Attachment 5.15
Overview of the Unit Cost Methodology

May 2014

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Contents

1 Introduction

The costs of efficiently constructing and maintaining Ausgrid's supply network have been accurately estimated, and reflect the efficient cost of undertaking the work required to provide a safe and reliable network. This document provides an overview of Ausgrid's unit cost framework, explaining the range of cost drivers, cost methodologies and initiatives in place to ensure that unit costs are prudent and efficient. We demonstrate, at a high level, how we have satisfied the criteria in the Rules with respect to a realistic expectation of cost inputs required to meet the capex objectives.

Cost drivers differ from our peer DNSPs, stemming not only from differences in location and customer base, but also inherited network design and delivery practices. Specifically, Ausgrid has developed a unique model for network service delivery over time to appropriately meet the needs of our customers. Whilst the approach to service delivery is being improved, this will take time to materialise through the 2014-19 Regulatory Period and beyond. Thus, the unit costs must be assessed in this context and interpreted appropriately.

The methodologies used to develop the unit costs vary between capital plans, and in some cases even between programs and projects within them. The most appropriate costing methods have been justified on the basis of data availability, forecast accuracy and various recommendations from the AER based on the 2009-2014 Regulatory Period. We have developed more accurate estimating models where possible, and reached a suitable level of consistency across methodologies.

The majority of capital plans utilise either a bottom-up approach, historical analysis or a cost function model. The accuracy of estimates across the board has improved: methodologies are more thorough, transparent, and have given greater attention to achievable efficiency initiatives.

An outline of the efficiency initiatives incorporated into the unit costs is detailed in Section 5, with descriptions of the improvements in the scope and delivery of projects. The quantification of the savings through this process has been established to demonstrate how the business plans to achieve a high level of service to network customers at an overall lower cost than originally anticipated. It is through the efficiency corrections that Ausgrid plans to meet customer's expectations whilst keeping prices within CPI.

2 Ausgrid Cost Drivers

The cost drivers specific to Ausgrid impact the unit costs greatly. They affect multiple parts of the business and differ to other Australian DNSPs. Independent reports prepared by Evans & Peck[1] and Huegin Consulting[2] describe the cost drivers in greater detail, and also explain the importance of the cost drivers for understanding and assessing the unit costs.

2.1 Evans & Peck: Review of Factors Contributing to Operating and Capital Costs Structures of Australian DNSPs.

A review by Evans & Peck (Document ID43780) was commissioned and presented in November 2012 to contrast cost factors between the companies and to measure Ausgrid against other Australian DNSPs. The Evans & Peck review highlighted an essential principle for interpretation of cost drivers: the acknowledgement of natural cost advantages and disadvantages that skew cost comparisons between companies.

Network scale, reliability levels, environmental conditions, risk appetite and historical management strategies were all identified in the review as cost drivers, and must be considered appropriately to understand the true performance of DNSPs. Exemplifying this, Evans & Peck found that Victorian DNSPs trended towards superior performance relative to

[1] ID43780 - Evans and Peck - Review of factors contributing to variations in operating and capital costs structures of Australian DNSPs
[2] ID00157 - Huegin Benchmarking report for NNSW

the non-Victorian DNSPs, regardless of the measure. The table above was published to indicate the states that may appear to have skewed DNSP unit costs due to natural cost advantages and disadvantages.

Summarising some of the findings in support of the above, it was found that:

- Based on network line length by voltage, Victoria requires fewer resources than other states. This can be traced back to historical factors that have lead to different reticulation systems.
- Victoria has a lower amount of line length per customer, which indicates higher concentrations of the Victorian population along transmission lines and a reduced need for sub-transmission.
- There is significantly lower underground cable per customer in Victoria, indicating that urban environments are less complicated compared to other states. Ausgrid in particular has higher overall value per kilometre of network as a result.
- The mean population growth in Ausgrid's network was 9.24% between 2001 and 2011, with two of the fastest growth areas in NSW located in Ausgrid's region. This is concentrated in highly urbanised areas where the retirement of older assets and infrastructure might be required and maintenance and construction costs are higher.

These highlight the natural cost advantages of Victorian DNSPs and the natural cost disadvantages that impact Ausgrid, which often materialises in the unit costs.

2.2 Huegin Benchmarking Report

Huegin Consulting presented an assessment of Ausgrid's cost driver characteristics compared to other Australian DNSPs[3]. The report compares the cost performance of each DNSP using several different metrics, but also gives attention to the inherent flaws in doing so: for instance the bias and potential misinterpretation of normalised data associated with vastly different distribution businesses.

Despite this, high level observations surrounding costs, cost drivers and their analysis have been determined as follows:

- The diverse operating conditions in Australia favour some electrical supply businesses over others, which ultimately are reflected in respective operating costs. This issue is compounded through the normalisation of only a relatively small number of DNSPs
- The higher population density in Victoria compared to other states affects any "per customer" analysis of costs, ultimately favouring Victoria
- The "per MVA" analysis of costs suffers from the discrepancy of installation and cost capitalisation
- With a large proportion of DNSPs costs attributable to vegetation management, geographical location of the network and workforce mobilisation are key factors, as well as accessibility and for instance traffic.
- The scope and treatment of operating costs varies from business to business, with inconsistency existing when delineation occurs between overheads and operating costs
- Non-system costs vary between DNSPs and the ability for companies to share or allocate costs to different parts of the business can be limited.

These observations indicate the complexity associated with distribution network service provider cost treatment and the need to consider cost drivers and their context. This gives weighting to understanding the operating conditions and challenges with building and maintaining the Ausgrid network in the process of interpreting and assessing all unit costs and their methodologies.

