Bonneagar Iompair Éireann
Transport Infrastructure Ireland

Energy Reductions in Public Lighting on National Roads

June 2016

Executive Summary

In response to the EU Energy Efficiency Directive (2012/27/EU), the National Energy Efficiency Action Plan (NEEAP) was published by the Department of Communications, Climate Change and Natural Resources. It sets Ireland an overall target of delivering 20% energy efficiency savings by 2020 and it challenges the public sector to lead by example in targeting a 33% reduction.

This report examines the possible energy saving measures relating to TII electricity consumption in public lighting on roads and tunnels which represents c. 45% of the total electrical energy use for TII.

The main opportunity for energy saving arises from changes in design standards which have been updated since the construction of many roads. These now require less lighting than was provided at opening in terms of both the extent of the footprint and the intensity of light.

However, a number of challenges exist. For example, significant funding will be required for the design and installation of energy saving measures; and collection of an accurate and detailed asset inventory is essential for assessment and design purposes.

In addition, new 'burn profiles' have been agreed with, but are yet to be implemented by, ESB Networks and the Commission for Energy Regulation. These are necessary to ensure that the notional billing arrangement for unmetered supplies is updated to reflect energy saving measures – without this, energy savings would not yield any cost savings to the bill payer.

TII have engaged consultants who have already carried out a number of sample designs and pilot schemes at representative locations across the network. Based on the knowledge-base developed as a result, three possible energy saving options have been identified.

In some locations, it may be possible to remove surplus public lighting poles which are no longer a requirement under latest standards. The estimated energy savings on the motorway network as a whole from pole removal would be 12%-18% with a payback period of 3-5 years. This option has the added benefit of removing unnecessary poles from the roadside which are under latest standards now considered a hazard. There is however a risk of negative public perception. A research project is ongoing to fully assess the safety and other implications of this proposal and it is planned to remove poles at a trial location in late summer 2016, subject to the necessary approvals.

Once surplus poles have been removed, dimming is the next most favourable option using power controllers at each supply point. These devices regulate and adjust the power supply delivered to the entire lighting circuit to ensure that the correct light levels are delivered. The estimated energy savings would be 22%-35% with a payback period of 4-8 years. The main risk associated with this option is that this technology may be overtaken in the long term if LED technology continues to develop.

Replacement of existing lighting units with LED technology will achieve the greatest energy savings at 50%-65% but has the longest payback period of 9-16 years due to their high initial cost. LEDs are

not currently available for higher power lamps which precludes their use on approximately one quarter of the motorway network and there is a risk that some existing poles will not support the additional weight of LED units. Notwithstanding this, LEDs may be the only viable solution for low power lights which are connected via small fragmented circuits to unmetered power supplies.

TII has already made good progress on a number of fronts. A national Public Lighting Steering Group and Working Group have been established to drive national policy and facilitate consultation with relevant stakeholders; sample designs and pilot schemes have been carried out in order to verify the suitability of various options; and Business Case reports are being finalised for the options described above. Also, a standardised national template has been developed for recording public lighting asset inventory information and funding has been provided by TII and SEAI to local authorities to collect this data.

We will shortly be in a position to provide overall estimates of energy savings achievable and the related capital expenditure requirements for public lighting on roads. This can then be aggregated with other business areas within TII to assess whether the overall target for the organisation as a whole is achievable.

The major issues and considerations to address in the coming months will be:

- Continued engagement with ESB Networks and the Commission for Energy Regulation to ensure their timely implementation of the agreed burn profiles;
- Keep TII Board appraised as to the public response to the removal of surplus public lighting poles;
- Securing funding to progress design and installation of energy saving works;
- Progression of the standardised asset inventory for the entire national roads network;
- Completion of all relevant Business Cases to inform investment decision making.

1. Background

In response to the EU Energy Efficiency Directive (2012/27/EU), the Department of Communications, Climate Change and Natural Resources ('the Department') published a series of National Energy Efficiency Action Plans (NEEAP), the most recent of which was in 2014. This sets out Ireland's approach to delivering the 20% energy efficiency savings required by the Directive by 2020 and further recognises that Government must take a lead role in this process and sets a higher target reduction of 33% for the public sector.

In order to meet the ambitious challenges set down in the NEEAP, TII is undertaking a review of its energy usage, examining each consumption type across all business areas in order to identify where energy and associated cost savings can be achieved.

