TONGA POWER LIMITED

SMART & PREPAY METERING

Confidential to Tonga Power Ltd

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POWER BUSINESS LIMITED

PO Box 109628
Auckland, New Zealand
info@powerbusiness.co.nz

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1. Executive Summary

This report is on the viability of prepayment metering and the introduction of Advanced Metering Infrastructure (AMI) for the Island of Tongatapu. Tonga Power Limited (TPL) is seeking to improve the returns to the business by introducing prepayment meters that should almost eliminate the relatively high number of disconnections each month and at the same time reduce the levels of bad debt and improve TPL's cash flow.

AMI affords not only significant reduction in both technical and not technical losses but it provides a foundation from which TPL can support the growing introduction of renewable energy sources connecting to the TPL grid. AMI would also provide for the introduction of a range of demand side management solutions that would benefit the consumers and TPL.

Power Business Limited (PBL) with the assistance of TPL have established that the benefits of a prepayment system for 3,000 Tongatapu consumers amount to some TOP750,000 pa. Whereas the costs of a prepayment system are approximately TOP1.1m with ongoing operating costs of TOP150,000 pa. When these costs and benefits are evaluated in a DCF model it is established that the post-tax return of 54%. This high return suggests that TPL should proceed with electricity prepayment to encourage those consumers who struggle to manage their electricity consumption in relation to their income.

Two AMI options that include 3,000 prepayment ICPs have been evaluated utilising (i) GPRS and (ii) RF Mesh communications technologies and both these options are viable. In particular the GPRS option is outstanding but this must be tempered with the caveat that the longevity of support for GPRS needs to be confirmed by Digicel in writing. The benefits of AMI and prepayment to TPL have been assessed at TOP2.04m pa. The GPRS economics produce post-tax return, without recourse to debt financing, of 24% for an outlay of TOP5.6m and TOP735,000 pa opex. The RF Mesh economics produce post-tax return without recourse to debt financing of 11% for an outlay of TOP6.2m and TOP1.2m pa opex.

From the work completed to date it is clear that the network benefits are sufficiently large to enable TPL to transform the existing network towards that of a modern smart grid and at the same time improve the commercial performance of the business for the benefit of both TPL and its consumers.

2. Introduction

Tonga Power Limited ("TPL") has 17,000 residential and 4,000 commercial customers on its electricity network throughout the Kingdom of Tonga.

TPL is interested in understanding the potential options for replacing its installed meter stock, with a view to improving the credit management of its business, and potentially accessing the functionality of smart metering technologies to improve the operation of its business.

Currently TPL disconnects close to 6% of its customers each month for non-payment of electricity charges and is not able to recover the full cost of disconnecting and reconnecting these customers.

Theft and meter bypass/tampering are also significant revenue protection challenges faced by TPL that suggest some form of prepay metering solution would have a meaningful impact on the payment behaviour of its customers.

In addition to these specific revenue protection issues, TPL recognise that it has a range of wider requirements including the move to more sophisticated tariffs, the ability to deal with distributed generation and remote monitoring and/or enhanced control of certain elements of its network which could be achieved through the use of Advanced Metering infrastructure (AMI).

TPL's challenge is to find a suitable technology solution to its multiple requirements that provide for some level of future proofing, while at the same time dealing with the company's specific issues relating to revenue protection.

2.1 Terminology

Terminology used in this report:

AMI – Advanced Metering Infrastructure a system comprising an electricity meter with inbuilt telecommunications modem that communicates via an air interface to a remote headend.

Headend – an application with a communication layer and database that manages the fleet of Smart Meters, performs data collection, remote load control, events detection/alerting, events log collection, firmware upgrade, commissioning and other operational functions.

Smart Meter – also known as Smart Meter that are capable of real time remote reading with integrated Time of Use (TOU), connect/disconnect, power quality logging amongst other functionality.

Legacy Meters – conventional non-half hourly meters currently installed on TPL's network

MDMS - Meter Data Management System is an application component of the AMI architecture that has its own database to manage receipt of data collected by the head-end, storage, validation, editing and estimation. This component is responsible for delivering billing reads services to a billing system. There is a range of functionalities that have been built on top of the traditional MDMS such as load control service interface with the head-end, events data management and delivery among others.

