Review of the Energy Efficiency Improvement Scheme

Part 4 – Empirical analysis

Prepared for:

ACT Environment Planning Sustainable Development Directorate

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CONTENTS

1 KEY MESSAGES

- Since 2013, inception of the scheme, the ACT's only Tier 1 retailer has consistently met both the Energy Savings Target (EST) and Priority Household Target (PHT), in accordance with the eligible activity methods under the Act.
- Tier 2 retailers, with one exception, elected to pay the Energy Savings Contributions (ESC) instead of organising the delivery of activities.
- At a high level, the scheme was found to be effective in reaching a large proportion of ACT households and businesses over its years of operation through mass implementation of small energy efficiency measures.
    - To date just over 70,000, or 45% of all households in the ACT, have received energy saving activities through the EEIS.
    - The total number of businesses who have participated in the scheme is just below 1,700, or 15% of total employing businesses in the ACT.
- The activities that contributed the most to lifetime energy and energy bill savings are:
    - Residential lighting upgrades.
    - Commercial lighting upgrades.
    - Space heating and cooling activities.
- Over time, the activities delivered have changed. The types of measures rolled out in 2017 changed significantly from previous years:
    - Heating and cooling activities represented 46% of all energy savings, while commercial lighting upgrades represented 53% of savings.
    - This contrasts sharply with previous years, when residential lighting, standby power controller (SPC), and sealing activities dominated the lifetime energy savings.
- The EEIS helps to reduce stationary energy consumption in the ACT. In terms of cumulative energy savings, the EEIS has been delivering an increasing trend in energy savings from 0.4% of total ACT stationary energy use in 2013, to 2.9% in 2017.
- 22% of energy savings were delivered to priority household participants, which is in line (slightly higher) with the Tier 1 retailer's PHT, but this varied significantly over time (as excess delivery under the PHT can be "banked" for subsequent years.
- The EEIS has delivered significant lifetime and cumulative greenhouse savings. However, the decision to increase the ACT's renewable energy sourcing for grid electricity to 100% by 2020 has significantly impacted the volume of greenhouse gas emissions reductions associated with the activities delivered under the scheme. On balance, an energy metric would better serve the ACT in focussing on energy management in the context of the Renewable Energy Target (RET).
- Since scheme inception, total lifetime bill savings for the residential sector are estimated at $180M, while savings for the commercial sector are estimated at just under $60M.
- Average cumulative weekly savings across the scheme from 2013 to 2017 are $4.80 per participating household, and the trend is that these weekly household savings are increasing as the scheme matures, with savings of $5.65 per participating household in 2017.
- The program has been efficiently delivered, with an overall low administration budget and overall positive benefit cost-ratio.
- The Benefit Cost ratio (lifetime bills savings / cost of the scheme to date) calculated from 2013 to 2017 was close to 4.

Introduction

1.1 Purpose of the empirical analysis

The empirical analysis was conducted to identify the net benefit the EEIS has delivered since scheme inception in 2013. However, since its inception, certain aspects of the scheme have evolved, such as updates to the ACT Government's **targets for renewable energy and climate change**. This policy change resulted in a lower carbon intensity of the grid than was initially anticipated in the modelling of the EEIS expected results. This impacts emissions abatement values and future abatement expectations. In addition, differences in assumed energy prices, new approved activities and updates to existing activity abatement methods, mean that the EEIS delivery to date may be different to what has been modelled in the past. Therefore, this empirical analysis aims to present a robust and defensible analysis of results, and drivers for discrepancies identified, for:

- Legislated targets:
  - The Tier 1 retailer's achievement against the EST and PHT.
  - The Tier 2 retailers' achievement against their ESTs.
- Scheme costs.
- Scheme benefits: Modelled energy, greenhouse gas and bill savings.

1.2 Legislated EEIS targets

In order to meet the EEIS objectives, a Territory-wide Energy Savings Target (EST) is set which correlates to mandatory energy savings obligations for individual electricity retailers based on their electricity sales in the ACT, converted to tonnes of CO_2-e. The EST is used to establish the Retailer Energy Savings Obligation (RESO). Each retailer's RESO is calculated as:

$$RESO\ (tonnes\ CO_2e) = EST\ \times retailer\ electricity\ sales\ (MWh) \times Emissions\ Multiplier$$

The emissions multiplier is a Disallowable Instrument made by the Minister and is based on the average emissions factor for electricity in the ACT over a specified time period. It had been set at 0.89 for 2013 to 2015; and is set at 0.4 from 2016 to 2020. The Emissions Factor for electricity is expected to stay relatively stable at around 0.03 to 0.09 (Table 18 in Appendix 1) beyond 2020. This impacts the assumed abatement values associated with activities undertaken under the EEIS, and this is reflected in the modelled greenhouse gas emissions savings from activities over their lifetime.

In order to meet their RESO, Tier 1 retailers must undertake eligible energy saving activities approved under the Act. Tier 1 retailers are also obliged to achieve a proportion of their RESO in low-income households, termed the Priority Household Target (PHT), as determined by the Minister by Disallowable Instrument. The PHT savings obligation is calculated by multiplying the Tier 1 retailer's RESO by the PHT.

Table 1 shows the scheme's statutory objectives since 2013.

Table 1. Key EEIS statutory objectives from 2013 to 2020

Statutory objective indicators	2013	2014	2015	2016-2020
Energy Saving target (EST)	7%	13%	14%	8.6%
Priority Household Target (PHT)	25%	25%	25%	20%*

* Note that this PHT is just set for 2016-2018 period and may be updated following this.

The EST is currently set at 8.6% of electricity sales for the period 2016 to 2020. This target is set so that it promotes activities that are considered achievable at a reasonable cost, with the objective to:

- deliver maximum benefit to community
- limit pass-through cost
- achieve value for money

- limit risks

Energetics developed the model underpinning the determination of the 2016-2020 EST, which calculates energy savings activity uptake at a maximum incentive price ($300/tonne CO_2-e), and from this the economic benefits to the energy consumers in the ACT. This corresponds to the 8.6% target of total electricity sales for the period. It is important to note, that this does not mean a reduction of sales year on year by 8.6%, it means that the reductions generated over the life of the energy saving equipment or activity should be equivalent to 8.6% of the electricity sales of the year of reference. This is based on deemed savings from each activity eligible under the scheme.

Under the EEIS, it is mandatory for Tier 1 retailers to undertake energy saving activities in order to meet their EST. A relatively high penalty ($300/tonne CO_2-e) is set for not achieving this target. However, Tier 2 retailers may deliver activities or pay an Energy Savings Contribution (ESC) set at the expected cost of compliance for a Tier 1 retailer. The amount of ESCs that the Tier 2 retailers pay is equivalent to their EST. This measure is in place in order to avoid imposing an unfair burden on retailers that have relatively small market share but would face relatively high fixed costs to set up and administer compliance activities. ESCs collected are then used to fund activities that align with the objectives of the Energy Efficiency (Cost of Living) Improvement Act 2012, such as the Actsmart Home Energy Advice program, Actsmart Low Income Home Energy Efficiency Program, Actsmart Business Energy and Water Program and the Solar for low income program, and to fund the EEIS administration and compliance costs.

1.3 Overview of the scheme's expected costs and benefits

1.3.1 Scheme's costs

Tier 1 and Tier 2[1] retailer costs of compliance with the scheme (i.e. undertaking activities and compliance costs – see below) are passed through to electricity customers (both households and businesses) in the ACT through their electricity bills after approval by the Independent Competition and Regulatory Commission (ICRC). In addition, to fund some activities' upfront costs, retailers may ask for co-contributions from activity participants. The costs of the EEIS can be broken up into three broad categories (that overlap):

- **Programme costs:** These include the costs to obligated retailers and their approved providers of carrying out activities in order to achieve their targets, and, sometimes, a co-contribution from end beneficiaries, to pay contractors delivering activities to partly or fully fund energy efficiency activities (including equipment costs). In addition, programme costs include resources expended on lead generation, internal administration of the programme, contracting installers, and reporting, monitoring and verification of results. These costs also include Tier 2 retailers' payment of ESCs ($116 per t CO_2-e energy savings obligation). These programme costs are passed through to customers in the ACT as part of the volumetric electricity retail price.
- **Societal costs:** These are costs passed-through from the retailers to end-users and the co-contributions paid by scheme participants for specific activities. Co-contributions are typically paid by scheme participants for more costly activities such as heating/cooling upgrades, where the cost to deliver activities exceeds a certain threshold and it becomes impossible for the retailer to fund the full implementation cost (as it would push up the overall scheme's cost). The incentive to participants is therefore the full cost of implementation minus the co-contribution.
- **Administrative costs:** These are costs to establish the rules of the EEIS, oversee the running of the EEIS, verify/estimate/evaluate what the EEIS has actually achieved and report on its results. In addition, the development of new activities, procedures and training of staff/installers fall under this category. Budgetary allocation decisions have been made to fund these administrative costs from the money collected from Tier 2 retailers electing to pay the ESCs rather than undertake eligible activities.

1.3.2 Scheme expected benefits

It is important to note that the EEIS has just two legislated targets, the EST and the PHT. All other energy, greenhouse and bill savings detailed in the scheme Regulatory Impact Statements are just modelling expectations, and, as such, not achieving the level of savings forecasted does not mean that the scheme objectives have not been achieved.

The benefits of the EEIS include:

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[1] Tier 1 includes electricity retailers with more than 500,000MWh of sales per annum in the ACT and at least 5,000 ACT customers. Tier 2 includes electricity retailers with less than 500,000MWh of sales per annum in the ACT and/or less than 5,000 ACT customers.

- Reducing household and business energy use and costs.
- Reducing greenhouse gas emissions.
- Encouraging the efficient use of energy, which is a cost-effective way to minimise the ACT's overall energy demand, and therefore reduce emissions associated with energy use.

Energy savings

One key objective of the EEIS is to increase energy efficiency and hence, reduce energy consumption in the ACT. Energy savings are the initiating event for the other benefits, greenhouse gas emissions reductions and bill savings.

In addition, as the ACT has committed to 100% renewable electricity by 2020, it must source increasing volumes of electricity from renewable sources. The EEIS helps to reduce energy consumption in the ACT, therefore reducing the overall need to source renewable electricity and reducing the impact of the ACT's Renewable Energy Target on energy bills in the ACT for beneficiary households and businesses (at a cost for energy users: see "scheme's costs".

Greenhouse gas emissions reductions

The core metric for the EEIS is the reduction of greenhouse gas emissions, which benefit all of society. This reduction contributes to the ACT Government's pathway to zero emissions by 2050.

This is achieved through the delivery of energy efficiency measures, reducing electricity or gas consumption (wood fired appliances are also part of the scheme, but marginal). Currently, activities that save gas reduce emissions more than those that save electricity, as the ACT progresses towards its 100% RET.

Energy bill savings

Monetary benefits accrue directly to individual houses and businesses that participate in the scheme and benefit from energy efficiency improvements; these improvements result in bill savings.

In addition, the EEIS has an objective of increasing opportunities for priority (low income) households to reduce energy costs. Therefore, benefits need to be assessed separately for both priority and non-priority households.

2 METHODOLOGY

This section describes the methodology followed to carry out the empirical analysis.

2.1 Key data sources

Comprehensive datasets were provided to support the empirical analysis. These included data on:

- Disaggregated EEIS activity delivery,
- Methodology for calculating cumulative and lifetime savings,
- Previous modelling of potential scheme outcomes,
- Algorithms and other calculations of energy, emissions and bill savings associated with EEIS activities,
- Retailer compliance plans and reports, and
- Financial reconciliations.

2.2 Approach

At a high level, this analysis endeavours to estimate some of the quantifiable scheme costs and benefits. In order to do so, the following tasks were carried out:

- A quantitative analysis of the EEIS results against its statutory objectives.
- A review of the allocation of Energy Savings Contributions (ESC) to projects and programs that meet the EEIS objectives.
- Modelling of cumulative and lifetime bill savings in terms of energy, emissions and cost savings for households (including priority households) and businesses. Key drivers of differences identified between these energy, greenhouse gas and bill savings, and those forecasted previously for the Scheme Inception RIS and the Scheme Extension RIS, are:
    - The level of Tier 1 and Tier 2 retailer participation.
    - Differences in energy prices.
    - A significant decrease in the ACT emission factor for electricity. This has an influence on “abatement values” defined for each activity.
    - The types of activities delivered by retailers in reality, versus expected delivery.
    - Higher than anticipated drop-off effects for specific activities.
      For example, from 2013 to 2015, approximately 30% of SPCs were disconnected by participating households. Although the original activity abatement modelling would have accounted for a drop-off effect, it was not as high as what actually occurred. Therefore, modelling carried out for the Scheme Inception RIS overestimated the abatement impact from the roll-out of SPCs. This issue has been corrected for in this empirical analysis.
- Calculation of net financial costs and benefits accruing to various stakeholders of the EEIS compared with previously modelled results, taking account of EEIS delivery to date, trajectory and pass-through costs

Table 2 provides our current understanding of how the various factors integrate with the energy, emission abatement and bill savings, and hence the reasons for discrepancies observed between the ex-post and ex-ante results.

Table 2. Exogenous factors driving differences in ex-post vs ex-ante results modelling

Factor	Influence on metric
Tier 1 / Tier 2 participation	Number of activities delivered
Gas / electricity prices	Bills savings by beneficiaries
Emission factor for electricity	GHG savings
Types of activities selected by retailers / customers	Number of households / businesses benefitting & Saving per customers (household / business)
"Drop-off" (i.e. failure or disconnection of device by beneficiary, e.g. SPC)	Energy saving over time

2.2.1 Scheme costs

Scheme costs include:

- total pass-through costs from retailers.
- co-contributions paid by households and businesses.
- scheme administrative costs.

Formulas for the calculation of these costs are provided below.

