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Measuring Energy Flows from In-Built Technology (Streetlights, EV Chargers, Other Street Furniture) Analysis – Draft Report

Prepared for the
Australian Energy Market Commission

ENERGEIA

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ENERGEIA

Executive Summary

Households and businesses are embracing Consumer Energy Resources (CER) at an accelerated rate because they promise consumers the opportunity to lower energy bills and to have a greater level of control over their energy use. However, current market arrangements may not adequately support the trading of flexible CER in the national electricity market (NEM). As a result, consumers will find it difficult to maximise the value of their CER and could potentially increase system costs if the growing number of CER is not integrated well.[1]

To address these concerns, the Australian Energy Market Commission (AEMC) drafted a Directions Paper that outlined the Commission's initial views and key areas it intends to improve in response to the Australian Energy Market Operator's (AEMO's) rule change request to unlock CER benefits through flexible trading.

This report focuses on the third workstream of the AEMC's proposed rule change, which focuses on enabling technology with in-built measurement capability to be used for settlement purposes, such as integrated streetlight controllers and electric vehicle (EV) chargers. The proposed changes primarily aim to reduce costs associated with metering and to enable consumers to access cost savings from the actual measurement of energy flows (versus use of algorithms to estimate energy flows).

Scope

The AEMC engaged Energeia to conduct a limited, desktop investigation into workstream 3 of the Rule Change - measuring energy flows from in-built technology (streetlights, EV chargers, other street furniture)[2]. The analysis focused on costs and benefits associated with uptake of streetlighting with dimmable lighting controls and public kerbside EV chargers that have in-built metrology.

While this Rule Change will cover other technology, such as such as traffic lights, CCTV cameras, and public barbecues, these use cases were not included in this analysis due to insufficiency of data.

Approach

Energeia's approach to delivering the above scope of work was broken down into the following workstreams.

Analyse Costs and Benefits

This workstream involved gathering and/or developing the inputs needed to configure a specified cost-benefit analysis (CBA), developing the model itself, and populating it with the inputs. This included the following tasks:

- **Gather Key Inputs –** Energeia developed estimates of counts, energy flows, emissions and costs over the 20-year study period for selected energy devices with in-built measurement capabilities.
- **Develop CBA Model** – Energeia developed and configured a cost and benefit model for the proposed Rule Change, using the inputs gathered in the previous step and generated results.

Documentation and Validation

This workstream documented the research and analysis findings for validation with the AEMC and ultimately industry participants via the public consultation process. This included the following tasks:

- **Present Findings –** Energeia met with the AEMC to verify the key inputs and assumptions developed, and draft key findings of the CBA.
- **Draft Determination Report** – Energeia then documented the CBA framework and methods, inputs and assumptions, and outcomes into this report for inclusion in the Draft Rule Determination.

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[1] Unlocking CER Benefits through flexible trading, Directions Paper, https://www.aemc.gov.au/sites/default/files/2023-08/ERC0346%20CER%20Benefits%20Directions%20paper%20-%20rule%20change.pdf

[2] Unlocking CER Benefits through flexible trading, Directions Paper, https://www.aemc.gov.au/sites/default/files/2023-08/ERC0346%20CER%20Benefits%20Directions%20paper%20-%20rule%20change.pdf

Results

For simplicity, and due to the limited nature of the study, Energeia's CBA assumed that the Rule Change would result in all new and replacement lights being smart controlled light-emitting diode (LED) lights that are individually metered and controlled via smart streetlight control technology. This Rule Change scenario was compared to a Business-as-Usual (BaU) scenario, which assumed all new and replacement lights would be LED but without smart streetlight controls.

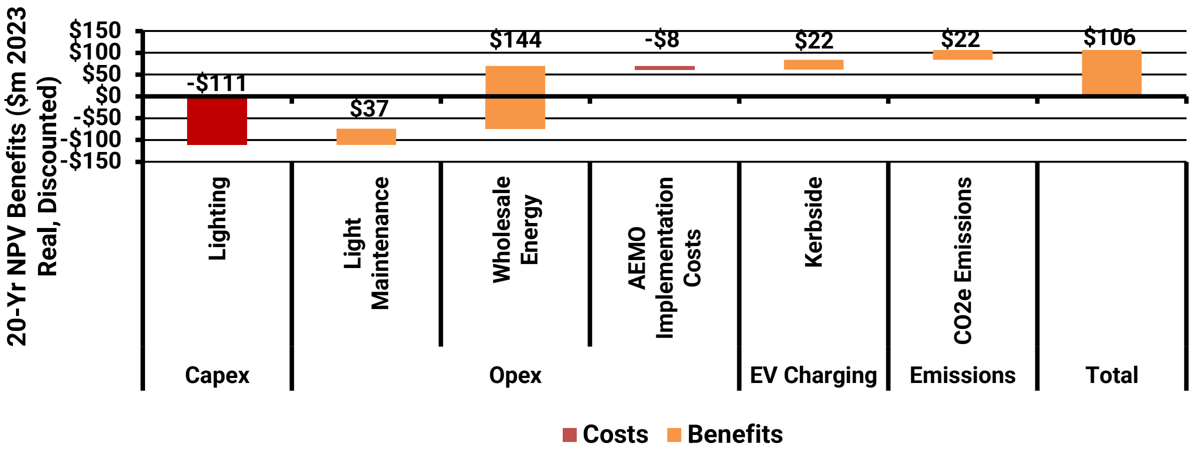
Energeia modelled the associated economic costs and benefits of the proposed Rule Change over 20 years in terms of lighting and metering assets, data, billing systems, wholesale energy, grid emissions impacts, network infrastructure capital (capex) and operational expenditure (opex). UFE impacts were calculated as well, but not included in the CBA as they represent a wealth transfer and not an economic cost.

The results of the CBA found that the Rule Change could deliver up to $106 million in net benefits over 20 years, on a discounted basis. While smart streetlighting technology has higher lighting asset and operational costs due to the cost of the smart streetlight controller and associated data and market services, the modelling shows this is offset by the reduction in energy consumption from smart controlled street lighting.

Figure ES1 shows the breakdown in the CBA by cost factor, revealing that the additional capex costs of smart controlled streetlighting is responsible for the largest increase in costs under the Rule Change. Wholesale energy savings is the largest category of net benefit, followed by savings in light maintenance. Changes in the assumed cost of smart controlled streetlighting or wholesale energy costs is estimated to have the largest impact on these results.

Energeia's analysis also estimated that avoided EV kerbside metering costs offered net savings of $22 million, based on the number of avoided metering locations assumed (i.e. by allowing internal EV charger metrology to be used in lieu of a discrete metering solution). A higher mix of expected kerbside chargers or a higher associated cost would increase the resulting net benefits of the Rule Change. The analysis similarly showed discounted net savings of $22 million in emissions reduction benefits from the reduced consumption of smart controlled streetlights.