Standalone Prepay Meter – mature technology meters with programmable business rules that enable self disconnection/reconnection by consumers meters where the business intelligence reside in the meter and there is no connectivity between the meter and the back office system that maintains the prepayment history of each meter. These Meters that have been built to perform the prepay meter functionalities of credit management based on configured tariff stored on the meter, automatic disconnection and reconnection based on the meter's remaining credit balance as per the configured emergency credit threshold. The meter is energised and topped up with credit by keying-in several digits called token.

3. Scope of this report

TPL has engaged Power Business Limited (PBL) to assist it determine and prioritise its business requirements now and in the foreseeable future and to determine an appropriate technology set and implementation plan to meet those requirements.

As an initial step TPL has requested that PBL develop a high level business case for both a standalone prepay solution and a more strategic AMI solution to enable TPL's board to determine the merits of a more detailed business case exercise.

Accordingly the scope of this work is to:

- Determine TPL's existing business requirements together with those it anticipates in the foreseeable future;
- Describe the core solution options that would enable TPL to meet those requirements;
- Estimate the costs associated with each of solution options based on indicative pricing from vendors and PBL's experience of implementing these solutions;
- Identify and quantify the likely benefit streams associated with each of the solution options using cost data and asset management knowledge provided by TPL; and
- Present a high level business case comparing the solution options and a recommendation of which option is most likely to best meet TPL needs and warrant further analysis.

4. Tonga Power Requirements

TPL’s requirements are both short term and long term. In the short term TPL wishes to:

- reduce the number of non-payment disconnections;
- reduce bad debts; and
- increase the revenue assurance associated with the distribution and sale of electricity.

In the longer term TPL wants to:

- significantly reduce technical and not technical losses;
- move to a TOU tariff regime under the existing tariff cap that rewards use of power in non-peak periods with a lower tariff; and
- transform the existing network into a smart grid network that supports increasing use of renewable generation sources.