3 Unit Cost Methodologies

In general, three types of costing methodologies were used to estimate the unit costs:

1. Bottom-up estimates
2. Historical models
3. Cost function models

Whilst many are based on established estimating systems, a number of new models were developed to more accurately calculate unit costs for the 2014-19 Regulatory Period. The justification and explanation of the methodologies has been supplied to the AER in supporting documentation within each Capital Plan; these documents also provide data and worksheets to enable recalculation of the estimates as required by the AER.

Where historical unit costs have been utilised as part of the bottom-up estimates or historical models, these have been escalated to constant 2012/13 dollars by CPI only. Escalators for each component of the forecast unit costs (i.e. internal labour, contracted services, materials) have been applied as described in the *Overview of the Cost Escalation Methodology*[4] document.

3.1 Bottom-Up Estimates

The bottom-up approach uses cost components to estimate projects through an aggregation process, based on the scope of work. The estimating systems are in-line with industry best practice, and they rely on data that is constantly validated and updated. The ATAD software package in particular was utilised for a number of network infrastructure

[3] ID00157 Huegin Benchmarking Report for NNSW
[4] ID36536 Overview of the Cost Escalation Methodology

project and program forecasts, with other packages such as the Contract Cable Layer (CCL) Estimator and external contractor estimating systems considered for specific types of Ausgrid works.

Some of the capital plans that rely on the bottom-up approach include:

- Area Plans (or augmentation projects) grouped by region (includes zone substations and sub-transmission substations (Greenfield and Brownfield), transmission and sub-transmission cables, new switchgear, 11kV Load Transfers etc.).
- Replacement Plans (e.g. distribution centres, distribution mains etc.)
- Duty of Care Plans

These are detailed in Section 4 below.

3.1.1 ATAD

The ATAD estimator, an external software package, was developed for electrical contracting work but has been tailored by Ausgrid to accurately assess the costs of network infrastructure projects. Typically used for non-recurrent infrastructure projects (i.e. augmentation works) ATAD was also utilised to estimate unit costs for some recurrent replacement projects.

Both internal and external data sources serve as basic cost component inputs to the system; labour rates (including on-costs and overheads), material costs and contracted services costs that are frequently validated and updated to maintain accuracy. The system is also closely linked to Ausgrid's internal Network Standards.

ATAD estimates were used for cost-benefit analysis and option selection as part of the planning process. As detailed below in Section 4.1.5, ATAD estimates were selected as preferable to CATS estimates (construction cost estimating software) for transmission and sub-transmission cable laying projects.

3.1.2 CCL Estimator

Distribution cable installation projects (up to 22kV) within the Area Plans were estimated through the Contract Cable Laying (CCL) Estimator package, which has a similar bottom-up approach tailored for cable assets. The system is based on competitive contractor rates and incorporates Ausgrid's specifications for laying underground cable: required trench profiles, backfill and reinstatement requirements and so on.

3.2 Historical Models

The use of historical estimating models has been justified where past costs were proven to be efficient. The capital plans in this category contained some of the following elements:

- A higher proportion of fixed costs;
- High (recurring) volumes;
- Minimal historic cost changes (limited scope variation); and
- Stable cost trends over time.

Additionally for two of the three distribution plans (the LV Plan and Customer Connection Plan), the Technology Plan, Reliability Plan, Area Plan strategic property costs and parts of the Non-System Property Plan, these unit costs involve a relatively lower proportion of internal labour costs compared against contracted services and material costs. The models use an appropriate sample of projects to form efficient unit rates for the 2014-19 Regulatory Period.

Functional support from planning, forecasting, compliance and network switching and control (network operators) have also been costed through historical models.

3.3 Cost Function Models

Cost function models are based on mathematical (mainly statistical) approaches to calculate unit costs. Through a base cost or basic unit of measure identified to correlate with a high-level cost, the required forecast could be calculated and projected forward for the 2014-19 Regulatory Period. Such cost function models typically arose where an existing model was either non-existent or inferior.

Noteworthy in this category was the 11kV Capacity Plan (part of the Distribution Plan), with a model created for both underground cables and overhead cables to produce unit costs. In both cases, carefully selected historical data was used to identify the cost relationship, with unit costs consequently produced for each network region based on the load density. This is detailed in Section 4.4.1 below.

Also included in this group was the method used to devise capitalised wages costs. This includes the costs for the Geographic Information System (GIS) group, Network Planning and Network Control (section 4.7.3 below). These forecasts were based on the indexes created using efficient historical base costs.

4 Unit Cost Methodologies by Capital Plan

4.1 Area Plans

The majority of Area Plan unit costs are estimated bottom-up using building block components. This approach is suitable to produce estimates for the 28 Area Plans that each have different augmentation and replacement needs. The following subsections provide an overview of the details provided in the suite of supporting documents to the Area Plans which is inclusive of costing associated with substations, feeders and switchboards[5], transmission underground cable projects[6] and 11kV load transfer support documents[7]. Details of the source data, the estimation software and important assumptions and inclusions that affect the cost estimates are provided below.

4.1.1 Source Data

Each building block is costed individually by asset type or resource within the cost estimating software (predominantly ATAD) and can be based on data from internal or external sources. These include:

- Internally collected actual data from Ausgrid's financial management system (SAP) and historical records
- Historical vendor quotes, period contract rates or supply agreements
- Externally sourced costs from the construction/engineering industry for material costs and contracted services costs

The building block data is stored in a database and is regularly updated to remain current. Furthermore, assets have a labour-time, or actual handling time (AHT) component to determine the total cost including equipping onsite.