Figure ES1 – Total 20-Year Net Benefits for Rule Change Scenario



Source: Energeia Modelling

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Disclaimer

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1. Background

Households and businesses are embracing Consumer Energy Resources (CER) at an accelerated rate because they promise consumers the opportunity to lower energy bills and to have a greater level of control over their energy use. However, current market arrangements may not adequately support the trading of flexible CER in the national electricity market (NEM). As a result, consumers will find it difficult to maximise the value of their CER and could potentially increase system costs if the growing number of CER is not integrated well.[3]

To address these concerns, the Australian Energy Market Commission (AEMC) drafted a Directions Paper that outlined the Commission's initial views and key areas it intends to improve in response to the Australian Energy Market Operator's (AEMO's) rule change request to unlock CER benefits through flexible trading. This rule change aims to facilitate better integration of flexible CER into the power system to deliver a more reliable and secure energy system that would benefit all consumers.

The AEMC has broken down AEMO's rule change request[4] into three core areas, which cover:

1. Optimising the value of CER flexibility at small customer premises
2. Flexible trading of CER with multiple service providers at large customer premises
3. Measuring energy flows from in-built technology (streetlights, EV chargers, other street furniture).[5]

This report focuses on the third workstream, which focuses on enabling technology with in-built measurement capability to be used for settlement purposes, such as smart streetlights and EV chargers. This change primarily aims to reduce costs associated with metering and to enable customers to access cost savings associated with selected energy devices with in-built measuring capabilities (versus use of algorithms to estimate energy flows).

We note that this workstream is linked to workstreams 1 and 2 of the Rule Change, in that the meter type developed for technology with in-built measurement capability could also be used for CER assets at small customer and large customer premises (e.g. EV chargers).

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[3] Unlocking CER Benefits through flexible trading, Directions Paper, https://www.aemc.gov.au/sites/default/files/2023-08/ERC0346%20CER%20Benefits%20Directions%20paper%20-%20rule%20change.pdf

[4] Rule Change Request – Flexible Trading Arrangements (Model 2) and Minor Energy Flow Metering in the National Energy Market, https://www.aemc.gov.au/sites/default/files/2022-05/ERC0346%20Rule%20change%20request%20pending.pdf

[5] Unlocking CER Benefits through flexible trading, Directions Paper, https://www.aemc.gov.au/sites/default/files/2023-08/ERC0346%20CER%20Benefits%20Directions%20paper%20-%20rule%20change.pdf

2. Scope and Approach

This section summarises Energeia's scope of work and our approach to delivering it.

2.1. Scope

The AEMC engaged Energeia to conduct a desktop investigation into workstream 3 of the Rule Change - measuring energy flows from in-built technology (streetlights, EV chargers, other street furniture)[6]. The aim of this engagement was to estimate the costs and benefits of creating new meter types in the National Electricity Rules (NER) to enable the measurement of energy flows from devices with in-built measuring capabilities. The required analysis focused specifically on rolling out this metering type to streetlighting and public kerbside EV charging.

The AEMC specified a cost-benefit analysis (CBA) to understand the following potential benefits and costs:

- System benefits from better allocation of unaccounted for energy (UFE) through measuring the load for streetlights (versus using an algorithm)
- Cost savings (benefits) to customers from better data allocation of UFE through measuring the load for streetlights and dimming capacity of streetlights (versus using an algorithm)
- Maintenance benefits for distribution networks derived from earlier and remote detection of faults in streetlights, avoiding inspections, customer calls and guaranteed service level payments
- Metering coordinator cost savings using in-built metrology (instead of a smart meter) for public Electric Vehicle (EV) chargers, as opposed to installing a separate meter under current arrangements
- Additional capital and operational cost of smart controlled streetlights with dimming and energy flow measuring capabilities, including the controller, and data communication, processing and storage
- Implementation costs for AEMO due to enhanced data communication, processing and storage capabilities as well as procedures and guidelines
- Additional cost of rolling out new metering arrangements and additional measurement points to industry participants, including data communication, processing and storage costs
- Emissions savings (benefits) resulting from the rule change enabling the smart streetlighting

It should be noted that while this Rule Change will cover other technology, such as such as traffic lights, CCTV cameras, and public barbecues, these use cases were not included in this analysis due to insufficiency of data. The additional cost if introducing third-party metering coordinators to take some role in the process also was excluded for similar reasons.

[6] Unlocking CER Benefits through flexible trading, Directions Paper, https://www.aemc.gov.au/sites/default/files/2023-08/ERC0346%20CER%20Benefits%20Directions%20paper%20-%20rule%20change.pdf

2.2. Approach

Energeia's approach to delivering the above scope of work was broken down into the following workstreams.

2.2.1. Analyse Costs and Benefits

This workstream involved gathering and/or developing the inputs needed to configure a specified CBA, developing the model itself, and populating it with the inputs. This included the following tasks:

- **Gather Key Inputs** – Energeia undertook desktop research to identify and develop accurate estimates of the current and forecast state of selected energy devices with in-built measurement capability counts, energy flows, emissions and costs. These inputs to the CBA are detailed in Section 3.3.
- **Develop CBA Model** – Energeia developed and configured an Excel-based model to estimate the costs and benefits of this proposed Rule Change, using the inputs gathered in the previous step, and then generated the key findings. The estimated Rule Change costs and benefits are described in Section 3.2.

2.2.2. Documentation and Validation

This workstream documented the research and analysis findings for validation with the AEMC and ultimately industry participants via the public consultation process. This included the following tasks:

- **Present Findings –** Energeia met with the AEMC to verify the key inputs and assumptions developed, and draft key findings of the CBA.
- **Draft Determination Report –** Energeia then documented the CBA framework and methods, inputs and assumptions, and outcomes into this report for inclusion in the Draft Rule Determination.

3. Methodology

This section outlines the key technical methods used to develop and conduct the Cost-Benefit-Analysis (CBA) on the impacts of creating new meter types in the NER for the measurement of energy flows from selected energy devices with in-built measuring capabilities. The analysis presented is focused on streetlighting and public kerbside EV charging.

3.1. Overview

Energeia adopted a 20-year study period to estimate the costs associated with switching from traditional streetlights to light-emitting diode (LED) or smart controlled LED streetlights. This provides a reasonable timeframe, balancing the interval of costs and benefits considered against the uncertainties in longer term forecasts.