At approximately 45% of the overall total, electricity consumption on public lighting on national roads directly under TII control represents a major element of the energy consumption for TII and therefore this has become an important focus in terms of meeting the NEEAP requirements.

However, the savings in public lighting must be viewed in conjunction with the savings achievable in other areas such as Luas operations, tunnels, motorway service areas and offices in order to determine whether the overall target for the organisation as a whole is achievable.

This report examines the possible energy saving measures relating to TII electricity consumption in public lighting on roads and tunnels.

2. Management of the National Road Network

TII has responsibility for the operation and maintenance of the national road network and undertakes this by means of three distinct methods:

Local Authority Management:

Local Authorities manage a total of 4,190km of predominantly single carriageway national road network on behalf of TII which includes approximately 20,000 public lighting points.

Currently, TII provides a contribution to local authorities to assist with energy and maintenance costs for public lighting but local authorities have consistently maintained that this subvention is often less than the actual operating and maintenance expenditure costs incurred.

Under current arrangements, the relevant Local Authority is responsible for achieving energy savings on this section of the national road network but TII will be responsible for funding the capital expenditure necessary for energy saving schemes while obtaining no recognition in relation to its energy savings performance.

MMaRC Contract Areas:

744km of the motorway/dual carriageway network is maintained on behalf of TII by three regional Motorway Maintenance and Renewal Contractors (MMaRC).

There are approximately 12,700 lighting poles with a total energy consumption of c. 16.8 million kWh per annum in the combined MMaRC network and while these are maintained by the MMaRC contractor, the related electricity accounts are in the name of the relevant local authorities, who recoup their costs from TII under the funding arrangement described above. A trial is currently underway to assess the benefits and feasibility of transferring these energy accounts over to TII from the relevant Local Authorities.

TII is responsible for achieving the energy savings objectives on this section of the network.

TII funding to Local Authorities in respect of route lighting on both the local authority and MMaRC networks was on average €6.27m per annum (incl. VAT) in 2014 and 2015 covering both energy and maintenance costs.

PPP Contract Areas

There are currently ten road schemes operated by PPP concession companies on the motorway network and together they operate 374km of national road motorway/dual carriageway, with a total estimated energy consumption of approximately 10 million kWh per annum.

PPP Contracts involve the transfer of a comprehensive array of risks ranging from the design, construction, operation and maintenance, including operational efficiency, of the road infrastructure; accordingly TII has considerably less scope in terms of influencing how energy savings might be achieved on PPP Contracts. However due to the fact that PPP companies are responsible for the routine maintenance and lifecycle renewal of all public lighting infrastructure on the project as well as the energy costs arising, we are aware of several PPP companies expressing interest in investigating ways in which economic savings can be achieved through energy saving measures, and some companies have initiated certain trial commissions.

The Sustainable Energy Authority of Ireland (SEAI) has confirmed its view that TII is responsible for ensuring that private sector PPP companies achieve energy savings and TII are awaiting confirmation from SEAI that the 20% private sector target energy savings level shall apply rather than the 33% public sector target.

TII is working closely with PPP companies to determine the levels of savings achievable on the various PPP contracts.

3. Basis of Energy Savings

A number of design standards relevant to public lighting have been updated in recent years. This now presents opportunities to TII to achieve energy savings in public lighting.

Firstly, the baseline light intensity levels required for lighting of roads has been reduced with the publication of current standards, BS 5489 – 1:2013 and IS EN 13201:2015. As a result of this, lighting designs which predate that standard currently deliver a higher light intensity than is now required under the current standards.

Secondly, UK Design Manual for Roads and Bridges (DMRB) standard TD22/06 "Layout of Grade Separated Junctions" was adopted in Ireland in 2009. This standard defines a reduced extent of the lighting footprint at motorway junctions. Junctions constructed prior to this, typically included lighting over a larger footprint and this offers the possibility of removing surplus lighting poles at such locations.

A decision regarding possible removal of surplus public lighting columns is also influenced by a change to design standard TD19 relating to the design of vehicle restraint systems. This standard was amended in 2007 to include a requirement that public lighting poles should be considered hazards and should be either frangible or be protected by a vehicle restraint system. Thus, the removal of surplus public lighting poles would have the double benefit of saving energy and removing what are now considered hazards from the roadside.