The building blocks for the Area Plans are:

- Labour costs (for internal equipping works)
- Contracted Services (mainly civil construction works)
- Materials and Equipment[8]

These can be aggregated to form standard modular subassemblies that are usable across different Area Plans.

4.1.2 Methodology

The methodology for producing unit costs is largely a bottom-up approach based on the scope of work specified. Each Area Plan is different and costed individually, with the process streamlined through the modular subassemblies. The process is as follows:

1. A cost planning check sheet (which forms the scoping document) is developed to guide the estimation process

[5] ID00075 Methodology & Cost Estimates for Pricing Subs, feeders & 11kV switchboard repl V1-9
[6] ID00076 Methodology & Cost Estimates for Costing specific 33kV & 132kV UG feeder projects
[7] ID00077_Methodology & Cost Estimates for 11kV Feeder Transfers for Area Plans
[8] Transmission cables, power transformers, circuit breakers, 11kV Panels, SCADA etc.

2. The building blocks and subassemblies are scaled by work volumes to produce an initial estimate
3. The estimate undertakes peer review
4. A comparison to previous estimates with similar scopes of work is completed, before a final scoping document and a master building blocks spreadsheet is generated
5. A desktop analysis is undertaken: often the full impacts of the site conditions cannot be incorporated, in particular when the site location has not been finalised.

Approaches to estimates have been detailed in the *'9 Volumes'* for the various asset construction arrangements.

As cable work estimates (transmission cables, 11kV load transfers) are highly dependent on the site conditions and route, these are detailed separately below in Section 4.1.5 and Section 4.1.6.

4.1.3 Assumptions and Inclusions

The Area Plan costing process has a number of limitations and also includes and excludes certain cost components to reach an appropriate estimate. The inclusions and exclusions are detailed to define a clear scope of works for the estimates. For whole substations, this usually includes everything within the boundaries of the substation site. Other estimate limitations are due to the availability of data and unknown site conditions, which can impact the accuracy of the estimates generated. This is countered through sensitivity analysis as part of the desktop study.

Table **1** below summarises assumptions that are included in the Area Plan estimates, and also details the consequent impact on the unit costs.

Table 1 Area Plan unit cost assumptions

Assumptions	***Impact on unit costs***
Major equipment (transformers, circuit breakers, HV cables) are sourced using long term orders for periods of up to 10 years	Material component of costs are lowered. Lower design costs through standard designs.
External design costs are based on a percentage of the building value.	Contracted services costs controlled through tender process and market competition
The community expectation for substation external finishes is continually increasing. This requires increased architectural requirements and landscaping	Increased contracted services costs, material costs and internal project management AHT due to increased project delivery time
Project Managers are assigned to multiple projects to efficiently optimise resources and overheads	Reduced labour costs
Project delivery times have increased compared to historical projects due to lengthier community consultation processes, external stakeholder approvals (e.g. local council), compliance requirements etc.	Increased AHT as part of design, planning and project management functions
Ausgrid internal resources used for selected specialised works where Ausgrid retains the knowledge and task expertise	Reduced AHT as a result of work process refinement and optimisation
All civil construction services are subcontracted	Optimal contracted services costs through the competitive tender process.

Additional to the assumptions, it is critical to understand the included cost components that are attributable to Ausgrid's internal processes, estimating system and overall approach to cost estimation. This is important to identify differences that arise when undertaking benchmarking comparisons.

The inclusions are as follows:

- Labour rates include overheads and labour on-costs. These rates are updated regularly for the purpose of estimating.
- Labour, design and project management costs are benchmarked and adjusted against historical data to determine actual handling time of tasks
- The cost of materials can include supplier labour, supervision costs and transportation costs

The overheads allocated to projects are specified as per Ausgrid's Cost Allocation Method (CAM)[9].

4.1.4 Brownfield Projects

Brownfield projects, or work within or in close proximity to live substations, incur additional costs as a result of the heightened safety requirements, limiting site conditions, the requirement to maintain supply whilst construction is carried

[9] ID45457 Ausgrid Cost Allocation Method

out and also staging of works. Whilst Greenfield sites are preferred, they are not always viable or available. Some of the cost impacts are listed below:

- Project schedule lengths often increase and the need for overtime can be unavoidable due to seasonal system outage windows (for instance during lower system loads in spring or autumn) and also daily outage windows;
- The civil works scope can be smaller, but it can also take longer due to outage constraints and the necessity to stage the work;
- Safety costs increase, with the need for a dedicated Ausgrid supervisor (a Risk Mitigation Technician) required when third parties undertake work within Ausgrid substations;
- Internal and external training requirements for access contribute to the safety compliance costs;
- Equipment limitations can apply due to minimum safe distances and clearance requirements. This compromises productivity with a necessary focus on safe work practices. This significantly impacts excavation works, concrete pouring tasks and equipment used for access such as scaffolding. This is important to minimise the risk of inadvertent tripping of adjacent equipment;
- Outage planning: typically outage lead times are at least six weeks. Outages may suddenly be cancelled due to weather, high load or reliability. This severely impacts coordination of works and results in costly delays; and
- Staging of works to maintain supply or to ensure structural integrity of buildings, which can often require expensive temporary arrangements.

These elements have been included into the estimates of the known Brownfield projects for the 2014-19 Regulatory Period where possible, based on the assessment of historical issues experienced.