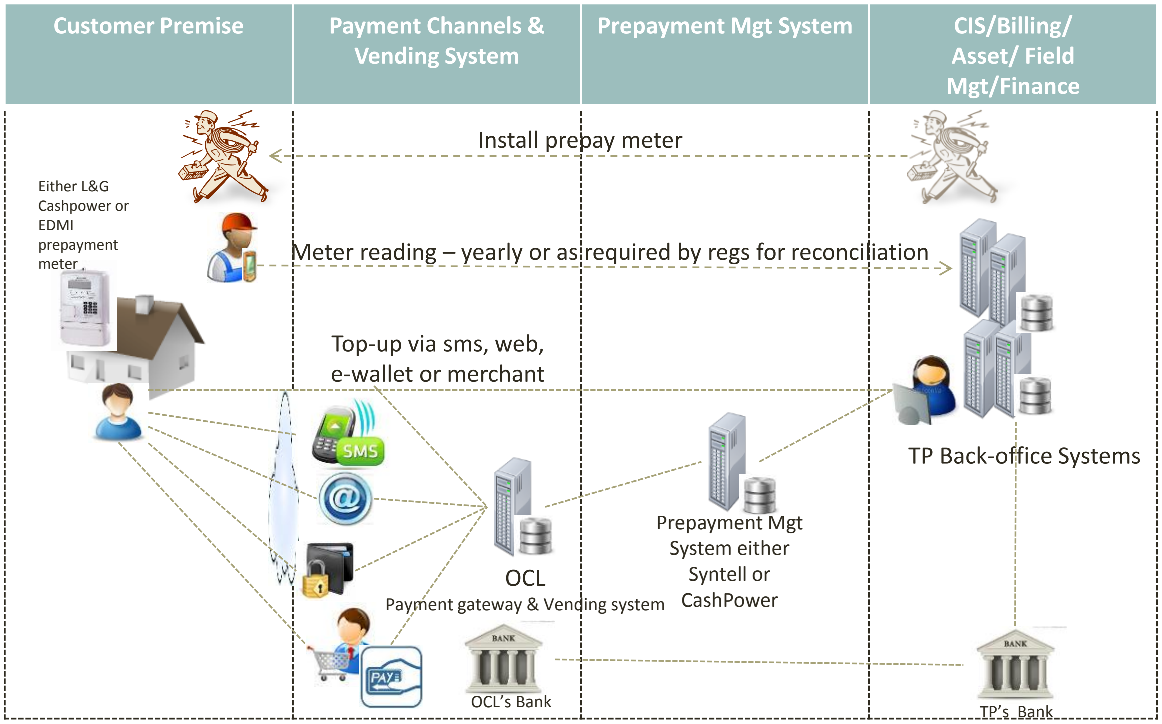
5. Core Solution Options

To address TPL’s requirements, two core solution options have been evaluated. These are presented in terms of conceptual architecture with corresponding candidate solution models to enable costing.

5.1 Standalone Prepay

The standalone prepay solution architecture presented in the diagram below builds on the key components of a prepayment meter, several vending channels and a back-office vending system, back-office prepayment management system that integrates with TPL’s ERP (CIS/Billing/Field Orders/Finance systems). The diagram likewise reflects the potential vendors for each of the components.

A high level description of the solution steps through the end-to-end process from procurement, provisioning, prepayment top-up, disco/reco, reading reconciliation, payments reconciliation and faults management.



5.1.1 Procurement of prepaid meters

Prepaid meters procurement is assumed to follow the standard PR/PO and goods receipt process of TPL.

Specification of what TPL would require to be presented on the faceplate of the meter, serial number or supplementary asset numbering, logo and tariff configuration set-up are all included as part of requirements specification pre-manufacturing phase.

5.1.2 Provisioning of prepaid meters

The provisioning process is assumed to follow TPL's standard customer sign-in and field orders process with extension of specific steps for prepaid metering set-up as follows:

- Either TPL offers the customer to move to prepaid electricity plan as part of Credit Management process or customers request TPL's prepaid electricity plan.
- TPL initiates customer sign-in process using its standard process.
- TPL raises Field Order to install prepaid meter or replace legacy meter with prepaid meter. During installation, energisation (token) code is normally used to energise the site that enables the prepaid meter to be stored with the correct tariff, emergency credit rule, non-disconnection window schedule, etc. This configuration parameters and initial load value will be based on TPLs business rule and costing.
- TPL Field Order gets completed and customer sign-in is completed
- TPL back-office upon completion of customer sign-in.
- TPL's Prepayment Management System (PMS) is updated with new prepaid

customer and meter standing data either via a manual back-office process using the PMS User Interface or via a file transfer process of extracted information from TPL's CIS Orion system that is picked up by the PMS for importing into its database.

- Daily synchronisation of CIS with PMS will be executed in order to ensure that PMS is up-to-date with new prepaid customer and meter standing data and also updated with inactivated customer and meter records.

5.1.3 Customer Prepay Top-up

Once the provisioning process is complete, the customer usually would have enough power for one or more days based on the initial load (energisation) code entered during installation.

Where emergency credit has been configured as per TPL business rule, the customer may see his credit on the prepaid meter going to the negative value without being automatically disconnected.

Warning signs may be given to the customer via an in-home display unit or via SMS alert coming from the TPLs Prepayment Management System. The customer has several options to top-up or purchase electricity. To describe this, we will present the options provided by a vending capabilities understood to be available in Tonga.

5.1.3.1 Vending Option 1 - Printed PINs

- Prepaid PIN / voucher receipt
- Fixed TOP denominations, i.e. 10, 20, 50, 100, 250, 500, etc (determined by TPL)
- TPL provides PIN codes to merchant network provider, PINs loaded onto merchant network provider's prepay platform via secure FTP
- TPL customer visits merchant who offers TPL prepaid power services. The merchant would have a GPRS terminal.
- On receipt of TPL customer cash merchant goes to terminal and selects appropriate denomination purchased under "TPL Power". The terminal prints receipt PIN and redemption instructions
- A PIN provides a customer with redemption options. These are immediate redemption calling an IVR or sending SMS adding meter number, in return after validation receiving token for input to meter.
- Customer enters token into meter, topping up meter.
- As part of a settlement process a reconciliation of PINs sold to TPL customers occurs, this forms the basis of the payment to TPL.