4. Challenges

A number of significant challenges exist to achieving the targets set down by the NEEAP and these are generally shared with the local authorities. In conjunction with the County and City Management Association (CCMA), TII has established a national Public Lighting Steering Group/Working Group to drive resolution of national issues relating to public lighting. In addition to CCMA and TII, members of these groups include the Department, SEAI, ESB Networks (ESBN) and the Energy Agencies.

Targets

In order to meet the goals for TII as a whole, it may be necessary to exceed the energy savings target in some areas to make up for other areas where there is less opportunity for increased efficiency. Public lighting is an area where it may be possible to exceed the targets subject to sound financial justification. However, this causes a challenge in that the target required in each part of the organisation cannot be determined without reference to those in every other part of the organisation.

Funding

Once progress has been made on critical tasks such as the asset inventory and the decision to remove surplus poles, a funding plan shall be prepared for TII Board approval.

The level of funding required for the implementation of energy savings measures will be determined by the specific technologies utilised which in turn will depend on the level of energy savings required. As a result of this, the range of funding that may be required is uncertain at this point but, will in any event, be significant.

Public Lighting Unmetered Supplies

An important factor in the ability to achieve energy savings is the electricity supply connection type. Public lighting supplies can be metered whereby energy is charged based on actual usage recorded by an electricity meter. This arrangement is more prevalent in newer sections of the network including a significant portion of the motorway network.

Alternatively for unmetered supplies, the energy charged is based on a calculation of the number of lamps and the 'burn profile' of each i.e. the rated power consumption and the assumed operating regime. This arrangement is more prevalent on older sections of the motorway network and on most non-motorway routes. The fundamental problem with unmetered supplies is that regardless of the reduction in the energy consumed, no cost savings will be achieved without the implementation by ESB Networks (ESBN) and the Commission for Energy Regulation (CER) of new burn profiles which reflect the actual energy used when energy saving measures are applied.

As part of the Working Group, TII has engaged with ESBN and the CER on this issue and eleven new burn profiles have been agreed. However, until these burn profiles are implemented by ESBN and the CER, energy savings on unmetered supplies will not result in any cost saving to TII or to local authorities.

Unfortunately, ESBN and the CER have been slow in implementing the necessary additional burn profiles for unmetered supplies and this currently represents a significant barrier to the introduction of energy efficient measures.

Asset Inventory

Prior to 2005 when the unmetered supply was opened to competition, ESBN maintained an asset inventory for unmetered supplies on behalf of its customers. After this date, ESBN handed over this information and each local authority was responsible for verifying the accuracy of the inventory and updating it as it evolved.

In the absence of a common template for collecting and recording data, local authorities collected different items of information using different mechanisms; some retained very limited data, sufficient for basic maintenance while others developed full energy management databases.

As a result, the current asset inventory across the various local authorities is not standardised or comprehensive and this does not permit detailed analysis of the various energy savings options.

5. Energy Saving Options

As a result of the work carried out to date, the energy savings options in Table 1 below have been identified as being appropriate for consideration on the MMaRC network. A Business Case has been prepared for energy saving options for a group of national road bypasses in the North West and this has indicated similar results to those below. Consequently, it is envisaged that these options will be appropriate on all motorways, dual carriageways and engineered roads generally constructed in the last 15 years.

On those sections of the national road network which are managed by Local Authorities on behalf of TII, LED is more likely to be the preferred option due to the large number of unmetered supplies and the presence of SOX lighting which is not dimmable.

	Remove surplus poles	Power Controllers	LED
Description	The removal of surplus poles not required under latest design standards.	The installation of power control devices at each supply meter / connection point which will reduce light supplied to the amount required by latest design standards.	The installation of new LED light fittings with integral control modules which are more efficient and which will reduce light to the level required by latest design standards.
Estimated Energy Savings	12%-18%	22%-35%	50%-65%
Payback Period[1]	3-5 years	4-8 years	9-16 years
CAPEX[2] [3]	€1.5m – €2.0m	€3.0m - €4.0m	€12.6m - €16.8m[4]
NPV[5] **at 5 years**	€0.9m	€0.6m	-€6.6m
NPV at 15 years	€5.2m	€7.2m	€5.6m
NPV at 25 years[6]	€9.0m	€12.9m	€15.6m
Risks[7]	- Possible negative public perception. Research project is underway to inform TII policy development in this area. - Extent of removals needs to be subject to a detailed safety assessment.	In the long term, this option may be overtaken if LED technology continues to develop with the possibility of an associated reduction in power controller availability.	- Agreed burn profiles for unmetered supplies have yet to be implemented by EBS Networks. - LED options for higher power lamps (>400W and high mast configuration) are limited and a solution for compliance with BS 5489 may not be available. - Existing lighting columns may be unsuitable for retro fit LED.