4.1.5 Transmission Cables

Transmission cable works were estimated through ATAD, incorporating detailed route design specifications. Unlike substation infrastructure, transmission cables traverse various built environments, thus the approach to estimating the costs is a combination of a bottom-up estimate and a model approach to incorporate different price factors.

There is a strong focus on the route path with continually changing site conditions (geotechnical specifications, traffic, council requirements), and also construction limitations and reinstatement requirements.

The basic building blocks include the civil works, cable supply and installation, structures (e.g. cable tunnels), underground to overhead connections (UGOHs), finishing or reinstatement works, and project preliminaries (or indirect costs). These feed into the estimation process:

1. The cable to be replaced or newly installed is firstly identified
2. Cable rating, type, size and trench profiles are confirmed from design groups
3. Preliminary routes are identified and costed using ATAD
4. A value engineering process is undertaken to identify the optimum solution
5. The final route is re-estimated with greater detail using the following:
    - Confirmed geotechnical details, traffic conditions and existing services along the route
    - Civil works required: priced using historical information
    - Cable supply and installation prices: extrapolated from market tenders
    - Pavement reinstatement costs: based on Ausgrid's internal rate
    - Asset decommissioning requirements: based on internal resource rates
    - Project management costs: priced on project duration and average unit time cost
6. A Monte Carlo simulation is then undertaken for different scenarios to produce a specific price with a known confidence level that is based on identified risks

The estimates have been benchmarked against modelling undertaken by an external contractor using the CATS estimating system (the 'CATS estimates'). CATS is designed for construction cost estimation but was appropriated for cable laying works to determine the lowest cost cable route. Analysis of the cost components and total costs showed that the CATS estimates were higher than Ausgrid's ATAD estimates for the same projects.

4.1.6 11kV Load Transfers

Load transfers of 11kV feeders involve the installation of new conductors between substations to shift load. They are crucial for the Area Plan projects, allowing customers to remain connected to the network whilst augmentation and replacement works are undertaken. They are also necessary as Ausgrid's network has limited spare capacity to transfer load through existing wires and switches with the radial network outside of the CBD.

Similar to transmission cable estimates detailed above, 11kV load transfer costs are determined by the site conditions along the new route, and therefore are costed using a tailored bottom-up model approach. The load transfers fall into one of four categories: urban (non-CBD) underground load transfers; CBD load transfers; standard connections to new switchgear; and overhead load transfers.

Overhead 11kV load transfers only form a minor portion of the total 11kV load transfers within the Area Plans; these have not been detailed and are costed case-by-case by the regional operation groups.

A. Urban (non-CBD) underground load transfers

   Urban underground load transfers are based on an estimating model that is largely bottom-up, with consideration of the route characteristics and historical cost data. Building block input costs are sourced from each regional operations group.

   The process for estimation can be summarised as follows:

   i. The load to be transferred (excluding load transferrable to the existing network) is specified, and the load per cable available is determined (typically based on summer cable ratings)

   ii. The cable route is broken down into multiple sections for costing, with each section specified and costed with regard to the following:

      - installation difficulty (detailed further below)
      - cable length required, cable volumes and joints needed
      - cable rating and duct arrangement (higher material costs to avoid cable derating), and utilisation of existing ducts
      - major road and railway crossing requirements
      - cable joints required, including underground to overhead pole requirements (UGOHs)
      - Number of 11kV circuit breaker terminations, including protection materials required and triplex cable for termination

   iii. Design, project management and commissioning management costs are based on an empirical formula relying on a base cost, cable volumes (the average number across all sections) and route length

   The difficulty levels are categorised by construction (including excavation) requirements, site conditions (traffic control for vehicles and pedestrians), and site access (e.g. permits and night work requirements). There are five difficulty levels altogether, with two variations headlined by 'footpath' installations, another two variations for roadway projects and last associated with main (RMS) road installations.

B. CBD Strategic Load Transfer

   The model for CBD 11kV load transfers is similar to non-CBD load transfers, with the addition of construction elements unique to the CBD. The unit costs include associated costs that are incurred as part of the works; for instance they amalgamate project management costs, design, traffic management, site access (confined space, asbestos removal) costs and other specific cost elements into the unit costs. The key differences to the non-CBD unit costs are outlined below:

   - A standard unit rate for triplex cable pulling (no segregation between difficulty levels). The cables used have a smaller bending radius, appropriate for the congested CBD environment
   - A standard duct installation arrangement (i.e. a 16-way ductline) cost. This includes a portion for excavation and spoil disposal, as well as thermal stable backfill (TSB) to maintain thermal resistivity.

- Cable jointing for triplex cable, including the jointing of pilot cables
- A cost element for asbestos duct removal, usually necessary to make way for new ductlines.
- Replacement of 2-way isolating and earthing switches with three-way ring main isolators: these reduce the need for jointing work, reduce the pit size required and improve CBD network connectivity
- Pit installations or enlargements
- Stringent permitted working times (night work requirement) and dampening construction noise
- Congestion due to other services and assets within the CBD, as well as obstructions
- Heritage and archaeological requirements, including surface restoration requirements (e.g. decorative stone paving). The latter can sometimes require a premium to be paid for reinstatement.

Many of the unit costs are developed using ATAD or CCL (see section 3.1 above), and are determined using a weighted average of selected contractor schedule of rates and lump sum charges as inputs. It is estimated that approximately 90% of the unit rates are based on the market.

