects, including damage to ecosystems and respiratory health problems.

Using the energy savings potential assessed above and natural gas emissions estimates obtained for Sharjah, the potential Greenhouse Gas (GHG) emissions reductions were estimated as follows:

Table (11): Potential GHG Emissions Reduction from Lamp Replacement (in tonnes CO2 -eq per year)

Lamp Phase Out	Sharjah CO2 (Tonne CO2 eq / yr)	UAE CO2 (Tonne CO2 eq / yr)
Incandescent	125,699	861,669
Halogen	10,168	67,960
Low-efficiency CFL	1,337	9,139
Total	**137,204**	**938,768**
Percent of Country Total	**14.6%**	**100%**

Source: (RTI, 2012c)

The CO2-eq savings in Sharjah, the third greatest in the UAE, are equivalent to removing

24,100

cars off the road

The annual GHG savings potential associated with the phase-out is almost 137,000 tons of CO2-eq emissions; approximately 15% of the country's total. This is equivalent to taking over 24,100 cars off the road each year. The results indicate that the elimination of nearly all incandescent lamps in residential homes would have the most beneficial impact on climate change. Figure (9) summarizes the potential reductions in emissions of these pollutants at Sharjah and UAE levels, respectively.

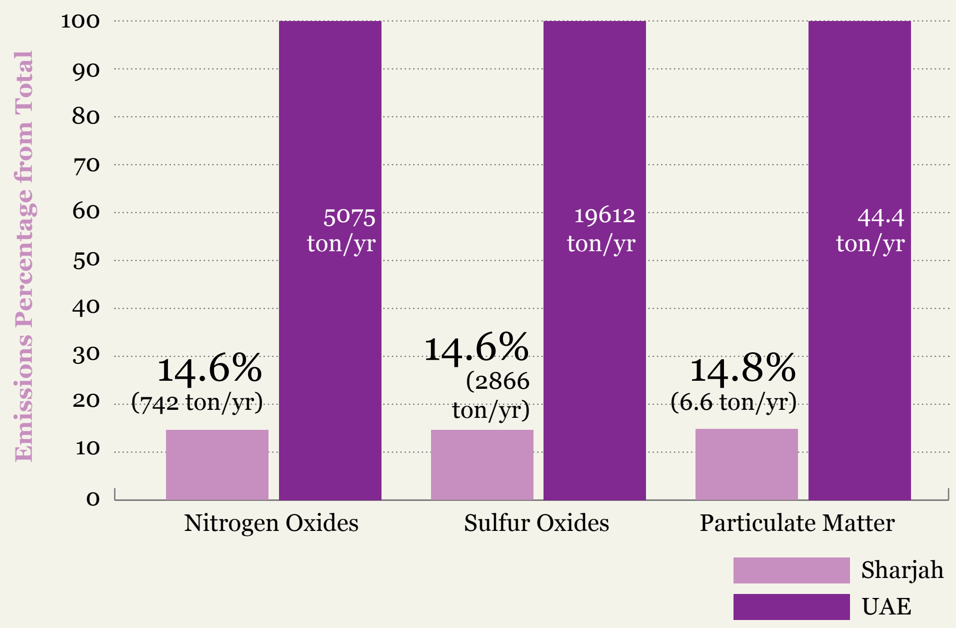


Figure (9): Potential Air Quality Pollutants Reduction from Lamp Replacement

Mercury

Mercury is also of concern because it is a highly toxic heavy metal that can incrementally accumulate in the environment and animal tissues. Very low concentrations of mercury can adversely impact the neurological development of foetuses, infants, and children. At low concentrations, mercury can affect the human nervous system, reproduction, immune system, cardiovascular system, and kidneys.

Mercury is present in a number of products. Figure (10) indicates the relative amounts of mercury in common household products. Fluorescent lamps (both LFLs and CFLs) emit an average of 2% of the total emitted mercury annually. (NEWMOA, 2008)