Table 1: Energy saving options for public lighting on the MMaRC network.

[1] The payback period is the time taken for the cost savings to repay the capital investment, allowing for inflation and discount rates. Refer also to Figure 1.
[2] CAPEX is the Capital Expenditure required to install energy saving measures. Figures quoted are ex VAT.
[3] The CAPEX and NPV quoted are for the works required to the MMaRC network only.
[4] Note that LED prices include for an anticipated 10% price reduction in line with current price trends.
[5] NPV is the Net Present Value. This is the sum of all the costs and benefits/savings over the time period stated expressed in today's terms. For example, the NPV at 15 years is the sum of all the investments and savings over the first 15 years, expressed in current day prices. The NPV is a measure of the overall benefit of carrying out the scheme. Figures quoted are ex VAT.
[6] Note that NPVs for long periods more than 20 years may be unreliable given that this exceeds the lifespan of all energy savings technologies.
[7] Although this table relates specifically to the MMaRC network, risks for the entire national road network have been included for convenience.

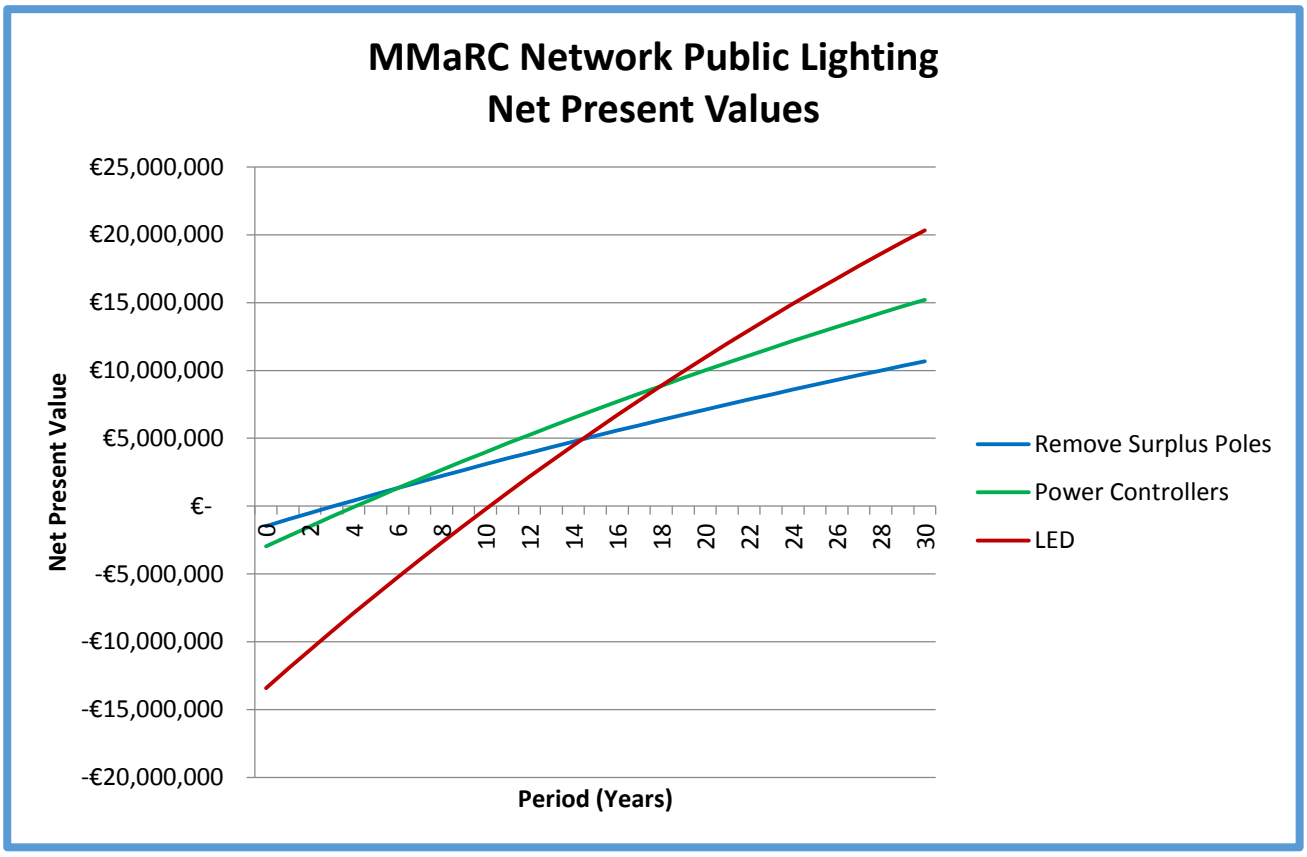

Figure 1: Cumulative NPV over time showing initial investment, payback period and NPV[8]. (Refer also to Table 1)

6. Current Initiatives

Local Authority Management

TII has worked closely with Local Authorities through the Working Group in pursuit of achieving cost effective energy reductions in public lighting. This has been essential given the shared responsibility and extensive overlap in both infrastructure and objectives. Specifically, the following steps have been taken:

- As previously referenced, TII is actively participating in a national Public Lighting Steering Group and Working Group to drive national issues relating to public lighting;
- Since 2011, TII have funded a number of public lighting energy saving pilot schemes around the country. Lessons learned from these feed into the Steering and Working Groups' deliberations and have been utilised in developing the cost and payback estimates referenced in Table 1 and the national decision making process;

[8] In this graph, the power controller option assumes no energy savings technology is applied to the 1.7% of the network where SOX bulbs are in use; the LED option assumes that power controllers are used on the 26% of the network where LED is unsuitable (i.e. is lit using high mast lighting).

- The Working Group has obtained agreement with ESBN and the CER for eleven new burn profiles for unmetered supplies. This will allow energy savings achieved to be reflected in reduced energy costs to the bill payer. The first four of these new burn profiles are programmed for implementation by ESBN and the CER during quarter 1 of 2017; the remaining seven will be implemented pending prioritisation of this work by the CER;