Two scenarios were designed to quantify the economic impacts of this proposed Rule Change:

- **Business-as-usual (BaU)** – This scenario assumed that all new lights, and replacement lights, would use LED lights.
- **Rule Change** – This scenario assumed that all new and replacement lights would be smart controlled LED lights, and all kerbside EV chargers would use in-built metrology[7] capabilities.

Total costs under both scenarios were calculated as a net present value (NPV) of the annual value of each cost category over 20 years, with the CBA being the difference between the Rule Change scenario and the BaU scenario by cost category.

3.2. Potential Benefits

The main potential economic benefits from this Rule Change are lower wholesale energy costs, emissions reductions, lower operating and maintenance costs, and lower metering costs for kerbside EV charging. Other potential non-economic[8] benefits include more accurate allocation of Unaccounted for Energy (UFE).

Each potential benefit is described below within the context of this proposed Rule Change, along with how it has been factored into the analysis.

3.2.1. Introduction of Smart Control Technology Including Metrology

Implementation of the proposed Rule Change could result in a faster deployment of smart controlled streetlights and LED lighting that would have the following flow-on effects across the National Electricity Market (NEM).

Energy Cost Savings

The main potential benefits from this Rule Change would come from unlocking more efficient streetlighting controlled by smart controllers, which have in-built metering capabilities. Smart controlled lights allow for lower[9] lighting levels when traffic is lower, for example from 10pm to 4am, require less frequent inspections and generate less complaints than non-smart controlled lighting, leading to a reduction in energy consumption and emissions, as well as lower operations and maintenance costs. This feature can also extend the life of streetlights by eliminating the need for them to operate at 100% brightness while active.[10]

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[7] EV charger in-built metrology refers to the integrated measurement and monitoring capabilities of EV chargers that allows them to track and record parameters such as energy consumption.

[8] An improvement in cost allocation does have an economic benefit from improving allocative efficiency, but it is not believed to be a material benefit in this case due to the relatively small levels of UFE and associated cost impacts.

[9] Actual levels and their timing are not yet standard in Australia, but research completed or this study found that 50% lower lighting was possible, and a 30% overall savings was possible based on the number of hours of dimming.

[10] Dimming can also reduce light pollution, which was not valued due to a lack of data and an assumption of a low quantum.

The reduced lighting load of smart controlled streetlights decreases wholesale energy costs during the dimming period, resulting in lower energy retail bills for consumers.

Energeia estimated the energy cost savings by calculating the reduction in total annual energy consumption between scenarios by year and multiplying it by the time weighted average nighttime wholesale energy cost per year, over the 20 year study period.

Emissions Reduction

Reducing energy consumption reduces associated emissions from energy generation, which have been assessed at the NSW Treasury carbon values.

Energeia estimated the Rule Change scenario emissions reduction by taking the relative reduction in annual energy consumption for a streetlight compared to BaU, and multiplying it by the average forecast nighttime grid emissions intensity from AEMO.

3.2.2. Reduced Maintenance Costs

Smart controlled streetlights can alert operators to faults in real time, thereby reducing the need for more frequent inspections and associated maintenance costs. Faults can lead streetlights remaining in the 'on' or 'off' position for days at a time until they are noticed and fixed, potentially generating complaints, which must be handled by a contact centre and can lead to payments for not hitting Guaranteed Service Levels (GSL).

Detailed data on inspection, contact centre and GSL payments is not widely available. Energeia therefore assumed that smart control technology could eliminate inspections, contact centre and GSL payments, which we estimated based on Ausgrid's ratio of inspection and contact centre opex to all opex, resulting in an estimated ~6% opex reduction.[11]

Energeia then estimated the impact of the Rule Change as being the difference in maintenance expenditure over time compared to the BaU scenario.

3.2.3. Better Allocation of UFE

Unaccounted for energy (UFE) represents the difference between the amount of energy being drawn into a distribution zone and how much is recorded on the meters as being used by consumers.[12] These differences can be caused by energy theft, inaccurate or faulty meters, estimation errors associated with unmetered devices, or errors in the distribution loss factor (DLF).

UFE can lead to incorrectly allocating costs between energy consumers and streetlighting rate payers and an increase in inefficient industry costs due to economic levels of losses in the system. With more accurate allocation of UFE, allocative efficiency would be improved, resulting in streetlighting consumers using more/less, and industry investing more/less to reduce losses.

By enabling in-built metrology streetlighting and other street furniture to be used as a meter, the Rule Change would reduce UFE and its associated error by providing actual consumption data.

To estimate the potential benefits of UFE allocation, Energeia estimated the level of streetlight related UFE by comparing the level of UFE during daytime and nighttime periods using regression analysis.[13] The result was divided by the number of streetlights to get a UFE per streetlight estimate, which was then scaled based on the number of smart controlled lights each year, to arrive at the annual avoided level of UFE.

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[11] A future opportunity to increase the accuracy of this analysis would be to increase the number of DNSPs used or a deeper dive into published streetlighting alternative control services cost data.

[12] Calculation and Allocation of UFE, AEMO, https://aemo.com.au/-/media/files/electricity/nem/data/metering/ufe/2022/ufe-fact-sheet-v10.pdf?la=en

[13] A future opportunity to improve the accuracy of this analysis would be to analyse UFE for each DNSP against their substation loads.

3.2.4. In-Built Metrology for Public EV Charging

Allowing in-built metrology in public EV chargers to be used for settlement purposes would avoid the need for a discrete meter at the device and the installation and associated costs.

Most public chargers are either installed in DCFC stations or public parking lots, with a front of house meter installed by the charging operator, to offset the consumption from the premise's native load. While using internal charger metrology could be used to avoid this front of house meter, its costs are spread over a significant number of chargers, and the avoidable cost is relatively low.

The biggest opportunities for this Rule Change to affect is kerbside charging, including using utility poles, kiosks and other distributed utility assets, to offer charging in more locations. These are more likely to require a 1:1 meter installation under the current Rules[14], and the value of using an internal meter is therefore highest. Another major potential opportunity is unlocking demand response from private EV charging, which would otherwise sit behind the main premise meter. However, this is being considered under another stream of work.

Energeia calculated the Rule Change benefits by calculating the avoided equipment and installation cost of meters for each kerbside EV charger forecast to be installed in the NEM.

3.3. Potential Costs

The main costs from this Rule Change are expected to come from the cost of additional smart light controls, National Metering Identifier (NMI) establishment by DNSPs, establishment of new metrology types and procedures by AEMO, and additional data management costs from each streetlight generating a 5-minute data stream compared to no data streams for unmetered streetlights at the moment.

3.3.1. Smart Control Technology

For the purposes of this analysis, we are assuming that the Rule Change would drive all new and replaced streetlights to use smart control technology. All streetlights are assumed to be LED moving forward regardless of the scenario, and all require installation, the marginal cost of smart control technology under the Rule Change scenario focuses on the cost of the controller.