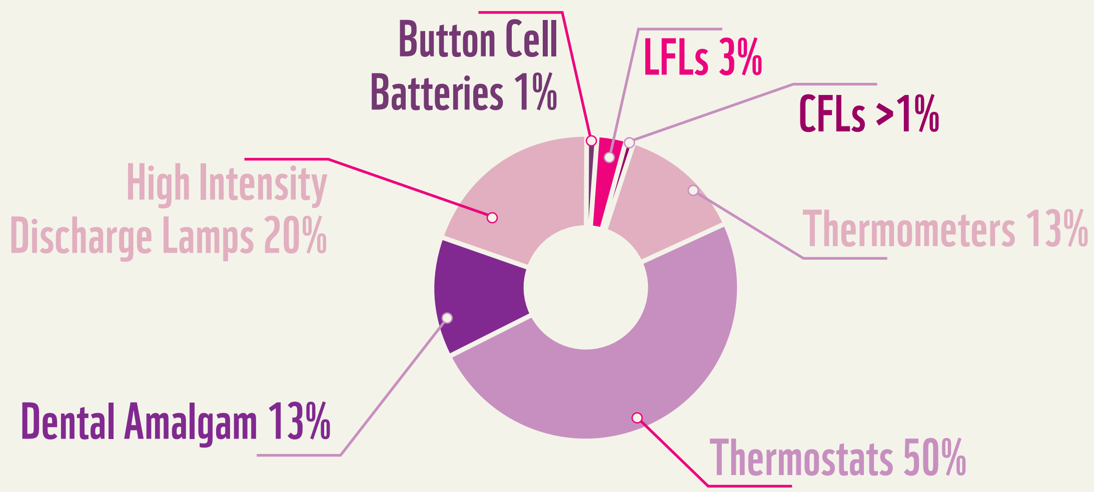


Figure (10): Relative amounts of mercury contained in individual products commonly found in residences

Although different scientific and media sources present contradictory information about the significance of mercury from CFLs and LFLs, most government sources pointed to mercury exposures from broken CFLs/LFLs as not likely to present a health risk to individuals or households, especially if proper precautions and clean-up procedures are conducted.

CFL lamps generally contain between 1.4 to 5 mg of mercury per CFL lamp (Hu and Cheng, 2012; VITO, 2009; New Zealand Ministry for the Environment [NZ MfE], 2009). LFLs generally contain 4 to 12 mg of mercury (NZ MFE, 2012). Using these mercury levels as low- and high-level estimates of the mercury in CFLs that could potentially be released during end-of-life processes, the additional amount of mercury discarded annually under each lamp replacement phase was estimated for the UAE, relative to the baseline. Results of the estimate are shown in Figure (11).

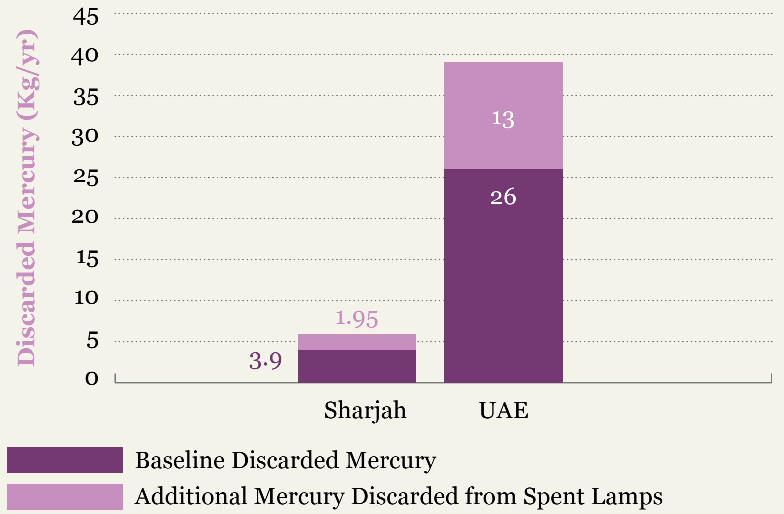


Figure (11): Annual estimated amount of mercury discarded from replacement of spent lamps with CFLs (kg/yr)

The estimated amount of annually discarded mercury from the highest mercury content scenario for the Emirate of Sharjah is approximately 3.9 kg/yr (compared to an estimated 26 kg/yr for UAE). This represents approximately 1.95 kg/yr more mercury than the current baseline scenario for Sharjah compared to an estimated 13 kg/yr more mercury for the UAE. The new lighting regulation in the UAE follows EU regulations and limits the amount of mercury per lamp technology, as per Table (12), hence generating the lowest possible quantities of mercury waste.

Table (12): Maximum Mercury Content Limits in the European Union for CFLs

CFL Wattage	Maximum Mercury Content	Dates of Applicability
< 30 W	5 mg	Expired December 31, 2014
	3.5 mg	After December 31, 2014 until December 31, 2015
	2.5 mg	After December 31, 2015
≥ 30 W and < 50 W	5 mg	Expired December 31, 2014
	3.5 mg	After December 31, 2015
≥ 50 W and < 150 W	5 mg	Not included in Directive
≥ 150 W	15 mg	Not included in Directive

Source: European Parliament and of the Council, 2011.

HOW DOES THE REGULATION WORK?