C. 11kV Load Transfers between Old Switchgear and New Switchgear

This category of load transfers is based on historical project costs, with separate unit costs depending on the switchgear locations. There are four categorisations used, with each based on different data sets and historical project samples to arrive at unit costs for the work:

i. Load transfers to new switchgear on adjacent sites

ii. Load transfers to new switchgear on the existing site

iii. Load transfers to new switchgear in the same building

iv. Load transfers to new switchgear in locations to be determined

For (iv) above, these are estimated based on samples of historical projects.

4.2 Strategic Property Plan

The strategic property plan is aligned with the Area Plans, detailing site requirements (as well as disposal and remediation of sites) for zone substations, sub-transmission substations and also sub-transmission switching stations. The costs generally exclude easement costs unless they are known, and vary based on location.

Sites are costed based on the land size required, using a dollar per square meter value. This metric varies depending on whether the site is a rural, urban or CBD site, and also differs between Sydney and the Hunter region. The rates are approximated using historical data.

4.3 Replacement and Duty of Care Plan

The Replacement and Duty of Care Plan unit costs largely align with those used in the Area Plan estimates, with each having similar building block costs for network asset components. ATAD and the CCL Estimator are used to develop the unit costs for each year of the 2014-19 Regulatory Period.

The costs in this plan are driven by the need to operate a safe network and maintain reliability, and also meet legislative and compliance obligations. The unit costs are detailed with a cost for contracted services, materials and labour (including overheads and on-costs). The unit costs for this capital plan also take into account:

- A separate cost for reactive work and planned work
- Integration of site specific costs: there is the ability to vary for individual site or regional differences, when for instance travel time or site conditions are known
- Benchmarking against historical project information: where available, costs were compared to historical unit costs.

The separate unit cost for reactive and planned work is the result of a refinement to the option selection process. This process has a high focus on risk management, and more options to undertake maintenance and refurbishment where feasible.

4.4 Distribution Capacity Plan

The Distribution Plan covers augmentation works for the 11kV network and low voltage 415V network, including works associated with new customer connections. The Distribution Plan is split into three separate plans: the 11kV Capacity Plan, the Customer Connection Plan and the Low Voltage Plan. These plans all utilise a cost-function model, derived from a sample of historical projects.

4.4.1 11kV Capacity Plan

The 11kV Capacity Plan covers the installation of new 11kV underground cables and overhead conductors for the augmentation of Ausgrid's network. The plan is predominantly comprised of non-CBD 11kV network augmentation works and is thus the focus of this section, with other components of the plan detailed in the latter part of the section.

The 11kV Capacity Plan is predominantly driven by customer load growth. This implies that project specific estimates are not possible with load growth projects forecast only two to three years in advance. Thus, a statistical cost-function model (referred to as the Augmentation Model) is used to derive the cost per kilometre of the non-CBD 11kV capacity works. This differs to the bottom-up costing methodology used in the Area Plans for 11kV load transfers (see subsection 4.1.6).

The Augmentation Model was designed with the following aims:

- To provide a portfolio or program level model rather than a project specific costing method
- To meet the requirements of Schedule 1 of the Design Planning Criteria, as part of the Licence Conditions
- To consider cost variations and complexities of different supply areas
- To include, where possible, the use of spare ducts
- To determine an efficient, generic 11kV trench profile (i.e. the optimum ductline arrangement)

These were addressed by analysing samples of representative historical projects and using global asset data from various sources where available. Strong relationships between cost and area load density were identified for internal labour (including reinstatement costs) and contracted services components, with optimum spare duct usage and trench profile installation derived from historical global Geographical Information System (GIS) data. Material costs, which make up only a small proportion of the total project cost, were included using generic cost data.

Ultimately, a strong correlation was identified between the total cost per kilometre of installations and a location's load density (per square kilometre). This provided unit costs for each network region, with separate unit costs for underground installations and overhead installations.

As for the other sub-programs of the 11kV Capacity Plan, these are detailed below in Table 2.

Table 2 11kV Capacity Plan sub-programs

11kV Capacity Sub-Programs	Cost Methodology
CBD 11kV capacity reinforcement	Based on historical project costs
Works from the current regulatory period (*First Review Work in Progress*)	Bottom-up planning estimates
Fault level works	Based on historical project costs
Voltage regulation works	Based on a historical percentage of total capex
Distribution substation loop-ins	Based on a historical percentage of total capex

Furthermore, there are three components of the 11kV Capacity Plan which make adjustments for forecast expenditure accounted in other capex plans, as well as an adjustment for demand management projects. See Table 3.

Table 3 11kV Capacity Plan adjustments

11kV Capacity Plan Adjustments	Cost Methodology
11kV Connection overlaps	Based on the removal of the Low Voltage Plan and Customer Connection Plan ‘connection cabling’ components
Area Plan 11kV Synergies	Based on a historical percentage of 11kV capacity constraints resolved by subtransmission projects
Project Specific 11kV Demand Management	Based on a historical percentage of Demand Management Opportunities

4.4.2 Low Voltage Plan

The Low Voltage Plan is a network augmentation plan for assets predominantly driven by customer load growth at the low voltage level (400V phase-to-phase). The costing methodology utilises a top-down approach to determine unit costs based on historical project scopes; similar to the 11kV Plan, specific LV projects are difficult to determine in advance and thus bottom-up project estimates are not possible. Furthermore, a top-down approach was used to counter:

- The inability of a bottom-up cost to capture available capacity of surrounding assets which can form part of the reinforcement solution
- The inability for bottom-up costs to forecast material variances between similar works

The unit costs feed into the costing model (the Low Voltage Fix-Mix model).