Energeia estimated the cost of the smart controller per light from desktop research. This cost would be directly incurred by the network but would ultimately be passed through to the consumer via council rates. No additional costs for the central control system were included due to a lack of information in the public domain.

3.3.2. Additional NMIs

The proposed Rule Change would see the number of smart controlled streetlights increase over the next 20 years, however there would be no increase in additional NMIs as it is assumed that all new streetlighting loads would be aggregated into existing NMIs on the network.[15]

3.3.3. Additional Data Streams

The proposed Rule Change would also see the number of data streams in the NEM remain constant over the next 20 years, as there would be no additional NMIs and all new streetlighting loads would be integrated into the existing data streams.[16]

Energeia estimated this cost based on AEMO's published Rule Change levies, calculated on a $/kWh basis.[17]

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[14] Energeia notes that there is nothing preventing the use of a charging profile, similar to streetlighting, but current pilots including for Ausgrid have been install discrete meters, in part to provide a basis for estimating charging profiles.

[15] Based on DNSP feedback that multiple streetlights are often allocated to a single NMI, ranging from 1 to 50,000.

[16] Energeia acknowledges that there would be a need for DNSPs to be able to handle smart meter data from streetlights and other unmetered loads, but considered this cost to be negligible since they already do this for other customer types.

[17] Energeia has requested specific cost data from AEMO, which was not available at the time of the report's publication.

4. Key Inputs and Assumptions

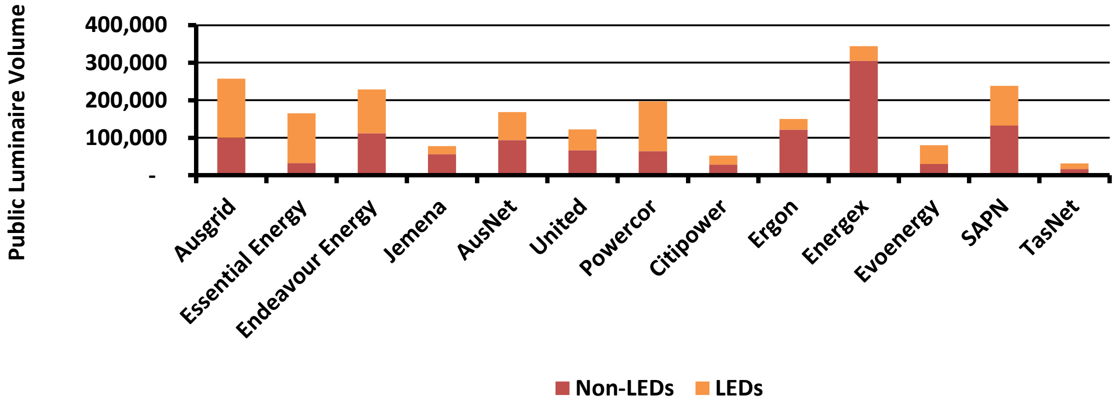
Calculation of the key costs and benefits associated with the proposed Rule Change and detailed in the preceding section required a range of inputs and assumptions, which are detailed in this section.

4.1. Streetlight Counts

Streetlighting counts are the key driver of costs and benefits in the CBA. They were used to set lighting stock and turnover rates, and to calculate key outputs including total energy consumption, emissions and costs per year by lighting type, being non-LED, LED and smart controlled LED.

The count of streetlights by light type was collected from the 2021–22 Category Analysis RIN for each DNSP to determine the current split of LED and non-LED lights. The total lighting count for each DNSP, split by type of light, is shown in Figure 1.

Figure 1 – 2021–22 Total Public Lighting Luminaire Count by DNSP



Source: DNSP Economic Benchmarking and Category Analysis RINs

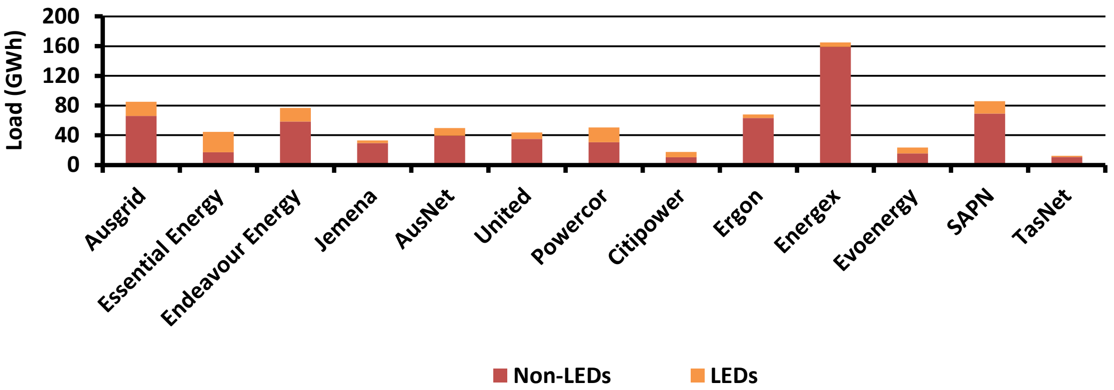
4.2. Streetlight Loads

Streetlight consumption was used in the CBA to estimate the total annual consumption, emissions and wholesale energy costs from streetlighting by light type.

While the 2021-22 Economic Benchmarking RINs for each DNSP provide the total volume of energy delivered to unmetered supplies, they do not provide a further split by public streetlight or public street furniture. To calculate this split, data on watts and counts by luminaire from DNSPs 2021-22 Category Analysis RINs was used with an assumed 4,100 hours of annual operation to estimate total public streetlighting load by type.

Estimated unmetered load, split by streetlighting and other unmetered loads, is shown in Figure 2.

Figure 2 – 2021–22 Total Load Split by Streetlighting Type (LED and non-LEDs) by DNSP



Source: DNSP Economic Benchmarking and Category Analysis RINs

4.3. Dimming Level

Streetlight dimming levels were used in the CBA to adjust the annual energy consumption of smart controlled LEDs compared to non-smart controlled LEDs.

Energeia assumed a dimming level (and therefore energy savings) of 30% based on data provided by the AEMC.

4.4. Smart Control Technology Prices

Smart control technology costs are used in the CBA to drive the capex premium in the model for smart controlled streetlights.

Energeia estimated a capex cost for the material and installation of smart controllers of $50.2 from Ausgrid's pricing proposal.[18] This cost would be directly incurred by the network but would ultimately be passed through to the consumer via council rates. No additional opex costs were assumed for the asset itself.

4.5. Wholesale Energy Prices

Wholesale prices were multiplied by consumption each year to produce wholesale energy costs and cost impacts by scenario for the CBA.