- A standard public lighting inventory template and a supporting guidance document have been developed by the Working Group. These have been issued to all local authorities by the Local Government Management Agency (LGMA) and TII and SEAI are providing funding in 2016, for national and non-national roads respectively, toward the costs incurred by local authorities in gathering and collating the required information;
- TII has made provision for capital funding of €1.5m (incl. VAT) in 2016 to fund energy saving public lighting schemes;
- A Business Case has been prepared by TII to calculate whole life costs and potential energy savings by upgrading approximately 1,350 existing public lighting units in 12 national road bypasses in the northwest of the country. Consultants are being procured to carry out detailed design for optimising the interventions in line with those described in Table 1. Exemplar procurement documents will be developed with a view to advertising in Quarter 1 of 2017.

MMaRC Contract Areas

There are a number of technical differences between the lighting on the MMaRC network and that on the remainder of the national road network. These include a significant percentage of high power lamps, a lower percentage of unmetered supplies and approximately 98% of existing lamp types being suitable for dimming. These differences require that a separate approach be taken to this section of the network and the steps carried out to date include:

- Asset inventory information is being gathered in parallel with routine maintenance works using the Energy Procurement Database as set down in the MMaRC contract requirements;
- Work is underway to rationalise circuits between the MMaRC networks and adjacent local authorities where economically justified, including the removal of non-public lighting loads such as traffic lights etc. ;
- A pilot scheme to assess the feasibility and benefits of the transfer of energy accounts from the local authorities to TII is currently underway;
- A study is underway regarding the feasibility of removal of surplus poles at motorway/dual carriageway junctions including a review of international best practice and the analysis of accident data and safety implications, with a view to undertaking a pilot scheme in summer 2016;

- An analysis of energy efficiency measures has been carried out at two typical sample junctions which has indicated that removal of poles achieves the greatest energy savings, with a payback period of ~3-5 years and 65-70%[9] energy savings. The next best option is dimming using power controllers with a payback of 4-8 years and 22-35% energy savings;
- Existing public lighting was replaced with LEDs incorporating dimming / trimming technology as a TII pilot scheme on N40 at Mahon Interchange in Cork in 2012. Energy savings of 45-50% were achieved, with a payback period of 15 years. Costs of LED lights are decreasing and payback time will reduce accordingly;
- A Business Case which examines the various energy saving options specific to the MMaRC Network is currently being finalised and will be available in August 2016.