Total household and business pass-through costs

In order to determine the total pass-through costs to households and businesses, the following equations were used:

$$Household\ pass\ through\ costs\ (\frac{\$}{yr}) = Total\ retailer\ pass\ through\ costs\ (\frac{\$}{yr}) \times \left(\frac{Total\ residential\ electricity\ consumption}{Total\ ACT\ electricity\ consumption}\right)$$

$$Business\ pass\ through\ costs\ (\frac{\$}{yr}) = Total\ retailer\ pass\ through\ costs\ (\frac{\$}{yr}) \times \left(\frac{Total\ commercial\ electricity\ consumption}{Total\ ACT\ electricity\ consumption}\right)$$

Table 20 in Appendix 1 provides the ACT electricity consumption assumed for this analysis.

Electricity price rise due to scheme

The estimated increase in electricity price in the ACT as a result of retailers' pass-through costs was calculated using the following equation:

$$Electricity\ price\ rise\ \left(\frac{\$}{MWh}\right) = \frac{Total\ retailer\ pass\ through\ costs\ (\frac{\$}{yr})}{Total\ ACT\ electricity\ consumption\ (\frac{MWh}{yr})}$$

Per household pass-through costs

$$per\ household\ pass\ through\ costs\ \left(\frac{\$}{\frac{hh}{yr}}\right) = Electricity\ price\ rise\ \left(\frac{\$}{MWh}\right) \times Av.annual\ household\ electricity\ consumption\ (\frac{MWh}{hh})$$

Table 22 in Appendix 1 provides the average household electricity consumption assumed for this analysis.

2.2.2 Scheme benefits – Modelled savings

When discussing the energy, greenhouse gas and energy bill savings delivered by the EEIS, the following definitions were used:

- **Cumulative savings for a specific year** are the savings that have been achieved from energy saving measures installed in a particular year plus all the savings achieved in that year from activities from previous years that are still in their "deeming period".
- **Cumulative savings to a specific date are** the savings achieved till that date from activities put in place since the beginning of the scheme.
- **Lifetime savings for the measures implemented in a particular year**. These are the savings achieved from measures installed in a particular year, plus all the savings that are estimated to be achieved in subsequent years over the expected lifetimes (or deeming periods) of the different equipment installed/ activities undertaken in that year.
- **Lifetime savings for the scheme overall**. These are the estimated savings achieved from all of the activities installed since the beginning of the scheme (2013) through to the end of life of the deeming periods for the activities.
- **Annual incremental savings** are the additional savings achieved in a particular year from measures installed in that year, with no account taken of savings in previous or subsequent years.

While the scheme's main metric is expressed as Greenhouse Gas (GHG) emissions savings, the analysis starts with the volume of energy saved, as this avoids the pitfall of ever changing energy prices (impacting on bill savings) and emission factors (impacting on GHG savings). Therefore, for this ex-post 2018 review, energy savings from delivered activities were used as the basis to estimate both energy bill savings and emission savings. These energy savings were provided directly by the EPSDD in an energy savings database document. Table 16 and Table 18 in Appendix 1 detail the energy prices and emissions factor assumptions used to calculate bill and emissions savings for this analysis.

Figure 1 presents a schematic of the various empirical analysis savings and of the drivers influencing them.

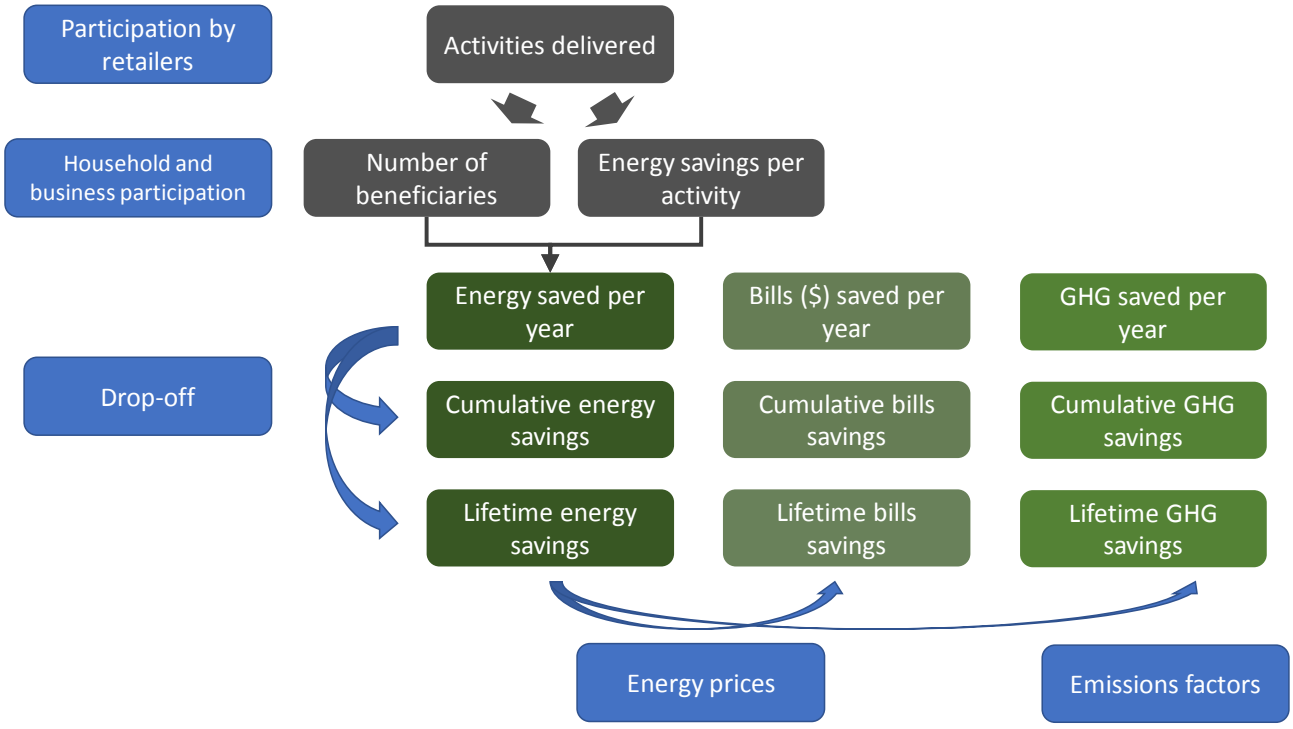

Figure 1. Empirical analysis method for 2018 review

Per household bill savings

Cumulative participating household bill savings for each year were determined using the following equation:

$$Per\ household\ bill\ savings\ (cumulative) = \frac{Total\ cumulative\ household\ savings\ (\frac{\$}{yr})}{Participating\ households\ in\ year\ (cumulative)}$$

All other savings are calculated using similar equations, however using lifetime or annual incremental values as appropriate.

Per business bill savings

Bill savings for businesses accumulated for one activity only – commercial lighting upgrades. Cumulative participating business bill savings for each year were determined using the following equation:

$$Per\ business\ bill\ savings\ (cumulative) = \frac{Total\ cumulative\ business\ savings\ (\frac{\$}{yr})}{Participating\ businesses\ in\ year\ (cumulative)}$$

2.3 Sensitivity analysis

A sensitivity analysis was carried out for two of the most important assumptions driving the modelled savings:

- **Electricity grid emission factors**: We used the historic emission intensity of the NSW grid based on the National Greenhouse Account Factors from 2013 to 2016. Future grid intensity was assumed to remain constant at 2016 levels. This sensitivity analysis highlights the emissions savings that would have been achieved by the EEIS had the 100% RET not been put in place.
- **Energy prices**: We conducted a sensitivity analysis to see how the modelled bill savings would change if there was an increase in electricity prices and gas prices post 2020 (see Table 17 for the sensitivity analysis assumptions).

2.4 Limitations of this analysis

For this empirical analysis we used data and information provided by the EPSDD, and where gaps existed, best publically available information that was endorsed by the EPSDD. Section 3.1 details these sources, with a brief description of what each contains and how the data sources were used for the empirical analysis. In addition, Section 6 provides the reference list for this analysis.

It should be noted that the EPSDD implements a comprehensive compliance and auditing framework to verify data and confirm abatement claimed by retailers. The EEIS Team conducts desktop audits, phone surveys and field audits and the Administrator also requires retailers that deliver activities to undergo an annual independent audit of their activities. Point Advisory were not required to audit the inputs or verify the integrity of the database provided as part of this scope of works. Methods used to determine energy savings per measure and abatement values have been based on other EEO schemes and peer reviewed by other consultants. For the above reasons it was assumed that the data provided by EPSDD is correct and robust.

Comparisons with the scheme inception modelling was limited as original models were not available, which constrained our ability to understand differences between the 2018 Review empirical analysis results and key indicators presented in the Scheme Inception RIS. In addition, the background modelling for the Scheme Extension RIS did not 100% reconcile with the key indicators provided in the Scheme Extension RIS. The modelling spreadsheet had the correct ACT economy NPV ($39,841 ('000)), however the abatement target was 504kt CO_2-e, rather 515kt CO_2-e, and the EST was 8.4%, rather than 8.6%. Therefore, it is important to understand that comparisons of the 2018 Review empirical analysis results with the Scheme Extension RIS modelling spreadsheet and the Scheme Extension RIS report have a degree of uncertainty around exact differences.

Another important caveat is that we did not check the methods used to determine energy savings per measure abatement values, as this was outside the scope of this engagement. However, where appropriate, we have conducted 'reasonableness' tests for key assumptions such as lifetime energy saved per measure, energy prices and emission factors.

In addition, timing for the review dictated that the analysis used quarterly data for the 2017 results, and not the periodic (annual) results which are used in annual reporting of EEIS outcomes. Final periodic data shows higher activity delivery than is reported here because the administrative reports were completed after the review analysis, for many large installations delivered in 2017.

Finally, we were not provided with quantitative data on the impacts (greenhouse gas savings, energy savings and energy user bill savings) of Actsmart programs financed through ESCs. However, this program is currently undergoing a separate review.

3 RESULTS

3.1 Legislated EEIS targets

Tier 1 retailer results are presented separately, as Tier 2 retailers have the option of paying the ESC instead of delivering activities and have elected to do so.

3.1.1 Tier 1 retailer participation

The ACT's only Tier 1 retailer, has consistently met both the Energy Savings Target (EST) and Priority Household Target (PHT), since 2013, in accordance with the eligible activity methods under the Act. In relation to the PHT, the Act provides the retailer the possibility to "bank" abatements delivered to priority households, if they deliver above and beyond their targets, to be used in later years. This is what occurred during the period.

In addition, for all audits completed since 2013, the auditor commissioned for this task found that the Tier 1 retailer's compliance report presents fairly, in all material aspects, in relation to:

- The number of activities completed
- The amount of abatement claimed
- The quantity of electricity sold
- The achievement of the PHT and RESO
- The confirmation that the delivery of on-ground activities was consistent with the EEIS code of practice

3.1.2 Tier 2 retailer participation

Tier 2 retailers must pay an Energy Savings Contribution (ESC), equivalent to their RESO, if they elect not to undertake activities. Until the end of 2016, all Tier 2 retailers elected to pay an ESC in place of undertaking activities. In 2017, only one Tier 2 retailer offered commercial lighting activities, an attempt that was short-lived (refer to stakeholder consultation report for more information). This reduced the size of the contribution they were required to pay in that year.

In total, Tier 2 retailers have contributed over $15M through ESCs since 2013. This is equal to 28% of all retailer costs since 2013. This has been used for the following purposes:

- EEIS program administration: The ESCs from Tier 2 retailers offsets the cost of administering the EEIS. The amount spent to date on the administration and compliance of the EEIS has been approximately $2M since scheme inception.
- Actsmart suite of programs and the solar for low-income program:
    - The suite of Actsmart Sustainability Programs offers complementary activities that meets the objectives of the Act but are not currently offered through the EEIS. Examples include education, behaviour change strategies, rebates for businesses and energy efficiency equipment for low-income households.
    - The Solar for Low Income Households Program provides an opportunity for eligible households in the ACT to invest in rooftop solar panels to help reduce their energy costs. Eligible participants are able to access a subsidy of up to 60% of the total cost of a solar system along with a three-year interest free loan to pay off the difference. This would likely only target home owners.
    - The amount of ESCs spent on these programs to date has been approximately $5.1 M.

- Energy Savings Contributions (ESCs) are received six months after the compliance period, retained in a separate account and allocated by the ACT Government through annual budget processes that take account of the objectives of the Act. The remaining ESCs have been previously allocated to current budget initiatives or will be allocated to future budget initiatives until the end of 2020.

This review aimed to understand whether ESCs are being effectively applied to meet EEIS objectives. As part of this analysis we were not provided with quantitative data on the energy, bill and emissions savings impacts of Actsmart and solar for low income household programs. However, we have reviewed the "Reconciliation of Energy Savings Contributions" document and the EEIS budget spreadsheets, and agree that the objectives of the EEIS are being met effectively through the use of ESCs for Actsmart funding and EEIS program administration.

3.2 Scheme costs

Retailers pass through their costs to all customers (not only beneficiaries). Table 3 provides the estimated pass-through costs to all households and businesses in the ACT. Pass-through costs to households decreased from 2014 to 2016. However, pass-through costs have risen again in 2017. This may be explained by the roll-out of more expensive, high impact space heating and cooling activities in 2017.

Table 3. Pass-through costs to households and businesses

Costs	Unit	2013	2014	2015	2016	2017
Average annual pass-through costs of scheme to households	($/hh/year)	$25	$35	$33	$22	$30
Average bill pass-through to business customers	($/ per $1000 spent on bills)	$12	$18	$20	$12	$14

3.3 Scheme benefits – Modelled savings

3.3.1 Energy savings

Lifetime energy savings

It is estimated that the EEIS will deliver a total of **4.5M GJ of lifetime energy savings** from activities rolled out since 2013 (until the end of 2017) with residential lighting upgrade activities delivering the largest share of savings, followed by commercial lighting upgrade activities, and space heating and cooling activities (Figure 2).