Assumed wholesale energy costs by state were first calculated using average nighttime[19] energy prices from AEMO's 2022 historic wholesale 30-minute prices by state.[20] A NEM lighting regional reference price (RRP) per kWh was then estimated based on a DNSP-volume weighted average (VWA). This cost was then used to calculate wholesale energy costs by year.[21]

The resulting streetlighting price per MWh by DNSP is shown in Figure 3.

Figure 3 – 2022 Average Nighttime Wholesale Price by State

Source: AEMO 2022 Historical Wholesale Price (30-min)

4.6. Avoided Maintenance Costs

The avoidable cost was used to reduce the maintenance cost input for smart controlled lighting compared to non-smart controlled lighting.

[18] Ausgrid Attachment 8.11 – Indicative Pricing Schedule – ACS, https://www.aer.gov.au/system/files/Ausgrid%20-%20Att.%208.11%20-%20Indicative%20pricing%20schedule%20-%20ACS%20%20-%2031%20Jan%202023%20-%20Public_0.pdf

[19] Nighttime hours are assumed to be between 18:00 and 06:00

[20] NEMOSIS, https://github.com/UNSW-CEEM/NEMOSIS

[21] A future opportunity to improve the accuracy of this analysis would be to use a forecast NEM price, as prices are likely to change.

To estimate the avoidable maintenance costs for smart controlled lights, the individual component costs for streetlight inspections and contact centre operations were collected from Ausgrid's Annual Reporting RIN to calculate a percentage of avoidable maintenance, which was then subtracted from the maintenance costs for LEDs, which was gathered from Energex's[22] RIN reporting.[23]

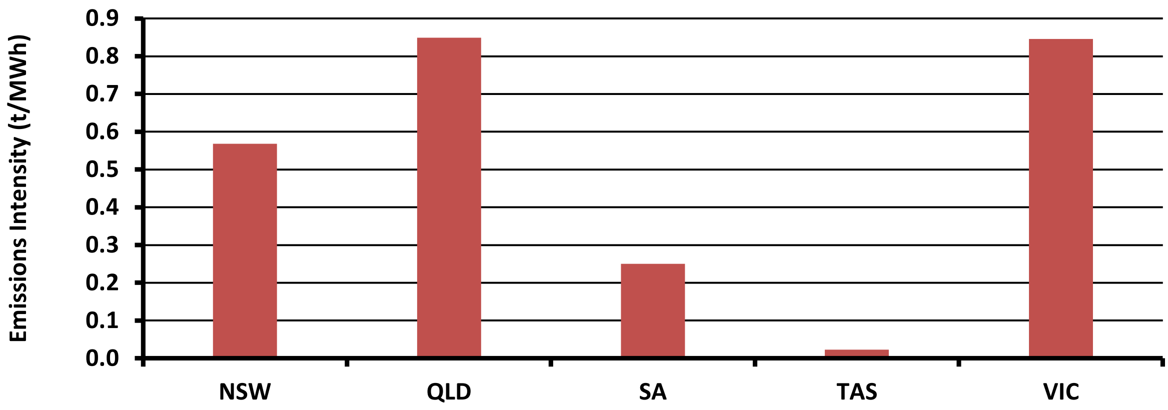
The result was a 6.6% opex reduction on an opex cost per LED per year of $73.85.

4.7. Grid Emissions Intensity and Cost

Grid emissions intensity refers to the amount of greenhouse gas emissions produced per unit of electricity consumed within electrical grids. Emissions intensity was multiplied by total streetlighting consumption per year to generate emissions per year by scenario.

Using NEMOSIS, a NEM open-source information service published by AEMO,[24] emissions intensity[25] was calculated by state on an hourly interval for non-renewable generators bidding into the market. From this data, a nighttime grid emissions intensity was calculated by state, which is reported in Figure 4.

Figure 4 – Nighttime Grid Emissions Intensity by State



Source: Energeia Research, NEMOSIS

These emissions intensities were then applied to each DNSP's lighting load based on their corresponding state and modelled out to 2043 using AEMO's 2023 Step Change NEM emissions trajectory forecast,[26] as shown in Figure 5, to determine the emission savings by light type.

[22] Energex's streetlighting opex costs were used as being the clearest among researched DNSPs.

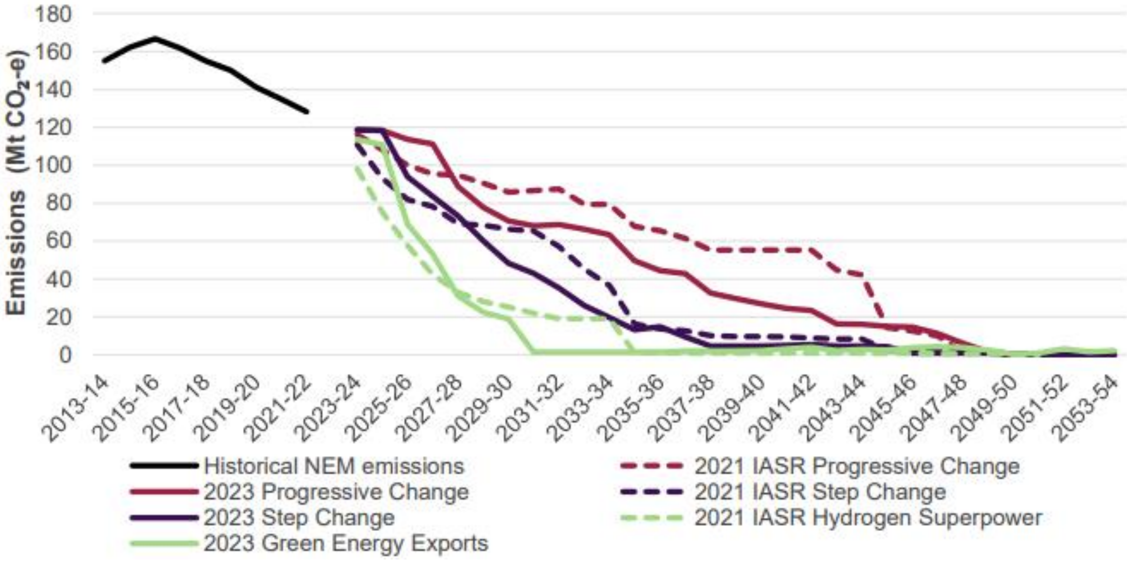
[23] A future opportunity to increase the accuracy of this analysis would be to increase the number of DNSPs used.