The purpose of a lighting regulation is to put in place requirements that ensure that low quality products not meeting specifications cannot enter a country's market. The regulation[6] includes the four main product requirements for indoor lighting, including safety, energy efficiency, functionality and hazardous chemical requirements:

- Safety requirements ensure that products entering the country meet all international regulations, including limits on hazardous substances, and requirements for equipped high quality electrical systems.
- Energy performance limits imposed in the regulation are used to phase out inefficient products from the market by setting energy efficiency requirements for different energy classes that products must meet in order to be used in the country. However, the lighting regulation includes an exemption list for certain products that have specific uses to enter the country such as specialty lamps for medical purposes in labs and hospitals.
- Functionality requirements in the regulation are to ensure that lighting products are of good quality with a high level of 'colour rendering' as determined by international best practices and industry recommendations.
- Lighting products contain hazardous substances such as Mercury, Lead, Cadmium, and other toxic heavy metals, and therefore need to be handled with care and treated as hazardous waste. Hazardous limits, which meet international standards, are established in the lighting regulation in order to prevent low quality products from entering the country.

THE UAE LIGHTING REGULATION ENSURES THAT ALL LIGHTING PRODUCTS ARE ENERGY EFFICIENT, ELECTRICALLY SAFE, ARE OF GOOD QUALITY, AND CONTAIN LIMITED HAZARDOUS MATERIALS

The regulation also specifies that all lighting products need to be certified, labelled and monitored for their compliance with the standards and that they should be disposed of safely with any waste managed according to specific guidelines that will be determined by ESMA. Products that do not meet the standards specified in the regulation will also not be allowed to enter the UAE for retail after 1st July 2014. Figure (12) overleaf provides images of some of the products that will be available to customers in the UAE.

The regulation requires market monitoring and testing to ensure products entering the UAE are compliant with the lighting regulation, particularly by regular testing conducted at official or independent testing laboratories. It is recommended that the UAE invests in an in-country testing facility to certify if EELs and other products meet the requirements; such testing and monitoring should be done regularly.

6 Lighting Regulation can be acquired through "The UAE Official Gazette", issue of December 2013, or through emailing EWS-WWF (info@ewswwf.ae)

THE "ENERGY STAR RATING" SYSTEM USED FOR THE LABELS WILL RANGE FROM 1 STARS TO 5 STARS, 1 BEING THE LEAST EFFICIENT AND 5 BEING THE MOST EFFICIENT

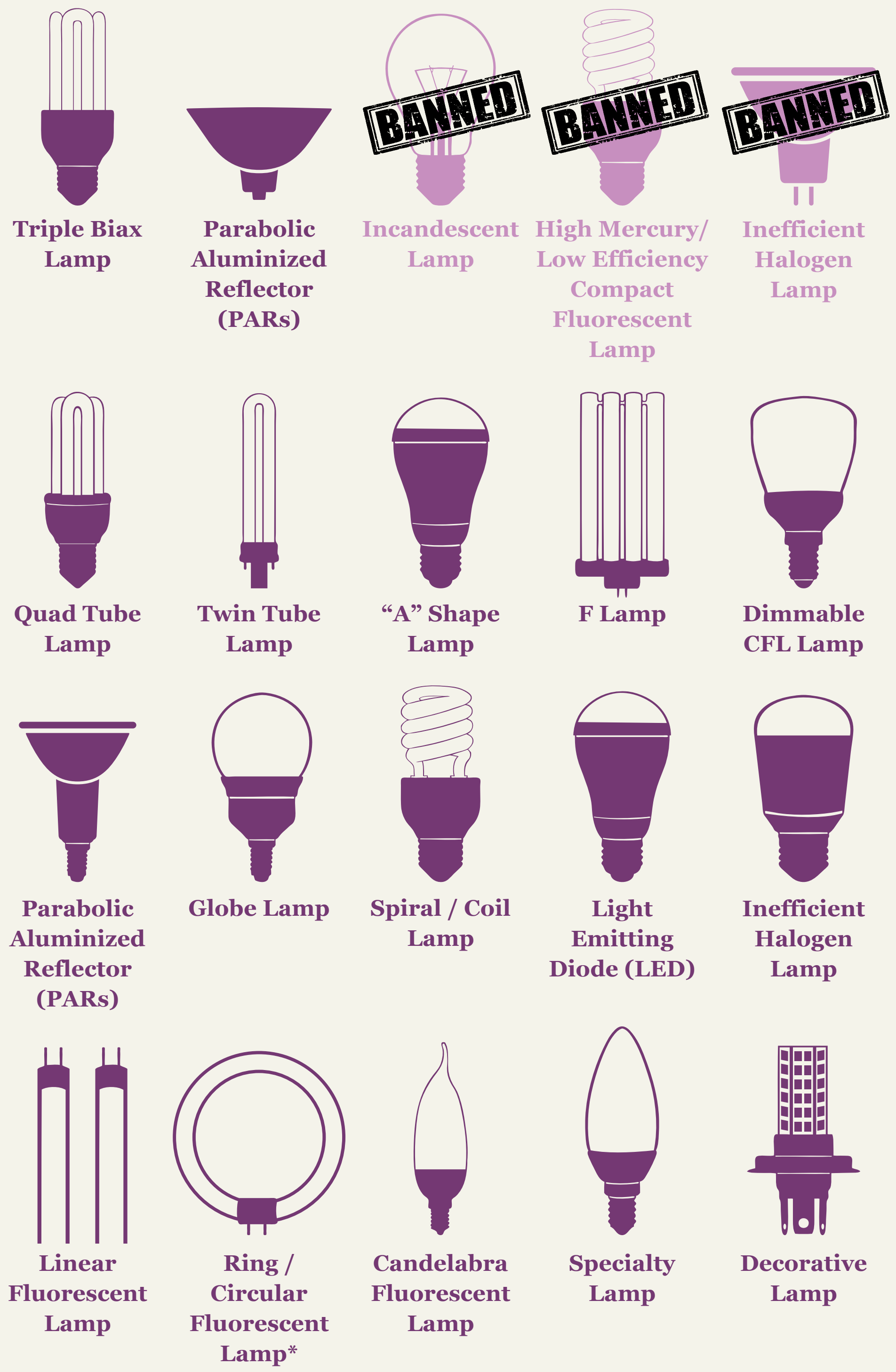
The roles and responsibilities of the waste management entities will need to be in accordance with the UAE Federal Law 24 of 1999 for the Protection and Development of the Environment, Cabinet Order No. 37 of 2001 for Executive Order of Law 24 on Handling Hazardous Substances, Hazardous Wastes and Medical Wastes and the UAE's commitments under the Basel Convention. The regulation highlights that the concerned authority in each Emirate is responsible for the handling and dealing of hazardous waste, and the Municipalities in the different Emirates can issue the license for the handling and dealing of hazardous waste to a third party which is in accordance with the above laws.