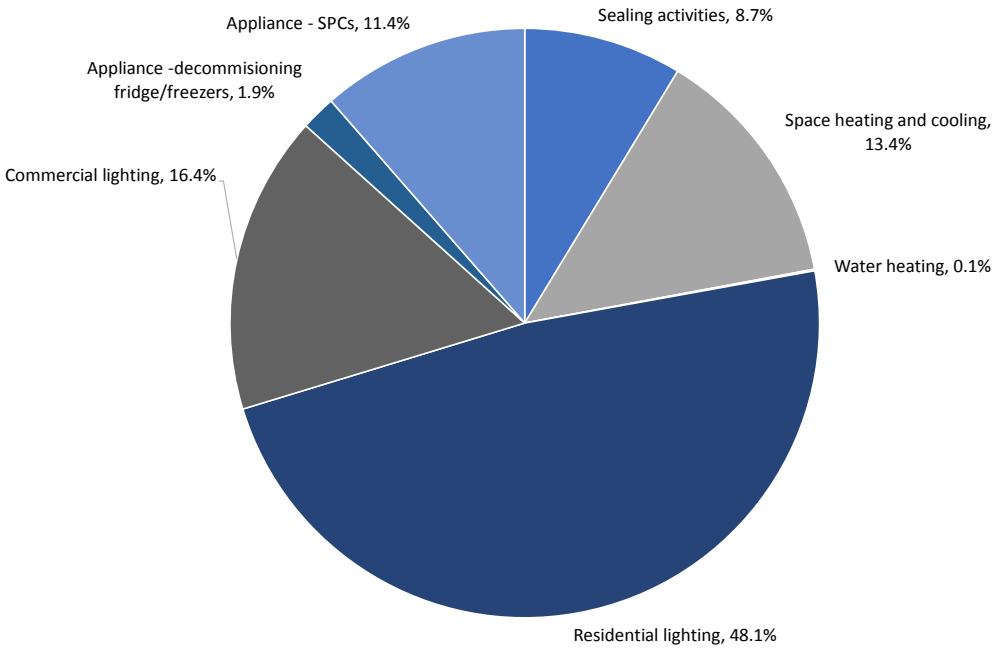

Figure 2. EEIS activity contribution to lifetime energy savings (2013 to end 2017)

Figure 3 presents the total lifetime energy savings per year from 2013 onwards. This shows that the types of measures rolled out in 2017 changed significantly from previous years:

- heating and cooling activities represented 46% of all energy savings, while commercial lighting upgrades represented 53% of savings.
- this contrasts sharply with previous years, where residential lighting, standby power controller (SPC), and sealing activities dominated the lifetime energy savings.

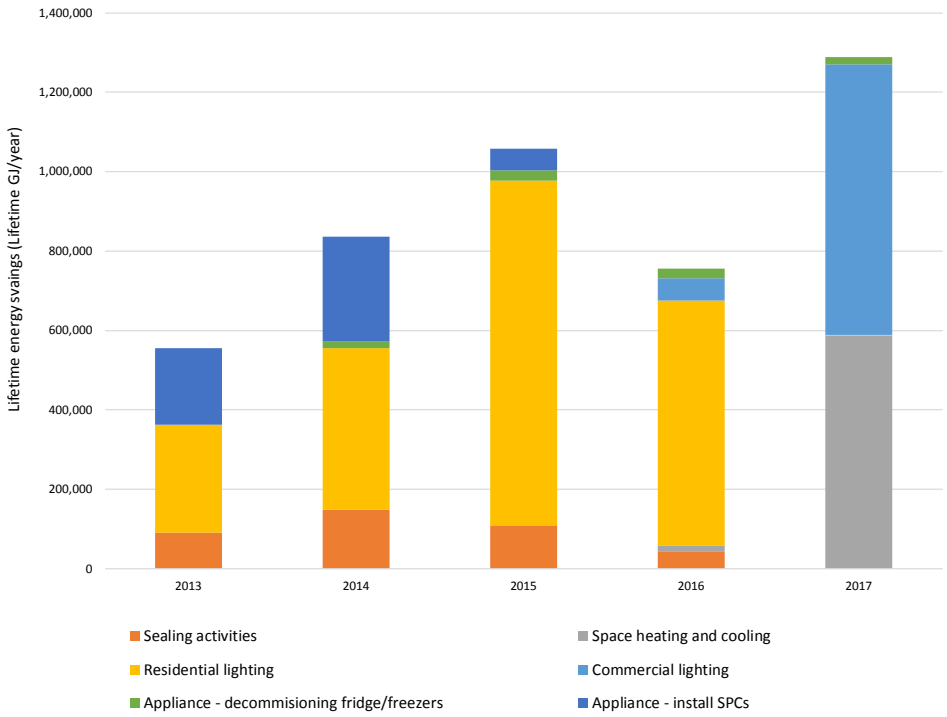

Figure 3. Lifetime energy savings per year

Table 4. Lifetime energy savings per year (GJ)

Total lifetime energy	2013	2014	2015	2016	2017	Total
Sealing activities	90,998	148,270	109,553	41,872	0	390,693
Space heating and cooling	0	0	0	15,195	586,910	602,105
Water heating	0	0	3,995	0	0	3,995
Residential lighting	270,958	406,712	867,769	617,533	1,823	2,164,795
Commercial lighting	0	0	0	56,497	680,884	737,381
Appliance - decommissioning fridge/freezers	0	17,232	25,297	24,059	19,315	85,903
Appliance - install SPCs	193,878	264,421	55,008	0	0	513,307
Total	**555,834**	**836,635**	**1,061,622**	**755,156**	**1,288,932**	**4,498,179**

Cumulative energy savings

In terms of total cumulative energy savings from the scheme's inception in 2013 to the end of 2017, it estimated that the EEIS has delivered over 1.5M GJ. Figure 4 presents these cumulative savings per year. The cumulative energy savings profile is different to lifetime energy savings, as cumulative energy savings take into account the savings coming from measures that were put in place in previous years, but not the savings over the life of the equipment put in place/activities undertaken. In 2017, residential lighting provided 56% of cumulative energy savings, while commercial lighting upgrades delivered 15%, which is a significant amount, as commercial lighting upgrades only started delivering savings in 2016.

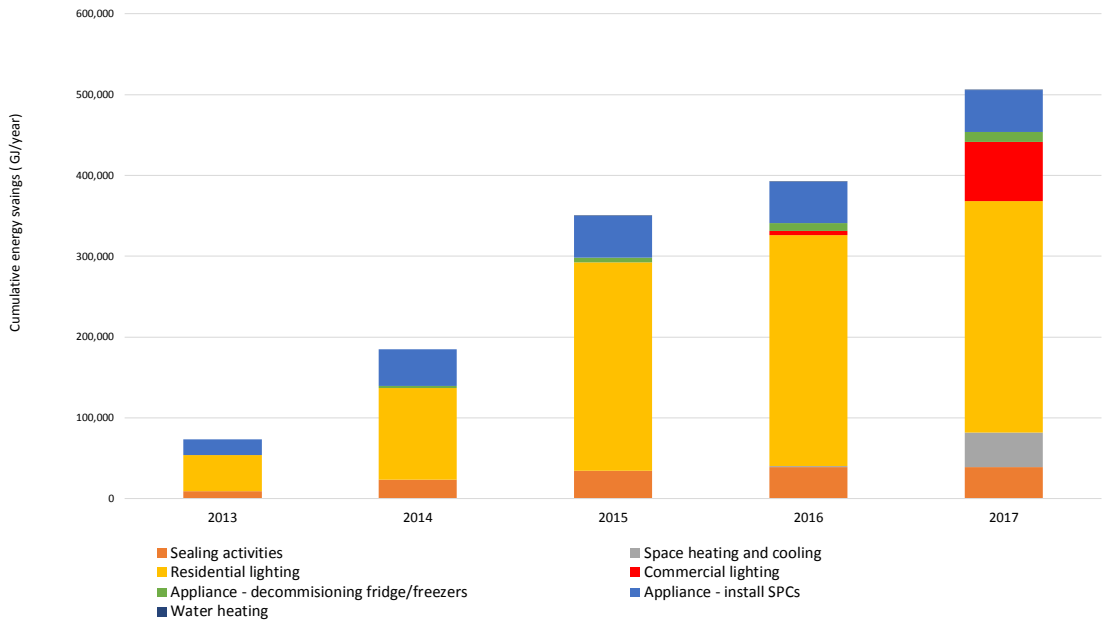

Figure 4. Cumulative energy savings per year

These modelled energy savings have an impact on the total stationary energy consumption in the ACT, as shown in Table 5.

Table 5. EEIS cumulative energy impact on ACT's stationary energy consumption

	2013	2014	2015	2016	2017
Total gas and electricity energy consumption in ACT – GJ*	17,672,481	17,408,740	17,409,010	17,571,935	17,633,022
EEIS modelled cumulative energy savings – GJ **	73,647	185,163	350,432	392,861	505,877
% of total ACT energy use	0.42%	1.06%	2.01%	2.24%	2.87%

* See Table 20 and Table 21 for the source of this data

** Assumes that all upgrades are still in place in line with modelling parameters

Energy saving activities in households

Many different activities have been implemented since the inception of the EEIS. Table 6 provides the number of households that have received different activities, along with the average energy savings per unit installed, total lifetime energy savings per activity and the energy saved per household by activity type. In terms of the number of households with different energy efficient appliances/upgrades, the most popular have been lighting upgrades (>80,000), followed by SPCs (>40,000), and then draft sealing (>20,000). It should be noted that these numbers are higher than the total number of unique scheme participants (~70,000 unique households) presented in Table 14. This is because some households will have received multiple upgrades over different years, in addition to multiple activities.

Table 6. Implemented energy saving activities (whole scheme)

Item	Description	Average energy savings per unit (Lifetime GJ/unit)	No. households that received activity[1]	Modelled total lifetime energy savings (GJ)	Lifetime energy savings per household (GJ saved / household)
Building Sealing - Doors	Door seals reduce the gaps under external doors or doors that separate conditioned from unconditioned zones in the home, reducing drafts and increasing the efficacy of HVAC.	7.6	22,694	378,363	16.7
Self-Sealing Exhaust Fans	Exhaust fans are designed to remove excess moisture and heat. By self-closing these fans help to reduce heat being lost when the fan isn't being used.	9.6	868	12,330	14.2

Item	Description	Average energy savings per unit (Lifetime GJ/unit)	No. households that received activity[1]	Modelled total lifetime energy savings (GJ)	Lifetime energy savings per household (GJ saved / household)
Replace a ducted gas heater with a high efficiency ducted gas heater	Inefficient gas heaters are replaced by more efficient versions that consume less energy per unit of energy output.	485	759	368,200	485
Install a specified high efficiency electric room heater	Inefficient electric heaters are replaced by more efficient versions that consume less energy per unit of energy output.	336	17	5,720	336
Install insulated gas heating ductwork	Non-insulated heating ductwork can leak hot air to areas that don't need heat, such as attics and crawl spaces. Insulating this ductwork saves energy for householders.	301	759	228,185	301
Switch from electric resistance to instantaneous gas water heating	Instantaneous or continuous flow water heaters are designed to deliver a steady stream of heated water for a bath, sink or shower. Each time a tap is turned on, water is heated instantly by gas and then flows to the outlet.	60	67	3,995	60
All residential lighting	Replacement of mains voltage incandescent or halogen lamps with low energy alternatives.	2.6	80,360	2,164,796	26.9
Decommissioning & disposal of refrigerator or freezer	Pre-1996 refrigerators and freezers are removed and responsibly disposed of.	17.9	4,351	85,902	19.7
Standby power controllers	SPCs switch off groups of appliances after they have been inactively operated for a period of time. Installation is available for information technology (IT) or audio-visual (AV).	6.5	43,361	513,307	11.8

1 Note that these numbers are subject to some uncertainty. This is because some households have received multiple activities and have been captured each time once as a unique address for one activity. In addition, some addresses have been reported without a unit number, meaning that more activities would have been rolled out than is recorded here. However, these numbers show that the scheme has delivered a wide spectrum of energy saving activities to a large proportion of ACT households.

Figure 5 shows the percentage of households in each suburb that have received energy saving activities. This highlights the accessibility of the program to a wide variety of building stock. Additional data would be required to determine exact causes for variations across suburbs however, as expected, the graphic clearly shows newer suburbs having generally received fewer activities than older suburbs.