In total, over 700 historical projects were categorised into 52 detailed unit costs. Historical projects are categorised according to the following categories based on historical expenditure:

1. Mains requirements
2. Infrastructure required (e.g. substation type needed)
3. Site conditions
4. Network region

These categorisations translate into a set of unit costs for the upcoming regulatory period based on generic project scopes, with each of Ausgrid’s network regions having their own costs associated with the set of generic project scopes.

The project scopes are profiled as follows:

1. New kiosk substation installations with either a large, moderate or small amount of mains required (amount of mains is a significant driver of costs)
2. New pole substations with either a large, moderate or small amount of mains required
3. Mains only – either a large or small amount required
4. Chamber substation (only one for each region due to a limited sample of projects)
5. Single generic unit costs per region for the following:
    a. Equipment uprating
    b. Substation refurbishment
    c. Low voltage load transfer

These underlie the LV Plan forecast when applied to projected volumes of work.

4.4.3 Customer Connection Plan

The Customer Connection Plan uses a similar methodology to the Low Voltage Plan unit cost method, but differs due to the cost drivers. Similar to the LV Plan, a Fix-Mix model of fix-type connection solutions is used, with each defined by a scope of work determined through typical historical projects recorded in the 2009-14 Regulatory Period.

The drivers for this plan are dependent on the connection type, size and type of customer (i.e. residential or commercial customers). On a basic level, connection unit costs vary between underground and overhead, with the size of connection determining the Ausgrid-funded portion of the connection cost.

For 2014-19, the Customer Connection Policy has been revised and this influences the portion of costs customers are expected to pay: this mainly applies to customer connections that require high capacity installations. The details of this new policy are beyond the scope of this document, with further information available in the Customer Connection Plan supporting documentation.

4.5 Reliability Plan

The Reliability Plan forecasts capital investment to maintain or improve reliability as required by the Licence Conditions applicable to Ausgrid.

With reliability improved with capital investment in other capital plans (for instance through asset replacement programs), the Reliability Plan targets assets that were identified additional to these already covered. These assets were identified as individual feeder works and individual feeder segment works.

These use a common set of unit costs which are based on historical cost averages from the 2009-14 period.

4.6 Technology Plan

Technology Plan projects and programs are costed bottom-up, with unit cost inputs largely based on historical project costs, vendor quotes, vendor contracts and IT industry benchmark costs. Projects and programs vary in their labour, contracted services and materials (i.e. software, hardware and associated facility requirements) requirements, which justifies the need for a bottom-up approach to capture the variability.

The cost components are specific to the Information, Communication and Technology (ICT) division, and are summarised below:

a) Labour – costed based on historical costs, and compared against IT industry costs. The model also specifies costs for external labour hire to enable resource scaling on a needs basis.

b) Hardware costs – predominantly for servers, storage and network requirements, these were costed depending on the hardware needed. For instance, server costs and storage costs are based on revised vendor contracts.

c) Software costs – sourced from existing contracts, vendor consultations or negotiations and also publicly available information. Larger projects have been determined through vendor consultations.

d) Facilities Maintenance – includes a variety of contracted services required by ICT, ranging from planning and design to required future needs. These are based on existing contracts from vendors.

These cost inputs are applied through a costing model which is based on the forecast project cost: projects are categorised as small, medium or large which consequently determines the labour and contracted services requirements. The methodology also uses a generic split of project expenditure across the project lifecycle in order to determine cashflow.

Forecast adjustments are made on a project-by-project basis, taking into consideration factors such as interfacing requirements, remediation requirements, implementation costs related to new technology and other infrastructure needs.

4.7 Other Support Capex Plans

4.7.1 Non-System Property Plan

The Non-System Property Plan includes projects to construct assets for Ausgrid personnel and equipment: offices, depots and other specialist sites (warehouses, storage yards, amenities, garages, parking etc). These are costed two different ways depending on the scale of the property:

a) Major property projects (including depots and office buildings): costed bottom-up

b) Minor property projects – (smaller depots, offices and specialist sites): costed bottom-up

c) Compliance and service upgrades : based on historical costs

The costs are made up of Ausgrid labour resources for project management and supervision, electrical fit out and IT installations, with the remainder externally contracted labour resources (design, construction, internal fit out etc). Materials costs are sourced from industry published prices.

The bottom-up costs were produced by an external quantity surveyor.

As for the compliance and service upgrade estimates, which forms only a small portion of the Non-System Property Plan, these are based on historically recorded costs captured by Ausgrid.

4.7.2 Non-System Fleet & Plant

The non-system fleet and plant costs have been streamlined across the three Networks New South Wales businesses in order to maximise savings for customers. A key change has been the standardisation of requirements between NNSW businesses, as well as policy changes (see Section 5 for further details).

The costs are predominantly derived from vendor contracts and quotes, with forecasts for specific plant based on historical costs.

4.7.3 Capitalised Wages

Internal work groups that provide professional services for Ausgrid's forecast capital program are captured as capitalised wages. The projected costs are capitalised to assist with the smoothing of required revenue and to minimise price shocks for customers, with the costs spread across relevant capex plans.

In general, the forecasts use a range of allocation methodologies to designate capitalised wage costs to individual capital plans. Many are based on either historic or forecast expenditure of relevant capital plans, which may be accompanied by other allocation methods depending on the professional service provided.

The methodology used by each service category is described in further detail below.

4.7.3.1 Network Control

The function of network control is to analyse when access to the network is possible, process network access requests from the field and schedule the switching of the network as required. They are responsible for the security of the network, the safety of those working near or around equipment and also the reliability of the electricity supply. The Network Security group and the Control Rooms co-ordinate network outages required to undertake work, and also assist with restoring the network to its normal state once the work is complete.