[24] NEMOSIS, https://github.com/UNSW-CEEM/NEMOSIS

[25] Emissions intensity is measured in tonnes of carbon dioxide (CO_2) per MWh

[26] AEMO 2023 Inputs, Assumptions and Scenarios Report (IASR), https://aemo.com.au/-/media/files/major-publications/isp/2023/2023-inputs-assumptions-and-scenarios-report.pdf?la=en#:~:text=The%202023%20Inputs%2C%20Assumptions%20and,participants%2C%20governments%20and%20consumer%20representatives.

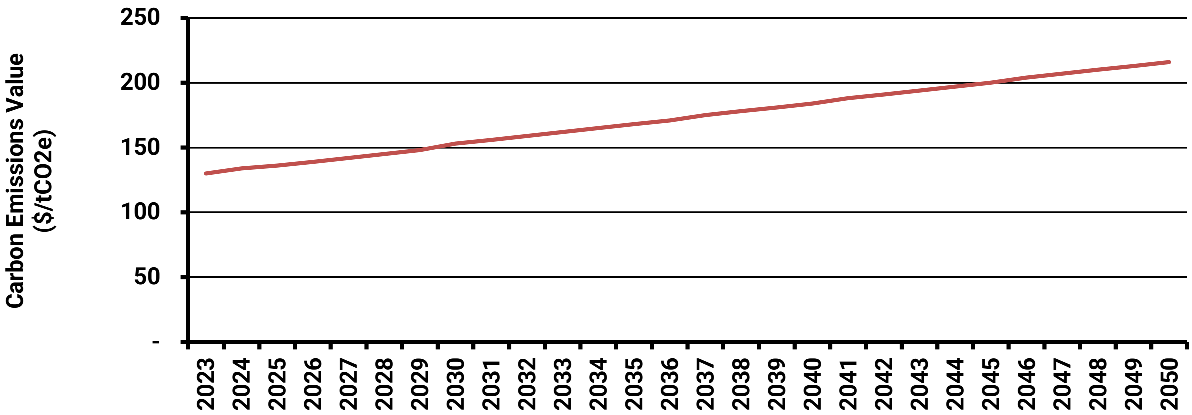
Figure 5 – Actual and Forecast NEM Emission Trajectories from Multi-Sector Modelling, All Scenarios



Source: AEMO 2023 Inputs, Assumptions and Scenarios Report (IASR)

The value of emissions reductions changes over time based on a 2023 Government Guide to CBA released by the NSW Treasury,[27] slowly increasing over the forecast period to 2032, with the remaining years being trended to 2050, as seen in Figure 6.

Figure 6 – Carbon Emissions Value ($/tCO2)



Source: NSW Treasury, 2023

4.8. Unaccounted For Energy

UFE refers to the difference between the amount of energy being drawn into a system and the energy accounted for via metering. UFE is therefore relatively higher in distribution systems that have relatively more unmetered supplies.

The estimated impact of the Rule Change on UFE was not included in the CBA, but was calculated to inform stakeholders, as there is likely to be some improvements in economics and fairness as a result.

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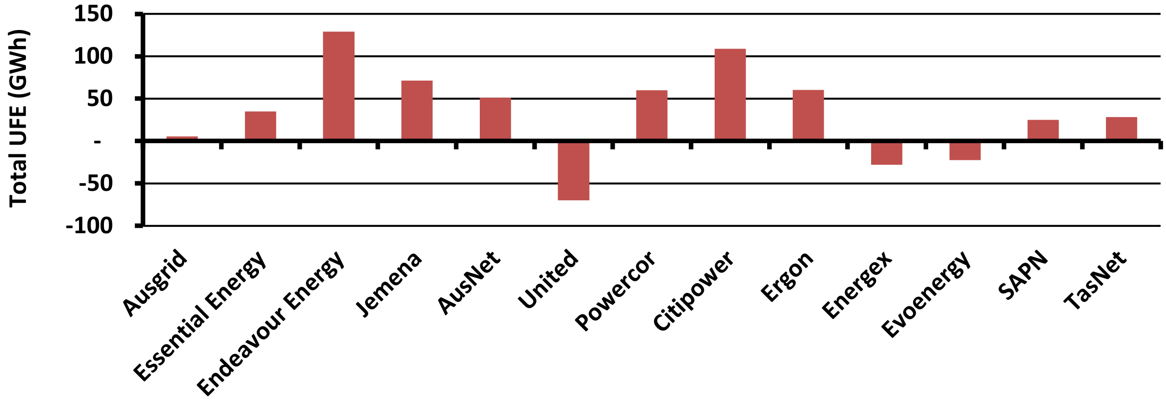
[27] Technical note to NSW Government Guide to Cost-Benefit Analysis TPG23-08, 2023, https://www.treasury.nsw.gov.au/sites/default/files/2023-03/20230302-technical-note-to-tpg23-08_carbon-value-to-use-for-cost-benefit-analysis.pdf

To estimate the total amount of UFE from unmetered streetlighting, data on the typical daily UFE profile and the total UFE reported by networks in 2022 was sourced and analysed from the AEMO UFE trends report.[28] Figure 7 reports on the resulting annual estimates by DNSP.

Figure 7 – Total UFE by DNSP



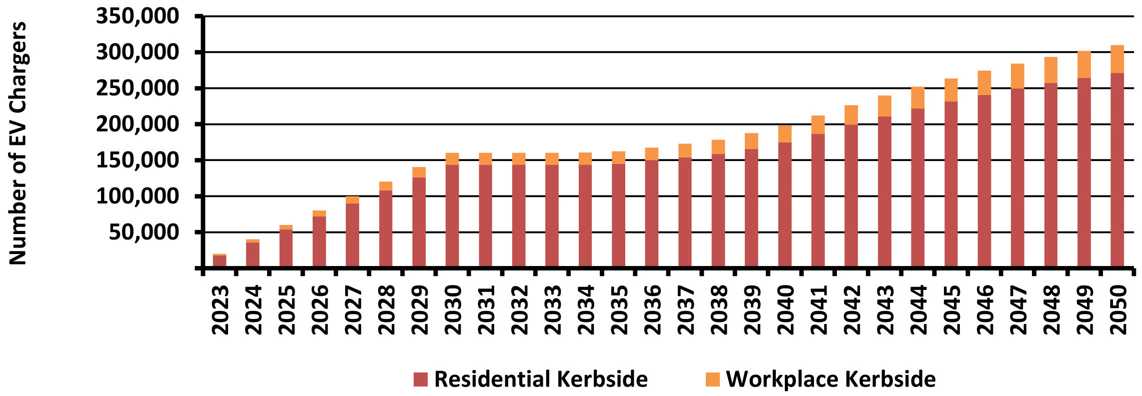
Source: AEMO Unaccounted for Energy (UFE) Trends Report 2023

4.9. Kerbside Public Charging Forecast

Forecast kerbside public EV chargers was used to estimate savings from the Rule Change by multiplying the forecast by the avoided meter and installation costs per charger.