Consequently, there is a need to develop a safe disposal and waste management system for lighting products in the UAE. Emirate level waste management authorities and the MOEW should ensure recycling plans for hazardous materials are included in their current long term strategies. Furthermore, private sector activities and programmes, such as Extended Producer Responsibility (EPR) programmes that require the manufacturer to take responsibility for the management of spent light bulbs, should be considered as a viable option in supporting the country with waste management. The implementation of modern sanitary landfills with liner systems consistent with the Basel Convention and the UAE Federal Law No. 24 is encouraged in order to prevent hazardous chemicals from spent light bulbs and other products from entering the soil.

To move the regulation forward, policy activities conducted in parallel could accelerate the transition to EELs[7]. Education and information campaigns could motivate households to switch out their incandescent and halogen lamps early (prior to failure). Exchange programs could also incentivize households to swap out their low-efficiency lamps prior to failure. Both of these policies have the potential to accelerate household adoption and, subsequently, the energy savings.

7 For more information on potential policy recommendations, please refer to "Technical Memorandum 4: Policy and Regulatory Framework" of the "Development of a UAE Lighting Standard" Volume (http://uae.panda.org/)

Figure (12): Energy Efficiency Lighting Products Available in UAE Market after 1st July 2014



* Allowed Compact Fluorescent Lamps (CFL) will be highly efficient with low mercury content.

LIST OF ABBREVIATIONS

AED	UAE Dirham
CFL	Compact Fluorescent Lamp
CO_2	Carbon Dioxide
CO_2eq	CO2 Equivalents
DEWA	Dubai Electricity and Water Authority
DSM	Demand Side Management
EEI	Energy Efficiency Index
EEL	Energy-Efficient Lamps
EPR	Extended Producer Responsibility
ESMA	Emirates Authority for Standardisation and Metrology
GHG	Greenhouse Gas
GWh	Gigawatt Hour
KWh	Kilowatt hour
LCA	Life Cycle Analysis.
LED	Light-Emitting Diode
LFL	Linear Fluorescent Lamp
MELA	Middle East Lighting Association
MoEW	Ministry of Environment and Water
NO_x	Nitrogen Oxides
PM	Particulate Matter
SO_x	Sulfur Oxides
Tonne	Unit of mass equal to 1,000 kilograms
UAE	United Arab Emirates
Watt	A derived unit of power that measures the rate of energy conversion or transfer
Yr	Year

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