The costs associated with these functions are based on historical cost information, which are then projected forward using capital expenditure forecasts. The estimation is undertaken as follows:

1. The capex related expenditure for Network Control activities from FY2013 was extracted from Ausgrid's financial accounting system

2. An index for each forthcoming regulatory year is created by dividing the total Ausgrid forecast capex for the respective year by the base Network Control FY2013 expenditure.

3. The base FY2013 expenditure is multiplied by the index for each year, resulting in a forecast for each year.

This approach allows the Network Control capex to scale as required, tracking project and program costs on the assumption that Network Control capex costs are all variable. It should be further noted that Network Control costs are predominantly labour costs.

4.7.3.2 Network Planning

Network Planning forms part of Ausgrid's Engineering division and is involved in the long term planning of Ausgrid's network in accordance with the National Electricity Rules. Costs are incurred by activities that comprise the following programs:

- Network Planning (note this is the name of a program as well as the name of the overall group)
- Maintenance and Replacement Planning
- Investment Management
- Planning Capability Development

Differing to Network Control costs which are assumed to be 100% variable, a number of Network Planning costs assume a fixed cost component as well as a variable component. Each Network Planning activity has a variable cost proportion (either 100%, 50% or 0%) which has been established based on the analysis of historical costs, and is qualitatively justified.

The fixed component is set by scaling the FY2013 expenditure by the fixed cost proportion. This is summed with the variable component, which also uses the FY2013 expenditure for Network Planning, scaled by the variable cost proportion and forecast project expenditure index (calculated using the change in value of annual capex forecast compared to the base year FY2013 for each relevant capital plan and each forecast regulatory year).

4.7.3.3 GIS Data Capture

Forecast costs associated with Geographical Information System (GIS) services are spread across several capital plans, with the service relied upon heavily in the planning and designing process of projects as well as data recording following any augmentation to the network.

The capitalised wages are based on a fixed cost component and a variable cost component. The fixed component is related to data quality services provided, and is determined based on historical cost centre expenditure from FY2013 actual data. The variable component is indexed using respective capital plan historical expenditure, and is also tied to Ausgrid's planned capital forecasts in order to reflect and real decreases.

Furthermore, the variable component tracks transmission and distribution expenditure separately to more accurately reflect GIS forecast expenditure. This was established through recorded GIS data of constructed, commissioned and decommissioned conductors from the current regulatory period.

4.8 Tools and Equipment

Ausgrid's costs for tools and equipment are based on historical expenditure modelling, with an efficient cost base established from the current regulatory period. The tools and equipment are typically required for:

- Construction, repair and maintenance of the network
- Safe work practices, and operation within equipment limits
- Testing of the network
- Responding to emergency network incidents 24/7

The category includes smaller testing instruments through to large diesel generators and heavy duty hydraulic crimping heads. It also includes technical survey stations and high voltage live work insulating gloves.

The efficient cost base is justified through the competitive tendering process, direct vendor supply and also the collection of competitive quotes prior to purchase.

5 Efficiency Initiatives

The unit costs have been made more efficient through several top-down initiatives, complemented with project and program level changes where identified. Recognising the need to balance efficiency with prudency, opportunities to lower costs were assessed to ensure that the appropriate level of service can be maintained.

5.1 Strategic Prioritisation of Area Plan and Replacement Plan Projects

The initial set of Area Plan and Replacement Plan projects underwent a prioritisation process to identify the most critical works required as part of Ausgrid's capital investment. In essence, this process has refined the scope of work which directly impacts the unit costs, as the majority of Area Plan and Replacement Plan works were estimated bottom up.

A prime example is the prioritisation of the Gas and Self Contained Fluid Filled (SCFF) oil filled cables which are now a superseded technology. These have been assessed based on historical defects and service risk, especially with many of these cables forming part of the backbone of Ausgrid's sub-transmission network.

5.2 11kV Area Plan Load Transfers: Refined Approach

The forecasting and planning of 11kV load transfers has been improved for the 2014-19 period with the development of a more refined approach to the needs and consequent costing of the needs. This in turn has streamlined the planning process: an improvement of the deliverability of the planning function as well as scope refinement.

The new estimation process is headlined by the following changes:

- A refined costing method and approach for planners

- Estimation based on more detailed route identification where possible – estimates were previously based on approximate distances between required zone substations or load centres
- Cable requirement specifications: a new approach has been determined to outline the need for additional cables per duct bank. This revision will eventuate in an improved scope of work
- Cable route breakdown: planners now have the ability to account for cost variations that may apply along the cable route
- More detailed unit rates reflecting real costs of works for:
    - Cable and duct installations, as well as various duct arrangements
    - Connection costs - previously assumed to be a percentage of the total project cost
    - RMS road crossings - a more accurate approach has been used to determine the cost of road crossings. This was established through historical analysis of road crossing types
    - CBD installation costs - previously based on high level cost per capacity approach, the new method is more in line with the detailed non-CBD costing method

5.3 Replacement and Duty of Care Plan

The Replacement and Duty of Care Plan includes several new efficiency initiatives that will improve the deliverability of the plan. As there are large volumes of (repetitive) work projected, deliverability is a key factor which will drive costs downwards.