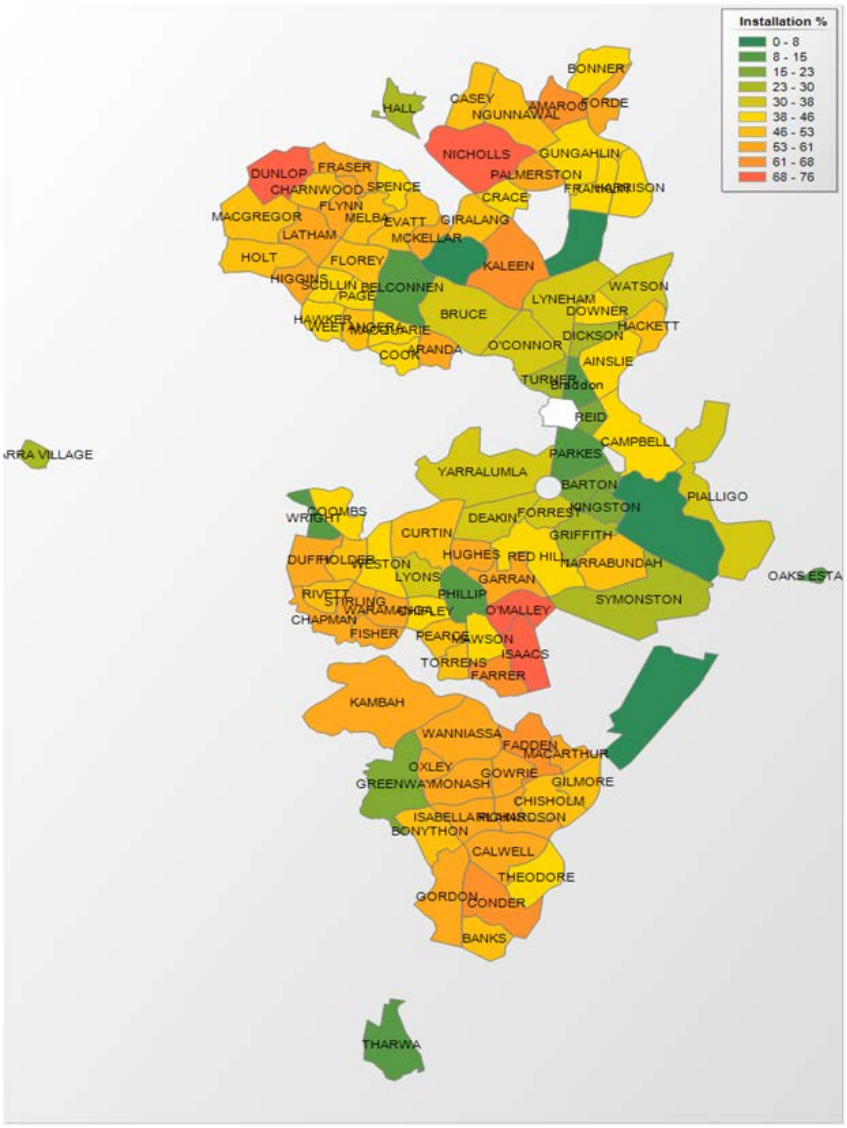

Figure 5. Percentage of households in each suburb that have received activities

3.3.2 Greenhouse gas emissions

Lifetime greenhouse gas savings

This is the translation of the lifetime energy savings into GHG savings by applying known emission factors for past periods and projected emission factors for the rest of the deeming period of the various activities. It is estimated that the lifetime energy savings presented previously will translate into **390 kt CO_2-e of lifetime GHG savings** from activities carried out from 2013 to the end of 2017 (Table 7).

Table 7. Lifetime GHG savings per year

	2013	2014	2015	2016	2017	Total
Lifetime emissions savings (kt CO_2-e)	77.8	99.3	117.3	31.5	63.4	389.4

Figure 6 presents the lifetime GHG emissions savings for activities undertaken each year since 2013. As for lifetime energy savings, residential lighting upgrades delivered the majority of abatement in the early years of the scheme, while commercial lighting activities only appear towards the end of the period.

There is a large drop in emissions savings between 2015 and 2016. This occurred because:

- The ACT grid electricity factor has changed and is expected to continue changing rapidly from 2013 to 2021, from 0.76 to 0.02 t CO_2-e/MWh (as the ACT progresses towards 100% RET).
- The average lifetime grid emissions factor used for a lighting upgrade that took place in 2015 was 0.43 t CO_2-e/MWh, versus 0.13 t CO_2-e/MWh for a lighting upgrade rolled out in 2016. This is over a three-fold difference, mostly due to the emission factors falling to just above zero once the 100% RET is achieved.
- Therefore, the assumed long lifetime of LED technologies means that while lifetime energy savings are high, a declining electricity emissions factor means that the lifetime emissions abatement is much lower, as it is effectively cut off in 2020.
- Other activities had not really taken over from residential lighting activities in 2016. However, in 2017, commercial lighting and space heating and cooling deliver the majority of abatements.

This highlights the fact that lighting upgrades post 2016 do not carry as much abatement value as in the early years of the scheme, due to the change in the grid emissions factor, while energy savings are actually increasing.

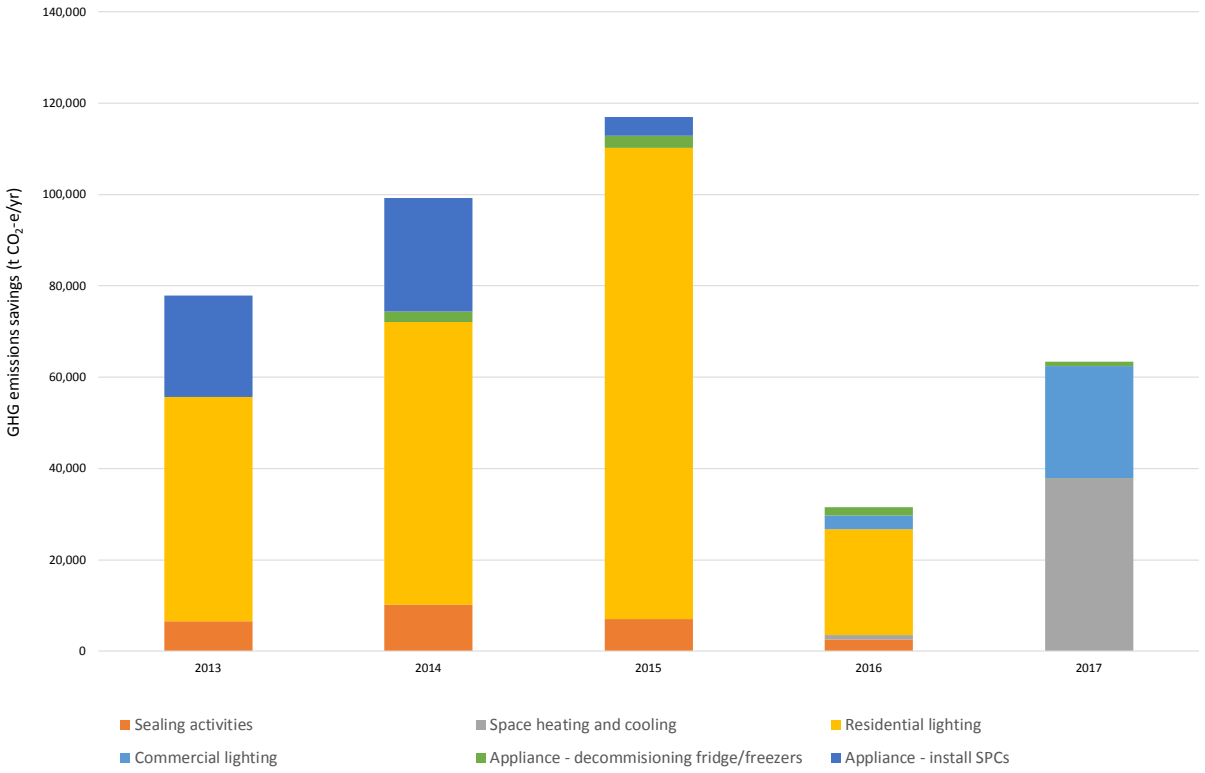

Figure 6. Lifetime GHG emissions savings per year

Cumulative greenhouse gas savings

Total scheme cumulative greenhouse gas emissions savings equate to 268 kt CO_2-e over the past five years, still dominated by residential lighting. Figure 7 presents the contribution of different measures to total cumulative abatement.

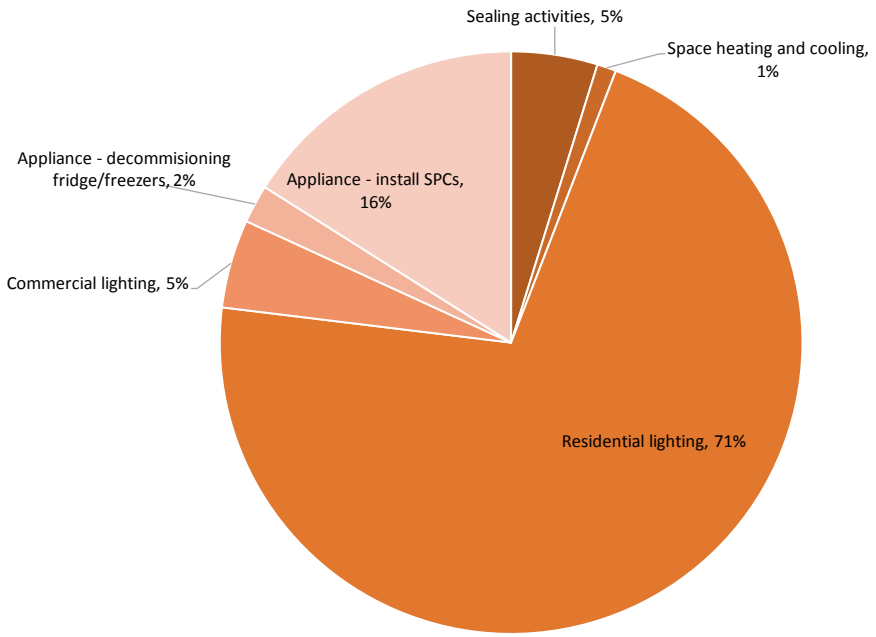

Figure 7. EEIS activity contribution to cumulative GHG emissions (2013 to end 2017)

3.3.3 Energy bill savings

Lifetime bill savings

This is a translation of the calculated expected lifetime energy savings into bill savings, based on average retail prices for households and businesses, as recommended by the EPSDD (from AEMC sources, see Table 16 in Appendix 1) for past prices, and flat price projections for years post 2020.

Based on actual energy prices until 2018, and the best available projections, lifetime bill savings for activities already delivered are expected to total approximately $240M. As with total energy savings, residential lighting contributed the most to savings, followed by commercial lighting upgrades.

For the residential sector specifically, it is estimated that lifetime bill savings are $180M, leaving nearly $60M for the commercial sector, which is remarkable after only a year and a half of active roll-out of the commercial lighting activity. This is partly explained by the assumption that retail prices (volumetric charge) for businesses are 45% higher than residential, the higher average per unit lifetime energy saved for commercial lighting upgrades (7.6 GJ/item installed) versus residential lighting upgrades (~2.6 GJ/item installed), and the rapid roll-out of lights (110,000 installed items since 2016).

Figure 8 presents the trend in lifetime residential bill savings across the life of the scheme. The trends for bill savings match energy savings (Figure 3) more closely than GHG emissions savings (Figure 6).

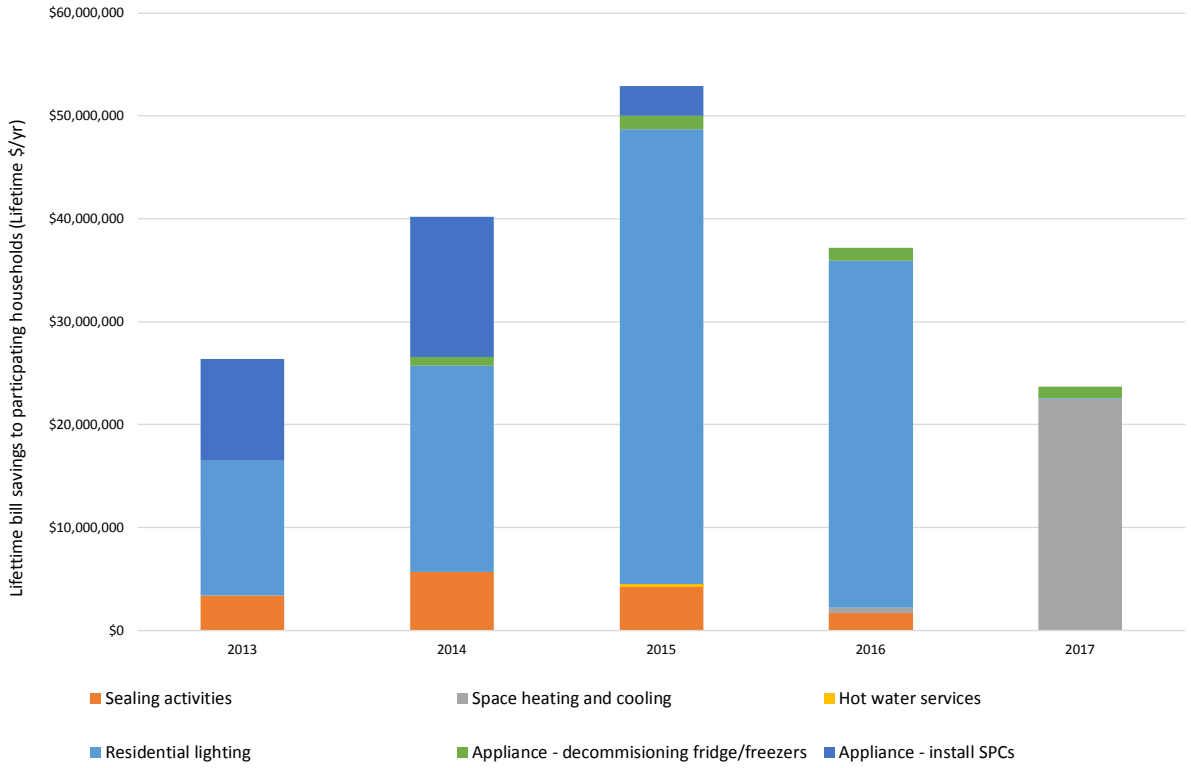

Figure 8. Residential lifetime bill savings per year

Table 8 provides lifetime bill savings to participating households in the ACT by activity type. To date just over 70,000, or 45% of all households in the ACT, have received some kind of energy saving activities through the EEIS.

Table 8. Lifetime bill savings to households by activity type

Lifetime bill savings to households	2013	2014	2015	2016	2017	Total
Sealing activities	$3,396,140	$5,657,921	$4,281,216	$1,672,092	$0	$15,007,369
Space heating and cooling	$0	$0	$0	$575,692	$22,507,028	$23,082,720
Hot water services	$0	$0	$205,859	$0	$0	$205,859
Residential lighting	$13,073,718	$20,055,153	$44,215,846	$33,658,691	$100,274	$111,103,681
Decommissioning fridge/freezers	$0	$863,678	$1,303,533	$1,286,687	$1,063,031	$4,516,930
Appliance - install SPCs	$9,876,714	$13,638,655	$2,891,506	$0	$0	$26,406,875
Total	**$26,346,572**	**$40,215,407**	**$52,897,960**	**$37,193,162**	**$23,670,333**	**$180,323,434**

The lifetime bill savings to the commercial sector are expected to total $60M – of which commercial lighting upgrades are the only contributor.