Energeia developed a forecast of EV public charging forecast using publicly available census data from the Australia Bureau of Statistics (ABS) and Energeia's internal suite of EV models. The resulting forecast, shown in Figure 8, breaks out kerbside charging into workplace and residential segments.

Figure 8 – Kerbside EV Public Charging Forecast



Source: Energeia Modelling, ABS

4.10. AEMO Implementation Cost

An AEMO implementation cost of $0.49 per light for each year was assumed based on the relevant AEMO fees from relevant programs.

[28] AEMO UFE Trends Report, 2023, https://aemo.com.au/-/media/files/electricity/nem/data/metering/ufe/2023/ufe-trends-report-1-may-2023.pdf?la=en

These programs outline required payment to recuperate costs derived from changes to data flows and updates to procedures and guidelines related to this Rule change. This value was used to calculate the implementation and management costs incurred by AEMO over the 20-year forecasting period.

4.11. DNSP NMI Establishment Cost

While there is a cost incurred to the DNSP associated with establishing new NMI's, no new NMIs are expected to be added in the Rule Change scenario, due to all new streetlighting loads being aggregated to existing NMIs. For this reason, the NMI establishment fee was not included in this CBA, as it would have been zero.

4.12. Discount Rate

A discount rate was used to calculate the NPV value over the 20-year study period.

A discount rate of 7% was used based on the Australian Government's Office of Best Practice Regulation guidance note on cost-benefit analyses.[29]

4.13. Network WACC

The network weighted average cost of capital (WACC) was based on a VWA of Energeia researched DNSP WACC's and assumed to be 4.6%. The network WACC was used to determine the periodic cost for each cost category over the assumed lifetime of each cost variable.

[29] Australian Government Office of Best Practice Regulation CBA Guidance Note, https://oia.pmc.gov.au/sites/default/files/2021-09/cost-benefit-analysis.pdf

5. Results

The following sections report the results of the proposed Rule Change CBA, including net financial benefits and the impacts on Unaccounted for Energy (UFE) and emissions.

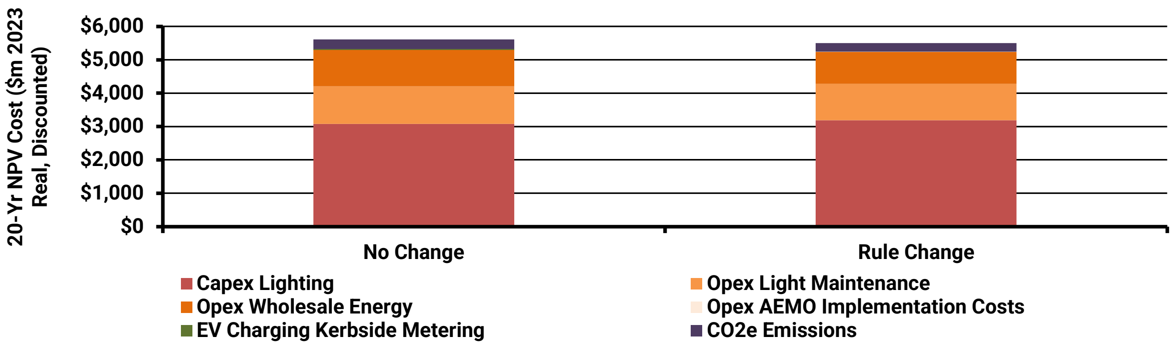
5.1. Cost-Benefit-Assessment

For simplicity, and due to the limited nature of the study, Energeia's CBA assumed that the Rule Change would result in all new and replacement lights being smart controlled LED lights that are individually metered and controlled via smart streetlight control technology. This Rule Change scenario was compared to the BaU scenario, which assumed all new and replacement lights would be LED but without smart streetlight controls.

Energeia modelled the associated economic costs and benefits of the proposed Rule Change over 20 years in terms of lighting and metering assets, data, billing systems, wholesale energy, grid emissions impacts, network infrastructure capital (capex) and operational (opex) expenditure. UFE impacts were calculated as well, but not included in the CBA as they represent a wealth transfer and not an economic cost.

The results of the CBA, shown in Figure 9, found that the Rule Change could deliver up to $106 million in net benefits over 20 years, on a discounted net benefits basis. While smart streetlighting technology has higher lighting asset and operational costs due to the cost of the smart streetlight controller and associated data and market services, the modelling shows this is offset by the reduction in energy consumption from smart controlled street lighting.

Figure 9 – Total 20-Year Economic Costs for Rule Change Scenario

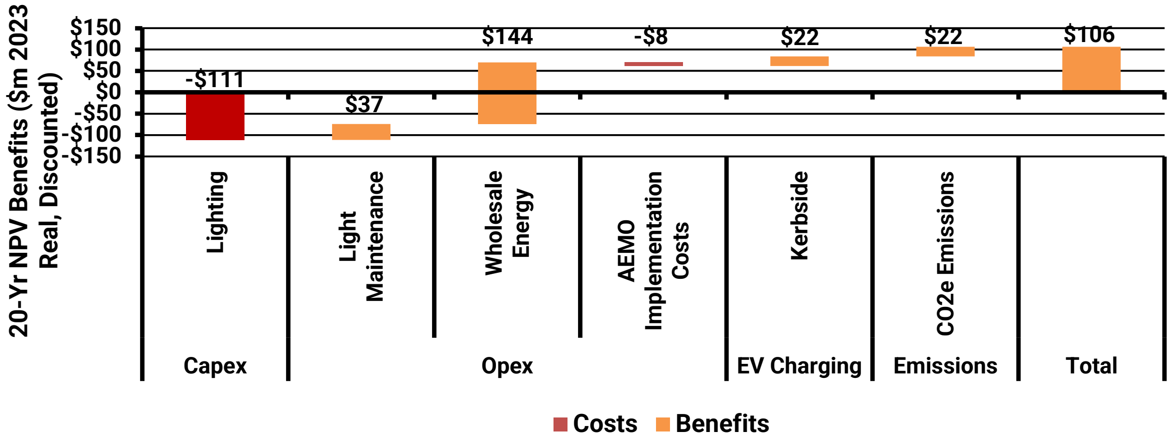


Source: Energeia Modelling

Figure 10 shows the breakdown in the CBA by cost factor, revealing that the additional capex costs of smart controlled lighting is responsible for the largest increase in costs under the Rule Change. Wholesale energy savings is the largest category of net benefit, followed by savings in light maintenance. Changes in the assumed cost of smart controlled lighting or wholesale energy costs is estimated to have the largest impact on these results.