PPP Contracts

The characteristics of lighting on the PPP network are similar to that on the MMaRC network and therefore it is expected that similar solutions will be applicable to both. TII have taken the following steps in respect of the PPP companies.

- TII are engaging with the various PPP companies to gain information in respect of energy consumption, energy saving plans and offering to share TII expertise in this area. To date the individual PPP companies have proposed dimming using power controllers and the removal of surplus lights as the most cost effective means of energy reduction. LEDs have not been adopted by any PPP company to date due to concerns as to the long payback periods involved and reluctance to adopt technology which is still developing;
- The most significant initiative taken to date has been a trial on the M50 which demonstrated the successful use of power controller technology to regulate power supplies and dim lighting based on traffic flow levels. Energy savings of 43% were achieved with a payback period of less than 3 years but this includes savings arising from power supply regulation which may not be available at every location. It should be noted that in the long term, this option may be overtaken if LED technology continues to develop with the possibility of an associated reduction in power controller availability.

Dublin Tunnel and Jack Lynch Tunnel

The lighting requirements in tunnels are quite different to those on other sections of the national road network. For example, maintenance costs are higher in tunnels due to the need for tunnel closures to facilitate maintenance works. In addition, light levels are higher due to the requirement to manage the transition from full daylight conditions.

[9] This is the percentage of energy that can be saved at junctions which contain surplus lighting poles. As many junctions do not have surplus lighting poles, the overall saving on the network as a whole is in the range 12%-18%.

On the direction of TII, the tunnel operator, Egis Road & Tunnel Operation, is examining the installation of LED lighting in the Dublin Tunnel which will result in energy savings and reduced maintenance frequency. The estimated level of savings is 40%-50% of energy used for lighting which represents c. 20% savings in overall energy usage.

There are two options for the upgrade of the lighting to LED technology at the Dublin Tunnel:

- Firstly, a retrofit solution in which new LED lighting trays are installed in the housing component of the existing luminaire; and;
- Secondly, a complete refit of the lighting system in which new LED luminaires are installed in the tunnel and the existing luminaires are removed.

Whilst there are advantages and disadvantages of both systems, a retrofit solution is currently being trialled because of the significantly lower capital cost, the shorter installation time required and the shorted payback period.

7. Next Steps

Within the overall context of energy savings, public lighting offers TII the best opportunities to achieve energy savings. TII will continue to progress a number of initiatives currently underway in order to develop an informed national strategy. As technology in this area is evolving rapidly, it is important that the outcomes of these initiatives underpin and inform future decision making and policy.

a) Inventory

In the first instance TII will complete the asset inventory project currently ongoing for both the MMaRC and Local Authority managed section of the network and will for the first time have an accurate up to date national database of the public lighting asset on the national road network. This standardised inventory will allow informed decisions to be made regarding realistic opportunities for energy savings and will facilitate discussion on the social versus transportation lighting issue.

b) Removal of Lights

Subject to approval, TII in conjunction with the M4 PPP company intend to undertake a trial in which surplus lighting poles are identified and removed, and the outcomes are monitored to assess the results and driver perceptions. Research currently underway by Arup will inform the trial in terms of location, extents etc. As the removal of lights could potentially attract negative commentary, it is imperative that the trial is carefully planned, controlled and assessed so as to inform future policy in this regard.

c) Standards and Specifications

Relevant TII standards will continue to be updated to account for technology changes and revisions to European and British standards in this area. This ongoing review will also ensure

consistency of standards and policy for the organisation whilst facilitating the deployment of newer technologies.

d) Cost Confirmation via Trial Contracts

TII will also progress the North West Bypasses project as an exemplar public lighting project and in doing so will explore installation costs, energy savings and the possible benefits of energy related performance contracting. This will validate the assumptions on which the Business Cases prepared to date have been carried out and will further refine the information contained in Table 1 above.

e) Continue to Work with Stakeholders

Finally, TII will continue to co-operate with the relevant stakeholders such as the CCMA, SEAI, PPP companies and the Department in order to ensure that efficiencies achieved through collaboration, best practice and knowledge sharing can be garnered in informing and progressing public lighting on the national network.

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