Cumulative bill savings

Cumulative bill savings (i.e. savings that have been achieved from energy saving measures installed in a particular year plus all the savings achieved in that year from measures installed in previous years) for both the residential and business sectors were estimated at **$70M** based on all activities delivered from 2013 to the end of 2017 (calendar year).

Figure 9 presents the contribution of different activities to cumulative household bill savings over the life of the scheme.

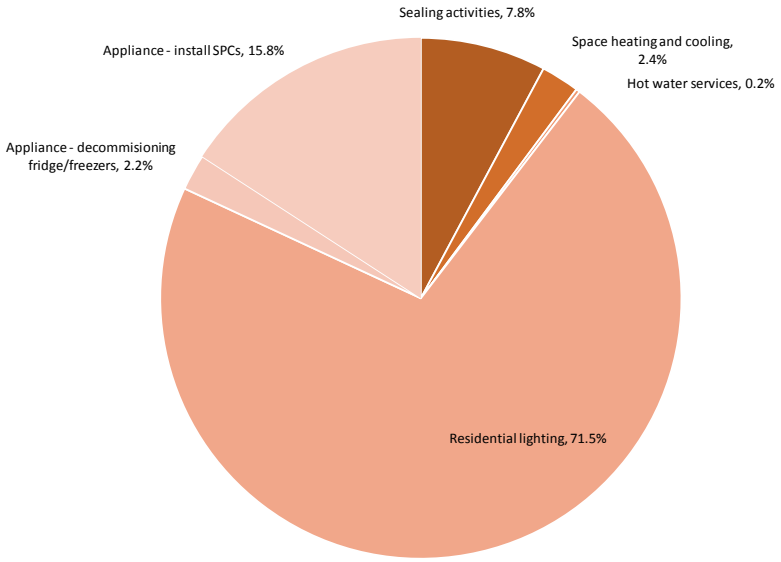

Figure 9. EEIS activity contribution to cumulative household bill savings (2013 to end 2017)

Per household bill savings

Figure 10 presents the estimated bill savings to participating households in the ACT delivered since 2013 overlaid over a typical ACT household energy bill (the split between different appliances/equipment seen in the energy bill was based on ABS Household Energy Consumption Survey data). This analysis shows that the EEIS saved a typical participating household between 9% and 12% of their annual household bill between 2013 and 2017. Average cumulative weekly savings across the scheme from 2013 to 2017 are $4.80 per participating household per week, and the trend is that these weekly household savings are increasing as the scheme matures, with savings of $5.65 per participating household in 2017. Across all households in Canberra, average cumulative weekly savings in 2017 were $2.60 per household.

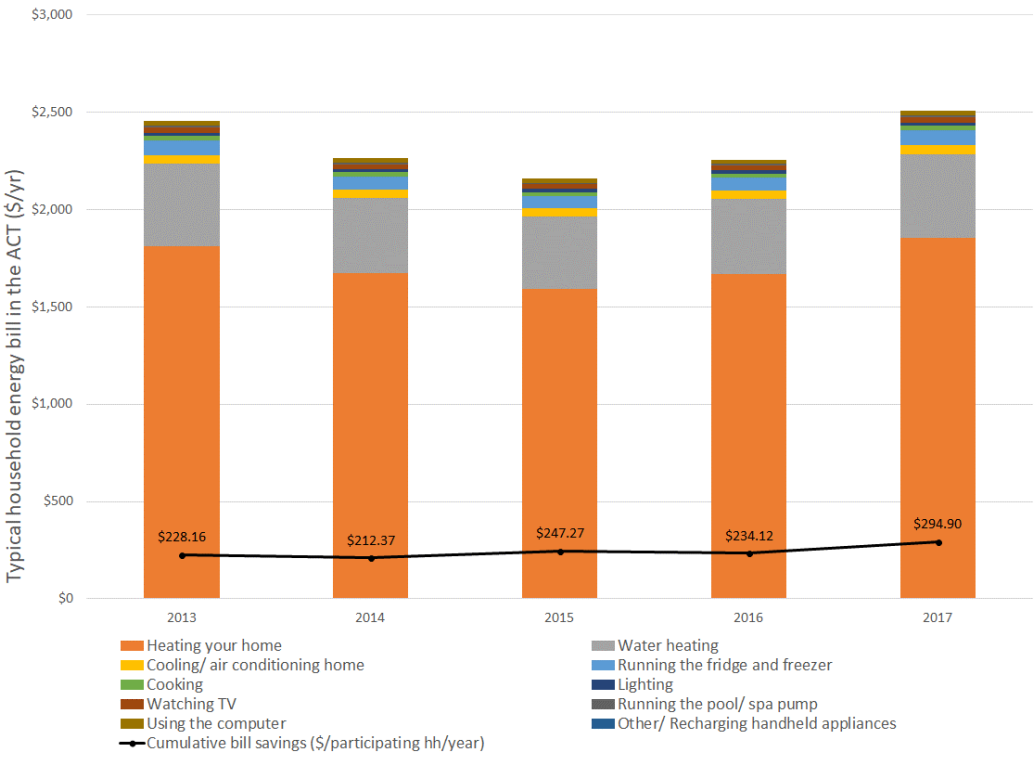

Figure 10. EEIS contribution to household bill savings

If we focus on annual incremental bill savings (the additional savings achieved in a particular year from measures installed in that year, with no account taken of savings in previous or subsequent years, divided by the number of new participants in that year), it appears that the push towards heating and cooling activities in 2017 has led to a very large increase in the bill energy savings for participating households, meaning the beneficial impacts from increased thermal comfort may also have increased. A much smaller number of households have however benefited from these types of activities, around 1,800 unique households participated in the scheme in 2017, with 1,250 of these households receiving activities that will deliver high energy bill savings compared with over 14,000 in 2016 when the focus was more on lighting upgrades. Figure 11 shows this large increase in per household energy and bill savings in 2017.

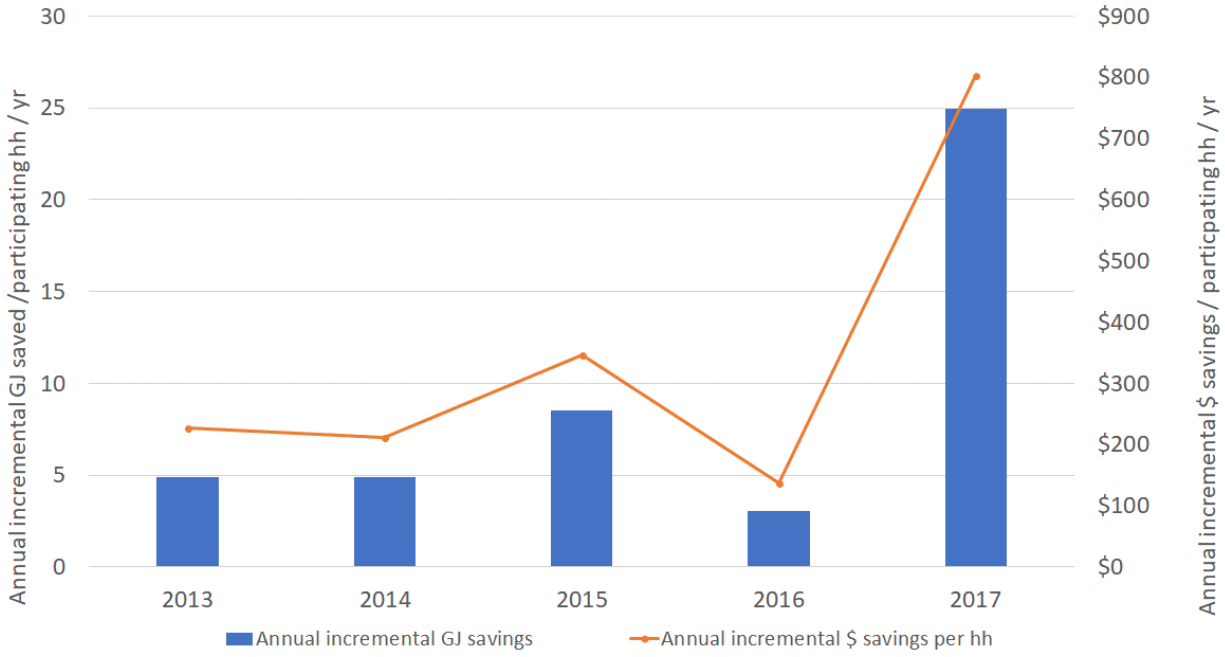

Figure 11. Annual incremental energy and bill savings for participating households in the ACT

Opportunities for priority households to reduce energy bills

Tier 1 retailers are obliged to achieve a proportion of their energy savings obligation in low-income households, as determined by the Minister by Disallowable Instrument, and as per the targets provided in Table 1. To date approximately 25% of the number of participating households have been priority households. PHT requirements are expressed in terms of savings: about 22% of savings from activities were achieved with priority households (see below). Overall, 17,900 priority households in the ACT have received some form of energy savings measure since 2013. Figure 12 shows that overall there is no major difference in the participation of priority households across activities, except for activity 2.3 - Install a specified high efficiency electric room heater, where 100% of participants were priority households. This graph also indicates that apart from activity 2.3, activities delivered to priority and non-priority households do not tend to differ.

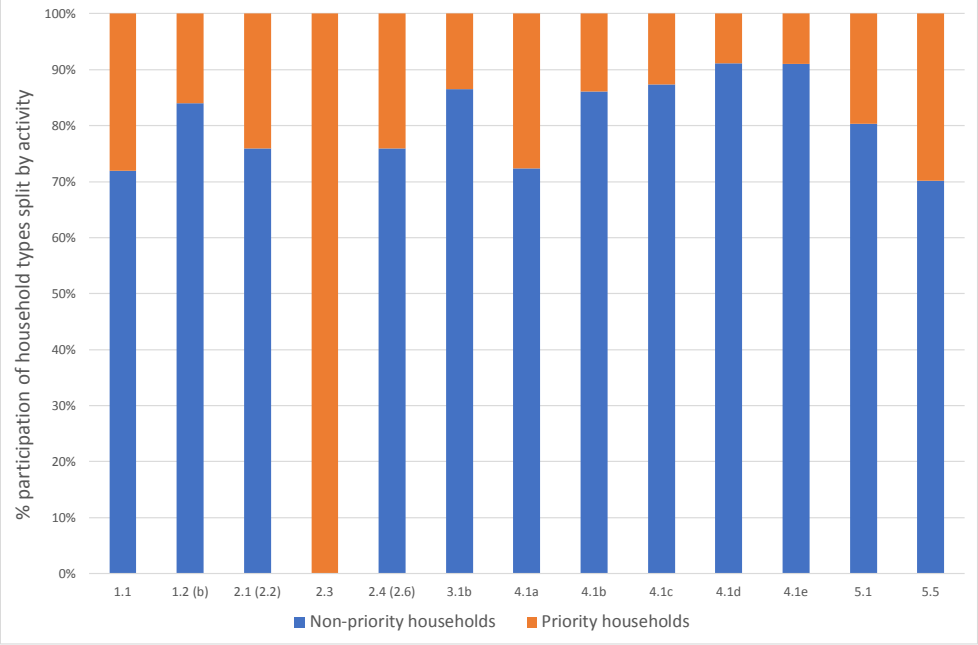

Figure 12. Proportion of household types receiving different activities (whole scheme)

Figure 13 provides a comparison of lifetime energy savings delivered in non-priority versus priority households. In 2013 and 2014, lifetime energy savings from priority households were over 30% of total scheme savings. In 2015 and 2016, the proportion of savings delivered in priority households effectively halved compared to previous years, recovering in 2017. This is allowed under the scheme as Tier 1 retailer more energy savings activities were delivered than required by the PHT in 2013 and 2014, meaning the surplus was used to achieve their PHT targets in following years.

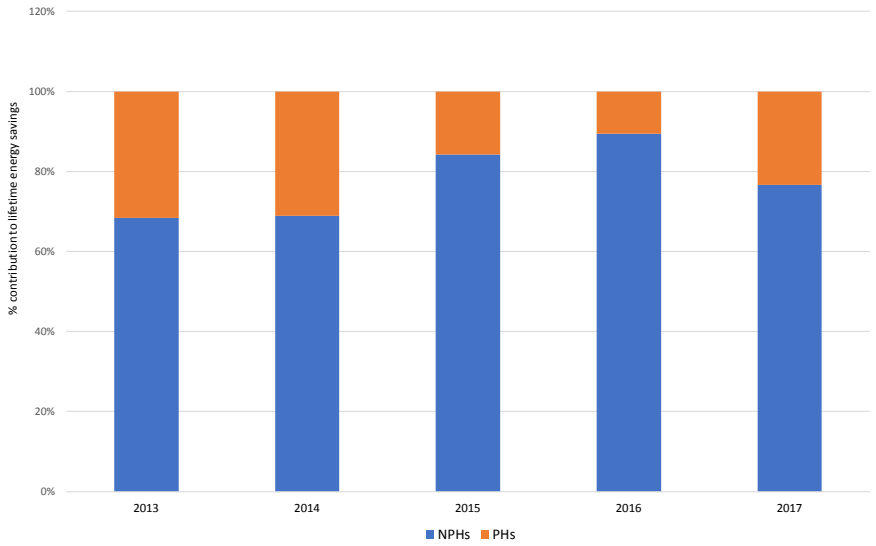

Figure 13. Proportion of lifetime energy savings delivered in priority and non-priority households

In total, the EEIS has delivered approximately **800,000 GJ** of lifetime energy savings in priority households, or 22% of total scheme residential lifetime energy savings. EEIS opportunities have shifted over the life of the scheme, and these changes are reflected in the types of activities that have been delivered by the Tier 1 retailer. Initially, most of the priority household abatement was delivered through a small set of activities including standby power controllers, lighting upgrades, draught sealing and refrigerator removal activities. The trend in recent years is to deliver heating and cooling activities in priority households. As demonstrated in Figure 11, this has a large impact on household bills for households that receive these activities. For example, replacing an inefficient ducted gas heater could save the households that receive it just over $16,000 in lifetime bill savings over the life of the measure (14 years), while

installing insulated gas heating ducting could save around $10,000 in lifetime bill savings over the life of the measure (based on 2017 gas prices –see Table 16). It is important to note that these are modelled average savings for an average household, and in reality, savings will vary from house to house. Another point to consider is that in 2017, just 14% of the priority households that received these measures were rentals, this was equivalent to around 25 households. Therefore, it may be worthwhile developing strategies in the future to address this split-incentive issue.