Pre-existing initiatives that commenced in the 2009-14 period and will continue through to the next Regulatory Period include:

- The maximisation of traffic control resources: this has resulted in an increased focus on suitably selected traffic control (contracted service labour) for the task required. Also where applicable Ausgrid has trained internal staff to assist with short-term traffic control needs
- The Common Planning Platform (CPP): Ausgrid developed a platform that displays a range of proposed work activities by geographic location. This results in improvements in scope and deliverability, with better scheduling increasing productivity. Works planners and schedulers are now able to have a detailed view of all outstanding work to be delivered, together in an integrated mapping platform. The collaboration also has resulted in huge improvements in the visibility of work between different parts of the organisation.
- Improvements to the project planning process: continual improvements to the planning of large works through new lessons learnt. For example, access and egress for both transmission and distribution networks from zone substations; avoiding high cost routes along RMS roads, avoiding routes with high risk planning and approval requirements including National Parks, Crown Land and private property unless worthwhile cost savings can be achieved.
- Negotiated a Memorandum of Understanding (MoU) with RMS: this MoU had a large impact on the deliverability of works, reducing the minimum cable depth of cover from 1.5m to 1m. This lead to savings in excavation, shoring, spoil disposal and also improved project delivery timeframes. Furthermore, Ausgrid was able to negotiate more cost effective options with regard to accessing RMS roads for cable installations (open trenching vs. costly boring).
- Reinstatement requirements: Ausgrid was able to negotiate more cost effective reinstatement rates than published by local councils and the RMS. This improved the deliverability of works.
- Greater use of trial holes: as part of improvements to planning and scope determination, cable route options were validated by trial holes. This enabled higher access to footpaths rather than RMS roads for installation.
- Proving existing ducts and the removal of out-of-service cables: where feasible, Ausgrid has increased the use of existing ducts which removes the need to excavate.

Supplementing these initiatives, for 2014-19 a number of new initiatives will come into effect:

- Greater access to the Low Voltage network: a process is in place to streamline access to the low voltage network, removing the need for labour intensive isolation procedures to meet WH&S obligations. The proposed solution maintains safety to staff and public while implementing engineering improvements to expedite access.

- Network operating by field groups: a roll out of limited network operating by field staff is being implemented to improve the access to the network, which consequently improves the deliverability timeframes of work.
- Mobile device platform solutions: deliverability of works is being improved through the provision of information to field staff in confined geographic areas. This is being implemented in addition to enhancements to the field information recording process.
- Internal benchmarking to drive productivity: greater analysis of productivity and performance is being implemented to feedback to work groups and improve the financial accuracy of programs of work

These initiatives are not limited to the Replacement and Duty of Care Plan, and apply to the majority of work crews operated by Ausgrid.

5.4 Low Voltage Plan and Customer Connection Plan: Estimation Improvements and New Customer Connection Policy

The LV and Customer Connection Fix-Mix models used to estimate the 2014-19 capital requirements were designed to drive improvements in the business-as-usual processes that underlie the works, ultimately improving the planning function (refining the scope of works) and also benefiting deliverability out in the field.

Specific initiatives for the Low Voltage Plan surround the provision of solutions at the lowest cost that permanently resolve the overload in the long-term.

For the Customer Connection Plan, to more closely align Ausgrid's capital expenditure with other DNSPs, Ausgrid has reviewed the Customer Connection Policy and made adjustments to Ausgrid's funding of customer connection works. Specifically, Ausgrid has placed a cap on funding customer connections: high-consumption customers will be required to fund part of for their connection.

5.5 Fleet and Plant – Policy Change

The Fleet and Plant Plan includes several improvements to the procurement of fleet. A new policy is being determined which is aimed at improving the efficiency of the fleet, ensuring that Ausgrid can continue to construct and maintain the network for the lowest possible cost.

The initiatives include the following:

- Standardisation of fleet across the three NNSW businesses: this will allow significant savings with greater buying power. This will reduce the number of standard specifications for fleet fit outs allowing a longer term favourable arrangement with suppliers
- Increased market testing and contracting out of fleet related services and procurement
- Revision of the standard asset lives of fleet: a scope change to the maintenance of fleet will include more refurbishment and thus longer fleet retention. This initiative was a finding based on average historical costs used for refurbishment works, but is also dependent on the availability of favourable market contracts.
- Revisions to the replacement of fleet: new criteria are being applied when assessing the need to replace fleet.

Details of the new Fleet Policy is beyond the scope of this document, but is available as part of the supporting documentation to the Fleet Plan.

5.6 Overhead Cost Allocation

The expenditure and accounting treatment of company overhead costs was reviewed as part of Ausgrid's Cost Allocation Methodology (CAM) preparation for the AER.

Whilst details of the overhead reductions are beyond the scope of this document, in general, new governance is ensuring that overheads more stringently address business needs in the future. This is complemented with improvements to the financial system to allow for greater monitoring and control of overhead expenditure.

5.7 Capex and Opex Trade-offs

Where reasonable, Ausgrid has identified opportunities to maintain or repair assets rather than replace or upgrade them when economically feasible. This not only applies to network assets, but assets that support the network: IT equipment and software, plant and tools etc.

Where maintenance or repair was not the preferable option, proposed value engineering ensured that the best option for replacement or augmentation was included in the forecast.

6 Conclusion

The unit costs are a significant input towards the capital expenditure forecast, and thus have been calculated and justified to be as efficient and prudent as possible. They reflect many of the cost drivers to the business, but there are also efficiency initiatives in place to put downward pressure on costs to customers in the forthcoming Regulatory Period. Costing methodologies have been assessed to accurately reflect realistic costs, and have also been improved to ensure that the capital forecast is sustainable and maintains the level of service that customers expect.