Energeia's analysis also estimated that avoided EV kerbside metering costs offered net savings of $22 million, based on the number of avoided metering locations assumed (i.e. by allowing internal EV charger metrology to be used in lieu of a discrete metering solution). A higher mix of expected kerbside chargers or a higher associated cost would increase the resulting net benefits of the Rule Change. The analysis similarly showed discounted net savings of $22 million in emissions reduction benefits from the reduced consumption of smart controlled streetlights.

Figure 10 – Total 20-Year Net Benefits for Rule Change Scenario



Source: Energeia Modelling

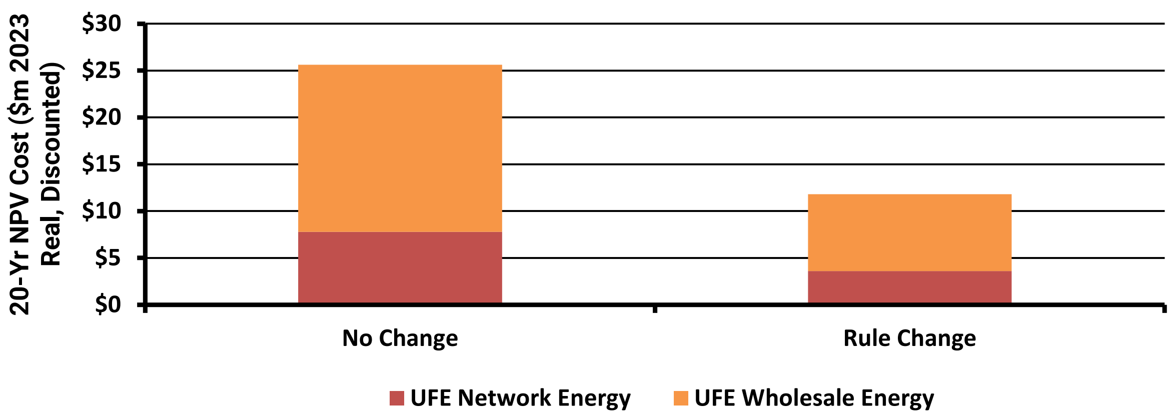
In summary, Energeia's modelling and analysis of the proposed Rule Change found it to increase system benefits over a 20-year period on an NPV basis.

5.2. Unaccounted For Energy Impacts

The UFE impact has been separately broken out below, with the total costs expressed as the NPV of the annual value of each UFE cost category over 20 years.

The total UFE costs, shown in Figure 11, demonstrated that the largest effects of the Rule Change scenario were on the network and wholesale energy costs. For the UFE cost drivers assessed, the analysis identified approximately $26 million and $12 million in real expenditure over the next 20 years for the BaU and Rule Change scenario respectively. Cost savings of $14 million were observed in the Rule Change scenario as a result of better cost allocation for UFE, which drove down both network and wholesale energy costs for energy consumers due to the reduced energy lost to measurement error.

Figure 11 – Total 20-Year UFE Costs for Rule Change Scenario

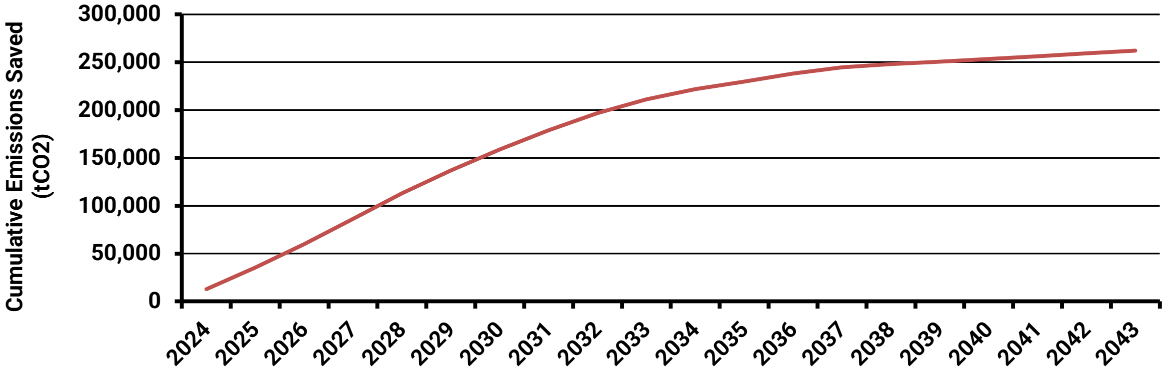


Source: Energeia Modelling

5.3. Emissions Impacts

The net savings from emissions reduction benefits identified in the CBA are due to a sharp drop in emissions over the 20-year period for the Rule Change scenario compared to the BaU. As shown in Figure 12, emissions saved in the Rule Change scenario accelerate until 2038 before starting to plateau due to the depleting stock of non-LED streetlights across both scenarios.

Figure 12 – Cumulative Emissions Saved



Source: Energeia Modelling

6. Model Limitations

Key limitations of the cost-benefit assessment modelling approach are described below, along with future work that could be carried out to mitigate the identified key risks and issues.

6.1. Limited Input Sources

A single DNSP was used in this work to determine the UFE due to unmetered load, costs incurred by networks for NMI establishment, as well as maintenance and operational costs of public streetlights, despite different types of streetlights having varying UFEs, and opex cost structures.

Future analyses could be expanded to include additional or all DNSPs.

6.2. Limited UFE Analysis

Estimation of UFE relied on a regression model, due to the additional complexity of analysing the UFE data against DNSP substation loads.

Future analyses could be expanded to use system load data to improve the accuracy of the estimate.

6.3. Lack of Public Furniture Counts by DNSP

A key limitation in this CBA model was the inability to separate public furniture loads from the remaining unmetered loads (once streetlighting loads were extracted) due to the lack of granularity for unmetered loads published by DNSPs in the public domain. This limited the scope of the analysis to consider only the potential benefits of a Rule Change for public streetlights.

If this data were available, it is expected that further benefits could be unlocked given that non-streetlighting unmetered supplies make up the majority of total unmetered load for networks. Contacting DNSPs could help address this issue in the future, as an average load split by public furniture could be applied across all other DNSPs to obtain an estimate of NEM wide public furniture loads.

Energeia's mission is to empower our clients by providing the evidence-based advice using the best analytical tools and information available



Heritage

Energeia was founded in 2009 to pursue a gap foreseen in the professional services market for specialist information, skills and expertise that would be required for the industry's transformation over the coming years.

Since then the market has responded strongly to our unique philosophy and value proposition, geared towards those at the forefront and cutting edge of the energy sector.

Energeia has been working on landmark projects focused on emerging opportunities and solving complex issues transforming the industry to manage the overall impact.

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