Per business bill savings

There are approximately 26,000 business operating in the ACT based on recent ABS data. Of these, 57% are sole traders and 43% (>11,000) employ staff while 176 are very large energy users that submit annual National Energy and Greenhouse Reports to the Australian government, and are excluded from participating in EEIS. Approximately 466 businesses EEIS savings in 2016, mostly body corporates and others who received downlight upgrades similar to those delivered to households. In 2017, 1,199 received commercial lighting upgrades. This brings the total number of businesses who have participated in the scheme to just below 1,700, or 15% of total business employing staff, or 6% of all businesses in the ACT[2].

Estimated average benefits for business are more difficult to determine than in the residential sector due to the significant differences in the nature and extent of energy use between different businesses. Total lifetime bill savings for businesses is just under $60M. In 2017, total cumulative bill savings to the commercial sector were over $5M, while in 2016 they were just over $300,000. This equates to savings of an average of $3 per MWh consumed by businesses in the ACT, for 2017. Note that this figure is conservative as the calculation is based on all commercial stationary energy consumption in the ACT, when in fact NGERs reporters are excluded from the scheme and consume approximately 67% of the total ACT stationary commercial energy. Therefore, the savings per MWh for participating businesses may indeed be higher.

3.4 Scheme co-benefits

Before an electricity retailer or authorised installer can undertake eligible activities, they must complete training on the EEIS and the individual activities they will be undertaking. The EEIS Induction Training covers industry standards, legislation, compliance, quality, health and safety, risks and other relevant aspects regarding each specific activity delivered under the scheme. Retailers, abatement providers and installers who deliver activities under the EEIS have to comply with high standard health and safety requirements, as well as offer high quality products, installations and customer service. Since 2013, 86 EEIS induction training sessions have been delivered to more than 540 installers across a range of EEIS activities, which include:

- installation of energy efficient light globes;
- door seals;
- exhaust fan sealing;
- decommissioning of refrigerators and freezers;
- installing high efficiency ducted gas heaters;
- installing high efficiency electric room heaters; and
- installing high efficiency water heaters.

3.5 Sensitivity analysis

3.5.1 Energy prices

A sensitivity analysis was conducted to identify the impact of increasing energy prices post 2020 on lifetime bill savings, as the base case assumes no price increase post 2020 due to considerable uncertainty surrounding energy prices beyond that date. Table 17 shows the energy price increase assumptions used for this sensitivity analysis.

Table 9 summarises lifetime bill savings to participating households in the ACT by activity type, using these sensitivity analysis assumptions. Lifetime household bill savings increase by approximately **8%** compared with the base case if energy prices do indeed increase post 2020 in line with the scenario presented in Table 17.

[2] Note that an additional 203 businesses received commercial lighting upgrades beyond those reported here, although these were not included in the quarterly data that were used in the review analysis.

Table 9. Sensitivity analysis: Lifetime bill savings to households by activity type (energy price rise post 2020)

Lifetime bill savings to households	2013	2014	2015	2016	2017	Total
Sealing activities	$3,506,417	$5,962,695	$4,623,601	$1,857,788	$0	$15,950,502
Space heating and cooling	$0	$0	$0	$729,868	$29,794,273	$30,524,142
Hot water services	$0	$0	$208,586	$0	$0	$208,586
Residential lighting	$13,073,718	$20,055,153	$44,460,176	$39,377,447	$118,440	$117,084,933
Decommissioning fridge/freezers	$0	$867,837	$1,320,801	$1,318,538	$1,104,849	$4,612,025
Appliance - install SPCs	$10,056,382	$14,039,396	$3,014,963	$0	$0	$27,110,741
Total	**$26,636,517**	**$40,925,082**	**$53,628,127**	**$43,283,640**	**$31,017,562**	**$195,490,928**

If energy prices rise post 2020, the lifetime bill savings to the commercial sector would be expected to total $64M, which is **7%** greater than the base case.

3.5.2 Grid emissions factor

A sensitivity analysis was also conducted to estimate the emissions savings that would have been achieved by the EEIS had the 100% RET not been decided. Table 19 provides the emission factor assumptions used for this sensitivity analysis.

It was found that if the ACT's grid emission factor remained similar to the NSW, instead of nearing zero emissions intensity, the total lifetime emissions savings from the scheme would have been **885 kt CO_2-e**, which is over twice the base case of **390 kt CO_2-e of lifetime GHG savings.**

4 DISCUSSION

4.1 Overall scheme benefits and costs

It is important to note that while costs associated with the scheme will end with the end of the scheme, savings will continue to accrue for the lifetime of the implemented measures. Figure 14 presents the expected lifetime energy bill savings for the whole scheme versus the costs of scheme delivery, noting that these are highly sensitive to future energy price assumptions that are quite uncertain. Since 2013, lifetime energy bill savings are considerably greater than scheme costs.

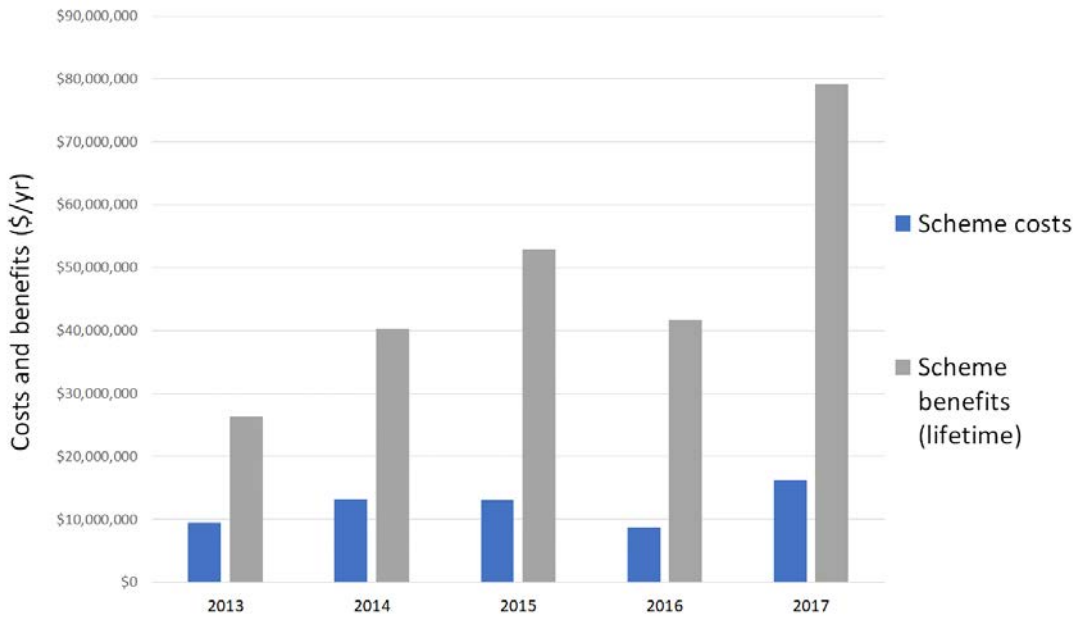

Figure 14. Lifetime energy bill savings versus costs of scheme

Figure 15 presents the cumulative energy bill savings delivered to date versus the costs of scheme delivery. For the first two years of the scheme the costs outweighed delivered savings; however, as the scheme matured, cumulative energy bill savings have been greater than scheme costs.

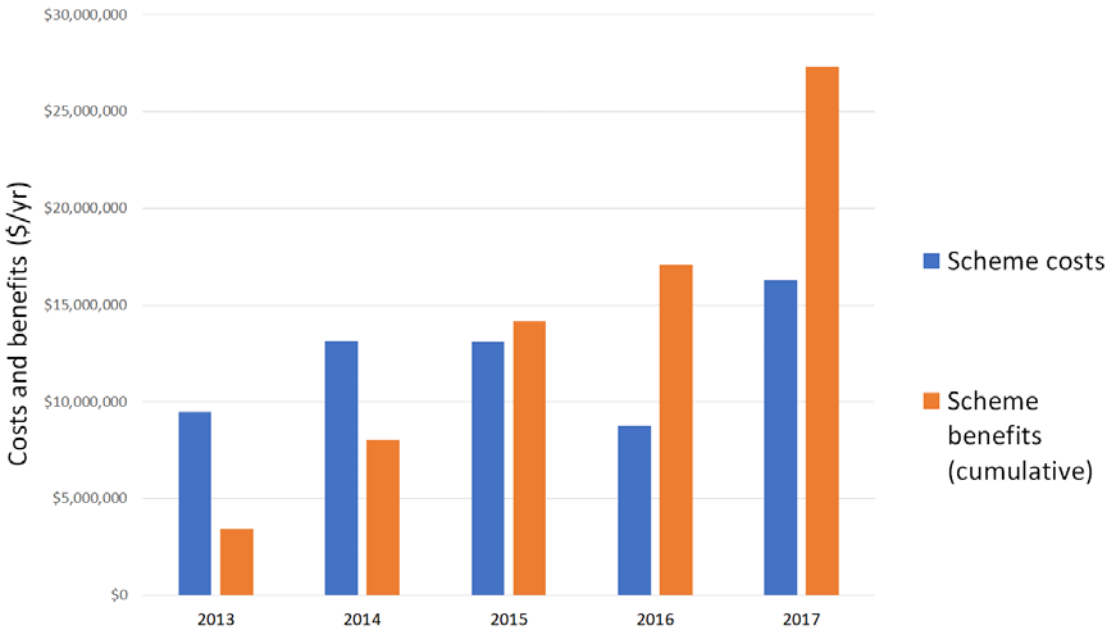

Figure 15. Cumulative energy bill savings versus costs of scheme

Table 10 provides the benefit cost-ratio of the EEIS based solely on financial costs and benefits. The cumulative benefits of the scheme accrue to participants as time goes by, as the cumulative energy savings from bills began to outweigh costs from 2015 onwards. Overall, the scheme has delivered a net benefit of **1.15** for cumulative energy bill savings.

It should also be noted that these savings will continue for the lifetime of the measures implemented, meaning that when/if the scheme ends, although costs will be zero, bill savings will still accrue (Table 10). Using this metric, the benefit-cost ratio for lifetime energy bill savings has been greater than 1 (i.e. delivering a net benefit) since scheme inception, at **3.95**.

Table 10. Benefit- cost ratio of scheme

Unit	Description	2013	2014	2015	2016	2017	Total
$	Total pass-through costs and co-contributions	$9,473,129	$13,153,897	$13,102,967	$8,779,768	$16,270,430	**$60,780,191**
$	Total cumulative energy bill savings to EEIS participants	$3,436,555	$8,040,641	$14,169,327	$17,062,158	$27,346,666	**$70,055,347**
Ratio	Benefit-cost ratio (TRC test based on (Molina M., 2014)	0.36	0.61	1.08	1.94	1.68	**1.15**
$	Total lifetime energy bill savings to EEIS participants	$26,346,572	$40,215,407	$52,897,960	$41,701,425	$79,099,045	**$240,260,409**
Ratio	Benefit-cost ratio (TRC test based on (Molina M., 2014)	2.78	3.06	4.04	4.75	4.86	**3.95**

4.2 Opportunities for priority households

The ACT has the highest rate of gas bill debts out of the five territories in the Australian Energy Regulator's market, at an average debt of $598 per household. In addition, electricity bill debt is $807 per household, which is exceeded only by households in SA and NSW (AER, 2018).

Due to the specific climate of the ACT, there is a lot of scope for priority households to benefit from heating and cooling energy saving activities being rolled out in 2017 by the EEIS. These activities can have a real impact on

household energy bills, meaning that households who are in energy poverty or debt may be more likely to be able to repay debts without the assistance of hardship programs.

In addition, Figure 16 demonstrates that low income Australian households spend on average almost 10% of their gross household weekly income on total household energy costs, around three times that of high income households. Nearly 400 priority households received these high impact activities since 2016, meaning that they should have significant bill savings (noting that this is higher than the unique number presented in Table 14, as the same households received activities 2.1(2.2) and 2.4(2.6)).

In total, over 50%, or 17,900, of priority households in the ACT have received some form of energy savings measure since 2013 (assuming approximately 20% of households in the ACT are priority).

Figure 16. Energy expenditure as a proportion of gross weekly household income, Australian average (ABS, 2013)

4.3 Opportunities for rental households

Since its inception in 2013, over 15,000 rental households have received energy efficiency activities under the EEIS. Figure 17 below demonstrates that this equates to approximately 22.5% of the total participating households. A figure that is quite significant in consideration of 2016 census data[3] which indicates that 31.8% of all ACT households are rental properties. The majority of the activities delivered for these rental households were lighting upgrades, followed by sealing activities and the provision of SPCs. However, as mentioned previously split-incentive issues exist for rolling out high-impact heating and cooling activities in priority rental households, and solutions to this should be investigated further.

3 http://www.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/CED801

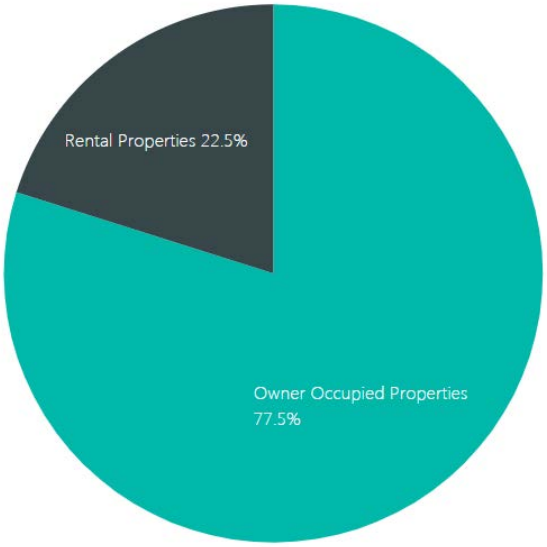

Figure 17. Percentage of households by occupancy status

4.4 Comparison with previous modelling

4.4.1 Pass-through costs

Figure 18 presents the pass-through costs to an average household in the ACT. Apart from 2013 when they were higher, pass-through costs have been similar or lower than forecasted in the Scheme Inception RIS and Scheme Extension RIS. In 2016, costs were lower, but so were the savings realised (see above).

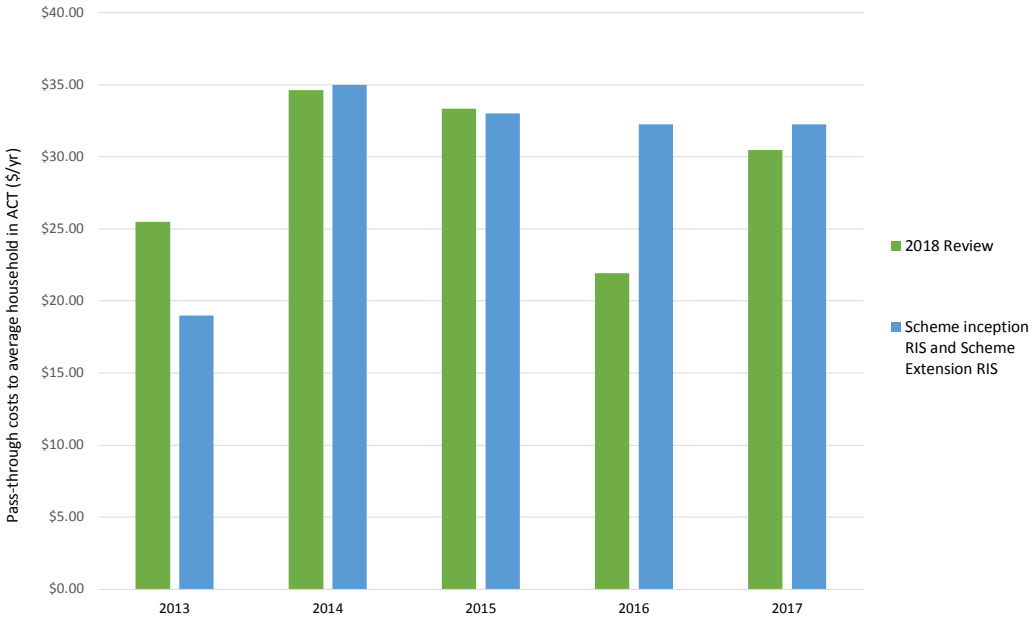

Figure 18. Comparison of pass-through costs to the average household

4.4.2 Per household bill savings

Figure 19 presents a comparison of the average cumulative bill savings across all households in the ACT (participating and non-participating), presented in the 2012 Scheme modelling and 2015 Scheme modelling, and the 2018 Review. Average household savings have been less than forecasted previously. The main reason for this is related to lower

than expected Tier 2 retailer participation, resulting in less lifetime energy savings delivered in reality than forecasted, and differences in energy price assumptions for the 2013 to 2015 period; hence the lifetime bill savings are also lower than modelled. Section 5.4.3 provides a detailed explanation of these differences.

The dashed area seen in Figure 19 represents the proportion of savings that would have been achieved if Tier 2 retailers delivered energy savings activities (based on historic Tier 2 market share of electricity sales). Therefore, it is more useful to compare the blue area of the graph with the 2018 review results (orange). This shows that as the scheme progressed the savings are more in line with what was forecasted previously, with savings in 2017 slightly exceeding those presented in the scheme extension RIS.

Note also that this figure excludes any bill savings associated with Actsmart programs financed through ESCs, as these were not provided to us for this analysis. This should mean that the 2018 review values are conservative.

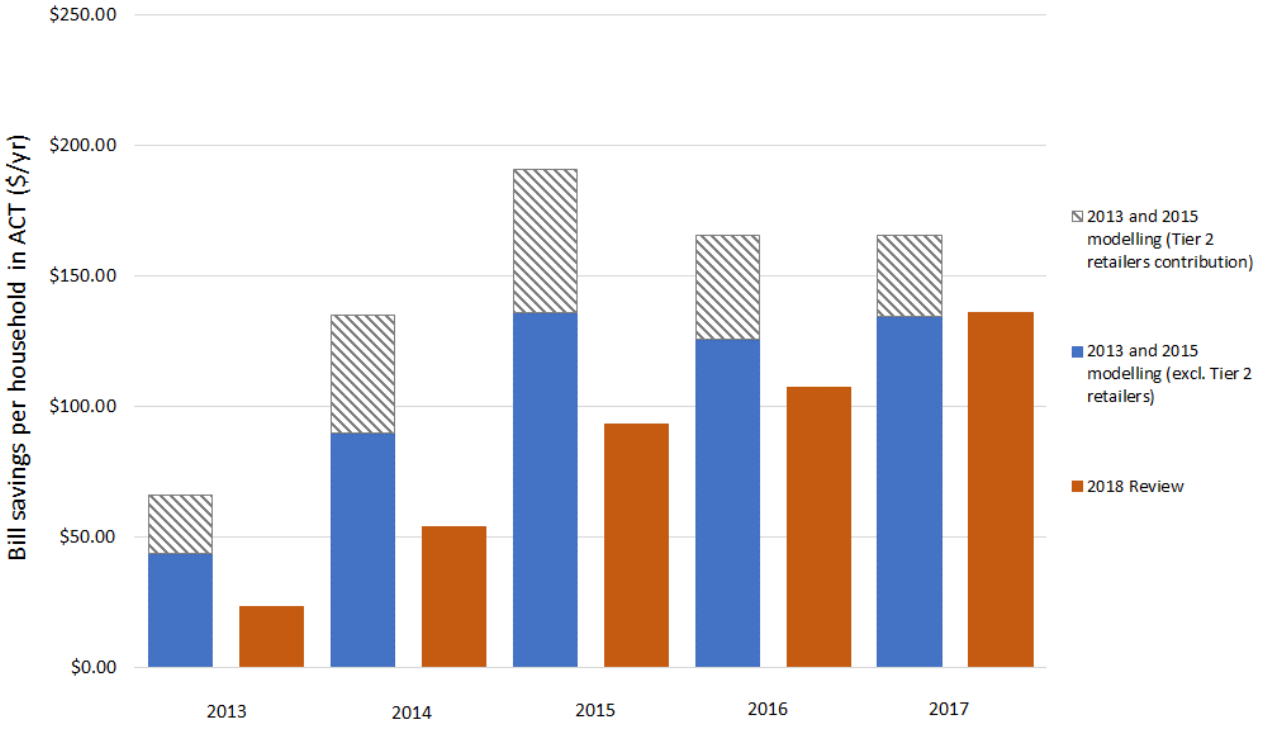

Figure 19. Comparison of bill savings to an average household in the ACT (participating and non-participating)

4.4.3 Overall scheme savings

Actual EEIS delivery of savings was compared with previously modelled results. It is important to note that this comparison is made difficult by a range of confounding factors and that original models were not always available. Table 2 in Section 3.2 provides our current understanding of how the various exogenous factors influence the energy, emission abatement and monetary savings, and contribute to explain the discrepancies observed between the ex-post (delivered) and ex-ante (forecasted) results.

It should be noted that such discrepancies are to be expected: as with any projections, actual figures are likely to diverge from estimated or modelled forecasts and actual parameter values from assumed values. This sentiment is expressed in both the Scheme Inception RIS and Scheme Extension RIS. The fact that the 2018 review (ex-post) results may not be in line with previously forecasted (ex-ante) results, has no bearing on the legislated EST and PHT being achieved by the Tier 1 retailer, as explained in Section 4.1.1.

Energy

The Scheme Inception RIS did not provide estimates of scheme energy savings for the period 2013 to 2015, therefore it is not possible to compare forecasted energy savings with the 2018 review results.

The Scheme Extension RIS did provide estimates of scheme energy savings for the period 2016 to 2020, however, there are differences in the assumptions driving the forecasted scheme extension RIS results (ex-ante) versus the 2018 review results (ex-post), making an accurate comparison difficult. The most important differences are:

- Lower than expected Tier 2 retailer participation. The Scheme Extension RIS modelling assumes 100 per cent participation when calculating the uptake of measures required to meet the target GHG abatement (515kt CO_2-e), and the associated cost. In reality, Tier 2 retailers have not participated (to the exception of one retailer participating in commercial lighting for a short period). This means that the expected abatement should be reduced by about 30%, resulting also in lower energy savings forecasts.
- For 2016, the delivery of specific activities, e.g. the installation of insulating gas heating ductwork, the decommissioning of a ducted gas heater and install high-efficiency (HE) equivalent, and commercial lighting upgrades, was not rolled out at the same pace as forecasted in the Scheme Extension RIS for 2020. In 2016, the delivery of these activities was low, hence the energy savings were not as great as expected.

As stated previously, comparisons between ex-ante and ex-post energy savings are difficult due to the differences in modelling assumptions. However, in general, the trend in ex-post energy savings is in line with those forecasted in 2015 by Energetics. The 2015 Scheme Extension RIS provides an estimate of lifetime electricity savings of 128,000 MWh and lifetime natural gas savings of 480,000 GJ for natural gas, from activities rolled out in 2020. This is equal to a total of 940,800 GJ for 2020. As the lifetime energy savings in 2016 were 755,156 GJ and 1,288,932 GJ in 2017, the trend suggests that energy savings forecasts to 2020 should be in line with, or even exceed modelled results (Table 11).

Table 11. Lifetime energy saved as a result of EEIS (GJ)

	Description	2013	2014	2015	2016	2017	Total
2018 Review	Lifetime energy savings activity data provided by Directorate	555,834	836,635	1,061,622	755,156	1,288,932	4,498,179
Previous modelling (corrected for non-participation by Tier 2 retailers)	Scheme extension RIS - corrected for Tier 2 non-participation	not available	not available	not available	714,883	763,264	

Greenhouse gas emissions

Table 12 presents a comparison of the ex-post lifetime emissions savings results developed as part of this empirical analysis, and the ex-ante results provided in the previous modelling. It shows that emissions savings are less than what was originally forecasted. There are several reasons for this:

- A volume effect: as less energy savings have been delivered than forecasted for the 2013 to 2015 period due to the drop-off effect for SPCs, the lifetime emissions savings also reduce.
- As for energy savings, the lower than expected Tier 2 retailer participation reduces the lifetime emissions savings compared with previous forecasts.
- For the 2016-20 extension (Scheme Extension RIS), estimations of lifetime emissions abatement were made on the basis of the ACT Government's 90% Renewable Energy Target by 2020. This RET was changed to 100% in 2016. However, in order to provide business investment certainty until the end of the scheme in 2020 to retailers, all modelling for the EEIS extension was based on the 90% RE target, resulting in a higher emission factor associated with deemed electricity energy savings to the end of the deeming period.
- For the period of 2013 to 2015, we have not been provided with the emission factors used (though it is likely that National Greenhouse Accounts Factors for NSW/ACT were used), therefore we cannot fully identify why there is a difference seen between these years. However, we understand that ACT government policies for renewable electricity have changed since the start of the scheme. As electricity grid intensity of greenhouse gas emissions has reduced, the amount of abatement per unit of energy saved has reduced proportionally. For the first three years, the scheme modelling was for lifetime emissions based on a Sustainable Energy Policy targeting 25 per cent renewable electricity by 2020, resulting in a significantly higher electricity emission factor.

Table 12. Lifetime greenhouse gas saved as a result of EEIS (kt CO_2-e)

	Description	2013	2014	2015	2016	2017	Total
2018 Review	Lifetime energy savings activity data provided by Directorate, multiplied by emission factors	78	99	117	32	63	389
Previous modelling (corrected for non-participation by Tier 2 retailers)	2013, 2014, 2015 value is from Scheme inception RIS, Table 7 Scheme extension RIS, Table ES 1, used for 2016-2017	128	226	241	78	84	757
Total difference		50	127	124	46	21	**368**

Figure 20 clearly demonstrates the disconnect between actual scheme emission savings and previously forecasted savings. As mentioned previously, one of the main reasons for this is the dramatic decrease in the grid emissions intensity factor as a result of the ACT's 100% RET, which was not accounted for in previous Regulatory Impact Statements models, as they were prepared before this target came into force. This highlights the need to move to an energy metric as is described in more detail in Part 5 – SWOT analysis.

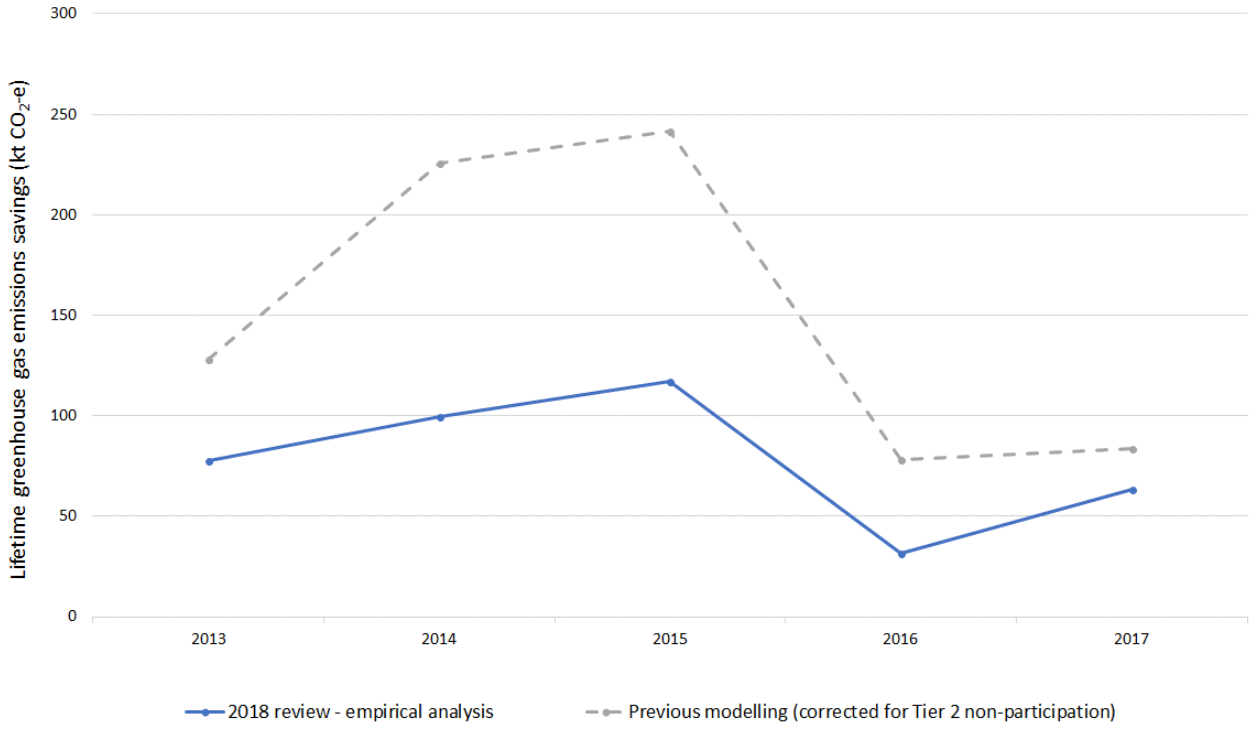

Figure 20. Comparison of ex-post (2018 review) versus ex-ante (previously modelled) lifetime emissions savings (corrected for Tier 2 non-participation)

Energy bills for households and businesses

Table 13 presents a comparison of the ex-post lifetime bill savings results developed as part of this empirical analysis, and the ex-ante results provided in the previous modelling. As with emissions savings, lifetime bill savings are less than what was originally forecasted. The main reason for this is the lower than expected Tier 2 retailer participation. In addition, differences in energy price assumptions drive discrepancies, however it should be noted that the energy price assumptions for this analysis were greater than those used for the Scheme Extension RIS.

The modelling underpinning the Scheme Inception RIS forecasted total lifetime bill savings of $358M from activities delivered from 2013 to 2015. Taking into account that that Tier 2 retailers paid ESCs rather than delivered activities for this period, the target lifetime bill savings for Tier 1 retailer reduces to approximately $243M. In fact, lifetime bill

savings delivered between 2013 and 2015 were $120M, which is closer to the original forecast. We cannot ascertain the exact reasons for the remaining differences however, as the modelling underpinning the Scheme Inception RIS was not available for this review.

The modelling underpinning the Scheme Extension RIS forecasted total lifetime bill savings of $490M from activities delivered from 2016 to 2020. Taking into account that that Tier 2 retailers pay ESCs rather than deliver activities, the target lifetime bill savings for Tier 1 retailer reduces to approximately $377M. This equates to roughly $75M of bill savings to be delivered each year, or $150M of savings in total for 2016 and 2017. As activities in 2016 and 2017 have delivered over $120M of lifetime bill savings, this means that just under 80% of forecasted bill savings have been realised for these two years. At the current average annual rate of activity roll-out (based on 2016 and 2017), it would be expected that the scheme will deliver over $300M in lifetime bill savings by 2020.

However, it also worth noting that between 2016 and 2017 bill savings nearly doubled, as a result of rolling out high impact space heating activities, albeit benefitting a smaller number of households, and commercial lighting activities. Therefore, it is reasonable to estimate that savings delivered in 2018 should be higher again.

Table 13. Lifetime bill savings as a result of EEIS ($)

	Description	2013	2014	2015	2016	2017	Total
2018 Review	Lifetime energy savings activity data provided by Directorate, multiplied by energy price	$26,346,572	$40,215,407	$52,897,960	$41,701,425	$79,099,045	$240,260,409
Previous modelling	Originally scheme inception RIS predicted $358M for 2013-2015. Energetics model predicted total lifetime participant bill savings of $490M. This was broken down to yearly savings of $98M for 2016 and 2017. The Scheme extension RIS presents lifetime residential ($106M) and business bill ($192M) in **present value terms** (as opposed to lifetime). This means that these present value savings are not comparable to the lifetime bill savings presented here.		$358,000,000		$98,000,000	$98,000,000	$554,000,000
Total difference*			**$238,540,061**		**$56,298,575**	**$18,900,955**	**$313,739,591**

* See explanation describing the reasons for these differences in paragraphs above.

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APPENDIX 1 DATA SOURCES AND ASSUMPTIONS

Table 14. Participating households in EEIS

	2013	2014	2015	2016	2017	TOTAL
No. of priority households visited per year	4,516	7,239	3,872	1,980	300	17,907
No. of non-priority households visited per year	10,546	15,562	15,570	12,020	1,500	55,197
Total households reached	**15,062**	**22,800**	**19,442**	**14,000**	**1,800**	**73,104**
Cumulative No. of priority households visited per year	4,516	11,754	15,627	17,607	17,907	
Cumulative No. of total households visited per year	**15,062**	**37,862**	**57,304**	**71,304**	**73,104**	
Total households in ACT[1]	**145,347**	**148,536**	**151,844**	**155,073**	**158,277**	

[1] (ABS, 2015)

Table 15. Lifetime and fuel split assumptions for energy savings activities

Measures	Measure lifetime	Lifetime Energy Savings (GJ)				
		Electricity	Gas	Gas	Wood	**Total**
Building Sealing - Doors	10	19%	77%	0.1%	4%	100%
Self-Sealing Exhaust Fans	10	19%	77%	0.1%	4%	100%
Replace a ducted gas heater with a high efficiency ducted gas heater (2016)	14	0%	100%	0.0%	0%	100%
Replace a ducted gas heater with a high efficiency ducted gas heater (2017)	14	0%	100%	0.0%	0%	100%
Install a specified high efficiency electric room heater	10	0%	100%	0.0%	0%	100%
Install insulated gas heating ductwork	14	0%	100%	0.0%	0%	100%
Install insulated gas heating ductwork	14	0%	100%	0.0%	0%	100%
Replace electric resistance heater with instantaneous gas water heater	7	100%	0%	0.0%	0%	100%
Low energy GLS lamps	6	100%	0%	0.0%	0%	100%
Low energy GLS lamps	22	100%	0%	0.0%	0%	100%
Low energy reflector lamps	22	100%	0%	0.0%	0%	100%
Low energy 12V lamps	22	100%	0%	0.0%	0%	100%
Low energy downlight	22	100%	0%	0.0%	0%	100%
Low energy GU10	22	100%	0%	0.0%	0%	100%
Low energy GLS lamps	6	100%	0%	0.0%	0%	100%
Low energy reflector lamps	6	100%	0%	0.0%	0%	100%
Low energy 12V lamps	6	100%	0%	0.0%	0%	100%
Commercial lighting	10	100%	0%	0.0%	0%	100%
Decommissioning & disposal of refrigerator or freezer	7	100%	0%	0.0%	0%	100%
Standby power controllers	10	100%	0%	0.0%	0%	100%

Table 16. Energy costs for different fuel types (base case)

Fuel	Units	2013	2014	2015	2016	2017	2018	2019	2020
Res. Electricity Flat[1]	(c/kWh)	17.50	16.24	14.87	15.87	19.10	20.62	19.79	19.79
Bus. Electricity Flat[1]	(c/kWh)	25.90	24.04	22.01	23.49	28.26	30.52	29.29	29.29
Gas[2]	(c/MJ)	2.95	2.93	3.09	3.23	3.44	3.65	3.88	3.88
LPG[3]	(c/MJ)	7	7	7	7	7	7	7	7
Firewood Closed[3]	($/t)	300	300	300	300	300	300	300	300
Firewood Open[3]	($/t)	300	300	300	300	300	300	300	300

1 We used the 2016 and 2017 AEMC price trends reports for the ACT to determine average electricity prices (c/kWh) out to 2020. The relative difference between household and business prices was determined using EEIS historic splits provided in the confidential EEIS - Activity Analysis 2016 V 2.24 (Stage 3 Master).xls. Post 2020 electricity prices remain constant.

2 We used the average ACT gas prices (c/MJ) to estimate household gas prices from 2013 to 2015.(Gas price trends review report 2017).To estimate trends out to 2020, we used the historical trends in wholesale, transmission, distribution and retail margin charges we used the historic trend from 2006 to 2015 presented in the Gas price trends review report 2017 for the ACT. This gave an annual average increase of 5% between 2013 and 2020. Post 2020 natural gas prices are assumed to remain constant.

3 All other fuel energy costs were based on previous modelling provided in in the confidential EEIS - Activity Analysis 2016 V 2.24 (Stage 3 Master).xls.

Table 17. Energy costs for electricity and natural gas (sensitivity analysis)

Fuel	Units	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Res. Electricity[1]	(c/kWh)	17.50	16.24	14.87	15.87	19.10	20.62	19.79	20.40	20.91	21.41	21.91	22.42	22.92	23.43	23.93	24.43	24.94	25.37
Bus. Electricity[1]	(c/kWh)	25.90	24.04	22.01	23.49	28.26	30.52	29.29	30.19	30.93	31.68	32.42	33.17	33.91	34.66	35.40	36.15	36.90	37.53
Gas[2]	(c/MJ)	2.95	2.93	3.09	3.23	3.44	3.65	3.88	4.10	4.33	4.57	4.84	5.10	5.37	5.67	5.99	6.34	6.73	7.14

1 We used the 2016 and 2017 AEMC price trends reports for the ACT to determine average electricity prices (c/kWh) out to 2020. The relative difference between household and business prices was determined using EEIS historic splits provided in the confidential EEIS - Activity Analysis 2016 V 2.24 (Stage 3 Master).xls. Post 2020 electricity prices remain constant.

2 We used the same method to estimate gas prices to 2020 as described for the base case. From 2020 to 2038 natural gas prices are assumed to grow by an annual average of 6%, with gas prices in 2038 equal to 11.97 c/MJ.

Table 18. Emissions factors for different fuel types (base case)

Fuel	Units	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Electricity[1]	(tCO2-e/MWh)	0.757	0.751	0.747	0.723	0.587	0.350	0.134	0.028	0.016	0.023	0.030	0.037	0.046	0.057	0.067	0.078	0.089	0.089
Gas[2]	(tCO2-e/GJ)	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064
LPG[2]	(tCO2-e/GJ)	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064
Firewood Closed[2]	(tCO2-e/GJ)	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Firewood Open[2]	(tCO2-e/GJ)	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050

1 We used the historic and projected grid intensity to remodel the historic and projected abatement provided by the EEIS since 2013 based on Sadler, H. 2018, Past and projected future components of electricity supply to the ACT, and resultant emissions intensity, ACT Government (with EVs). Post 2030, the grid intensity is assumed to remain constant.

2 For all other fuel types, the National Greenhouse Account Factors were used.

Table 19. Emissions factors for grid-derived electricity (sensitivity analysis)

Fuel	Units	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Electricity[1]	(tCO2-e/MWh)	0.850	0.835	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830

1 We used the historic grid intensity of the NSW grid based on the National Greenhouse Account Factors were used. Note that financial year results were averaged to develop calendar year intensities. This method for these grid factor assumptions were based on specific feedback provided by the EPSDD on the 21/03/18. Post 2030 the grid intensity is assumed to remain constant.

Table 20. ACT electricity consumption to 2019-20

TJ	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Residential – electricity[1]	4,237	4,169	4,204	4,232	4,259	4,266	4,280
Commercial – electricity[1]	6,603	6,498	6,553	6,596	6,728	6,818	6,902
Total	**10,840**	**10,667**	**10,757**	**10,829**	**10,987**	**11,084**	**11,182**

1 The electricity consumption for 2013-14, and 2014-15 are based on Sadler, H. 2018, Past and projected future components of electricity supply to the ACT, and resultant emissions intensity, ACT Government. The electricity consumption for 2015-16 onwards are based on advice provided to PA on 22/01/2018 by the EPSDD.

Table 21. ACT gas consumption to 2019-20

TJ	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Residential – gas[1]	4,342	4,284	4,227	4,285	4,223	4,169	4,116
Commercial – gas[1]	2,491	2,458	2,425	2,458	2,423	2,387	2,346
Total	**6,833**	**6,742**	**6,652**	**6,743**	**6,646**	**6,556**	**6,462**

1 The total gas consumption is SPR 2017, ACT Transition to Net Zero Emissions – Stationary Energy/Buildings, ACT Government, medium reference scenario (SPR, 2017).

Table 22. Per household energy bills

	2013-14	2014-15	2015-16	2016-17	2017-18
Electricity use per household (kWh/yr)	8,097	7,796	7,691	7,581	7,474
Per household spend on electricity ($/yr)	$1,417	$1,267	$1,144	$1,203	$1,428
Gas use per household (GJ/yr)*	35	34	33	33	31
Per household spend on gas ($/yr)	$1,036	$995	$1,013	$1,052	$1,079
Total household energy bill ($/hh/yr)	$2,453	$2,261	$2,157	$2,255	$2,507

* Note that the gas use per household was calculated based on the assumption that 85% of households in the ACT are connected to the gas network (Energy Networks Australia, 2017)