Quick Benefits

- Quick and easy to set up and deploy

- No need for customer to have their meter / account number with them to purchase power
- Family & friends can buy a voucher and give to others
- Minimal software programming work required to setup on existing merchant network provider's prepay platform product denominations, etc
- Does require paper receipt and GPRS terminals

5.1.3.2 Vending Option 2 - Electronic (SMS) PINs

- Denominations as above but delivery is by SMS with PIN sent to customer's phone
- Customer visits reseller or merchant who offers TPL prepaid power services – terminal not required.
- Merchant uses Merchant network provider's mobile phone application loaded onto merchant's handset selecting appropriate product (denomination) also entering customer's phone number, merchant confirms transaction
- Customer (virtually instantly) receives SMS message with PIN with redemption information
- Again customer has redemption options. A customer can call IVR entering PIN and meter number at prompts receiving SMS token after validation. Forwards SMS message with meter number to TPL redemption number receiving token at after successful validation. Or forwarding PIN to relative or family member to redeem.

Benefits

- Reduces number of GPRS terminals required lowering operating costs
- Requires merchants to have a smart phone which they have today
- No need for customer to have their meter / account number with them to purchase power
- Family & friends can buy a voucher and give to others

5.1.3.3 Option 3 - Direct Electronic Top Up dispensing Meter Tokens

- A direct electronic method where merchant acquires a meter Token via Merchant network providers prepays platform connecting through to TPL's Prepay management software.
- TPL customer visits merchant who offers TPL prepaid power services. The merchant would have either a GPRS terminal.
- On receipt of TPL customer cash merchant goes to terminal selecting "TPL Power" on terminal menu. Merchant inputs transaction value and customer meter number.
- Terminal connects to Merchant network provider's Prepay Platform and successfully validating merchant details, and then messages meter prepayment system (MPS) sending top up amount with meter number, MPS validates information replying with token. Token prints at terminal.
- Customer enters token into meter, topping up meter.

- As part of a settlement process a reconciliation of direct top sold to TPL customers and MPS occurs, this reconciliation forms the basis of the payment to TPL.

Apart from the vending channels, a key component of this solution is the Prepayment Management System that generates the token via an STS encryption service. This is the component that holds the customer and meter records with its applied tariff.

Normal global settings for emergency credit, maximum vending amount, non-disconnection hours are configured based on TPL's business rules. There is a range of solution options for this component including software sourced either from meter vendors or independent technology providers.

5.1.4 Disconnection/ Reconnection

The prepayment meter calculates the credit balance against kWh usage based on the tariff rate for the customer. Once the credit threshold is exceeded (e.g. TOP10.00 if with emergency credit setting of TOP10.00) then the meter disconnects automatically upon detection during the disconnection window.

The disconnection window is typically configurable as part of the tariff. If the customer exceeds the threshold outside of the disconnection window, the meter will not disconnect but continue to accumulate corresponding negative credit. Upon customer top-up and entry of the token into the meter, the meter will detect the credit entry and calculate remaining credit. The top-up amount will first be applied to the outstanding negative credit and the remainder will become positive credit. Upon detection of positive credit calculation, the meter will automatically reconnect the meter.

5.1.5 Meter Reading Reconciliation

The meter reading reconciliation process would depend on TPL's and regulatory requirements. If yearly site visits are required then the prepaid sites may still be included in TPL's manual meter reading rounds by allocating the prepaid site to a yearly read meter reading route.

The actual meter readings derived from this periodic reads will be reconciled against the derived energy sales extracted from the Prepayment Management System. Manual reconciliation process may be done for this purpose.

5.1.6 Payments Reconciliation

A three way payments reconciliation may be done periodically (daily, weekly, monthly) based on the vending partner's payment transactions report, Prepayment Management System payments transaction report and the bank statement.

5.1.7 Faults Management

Meter faults is envisaged to follow the same process as the standard TPL's meter faults but may add to the type of metering faults e.g. Prepaid Meter Fault (positive credit but no power, etc). Vending faults will be managed via the business continuity plan discussed with the vending partner.

5.1.8 Generic Features and Constraints

The generic features of the Standalone Prepaid Solution are:

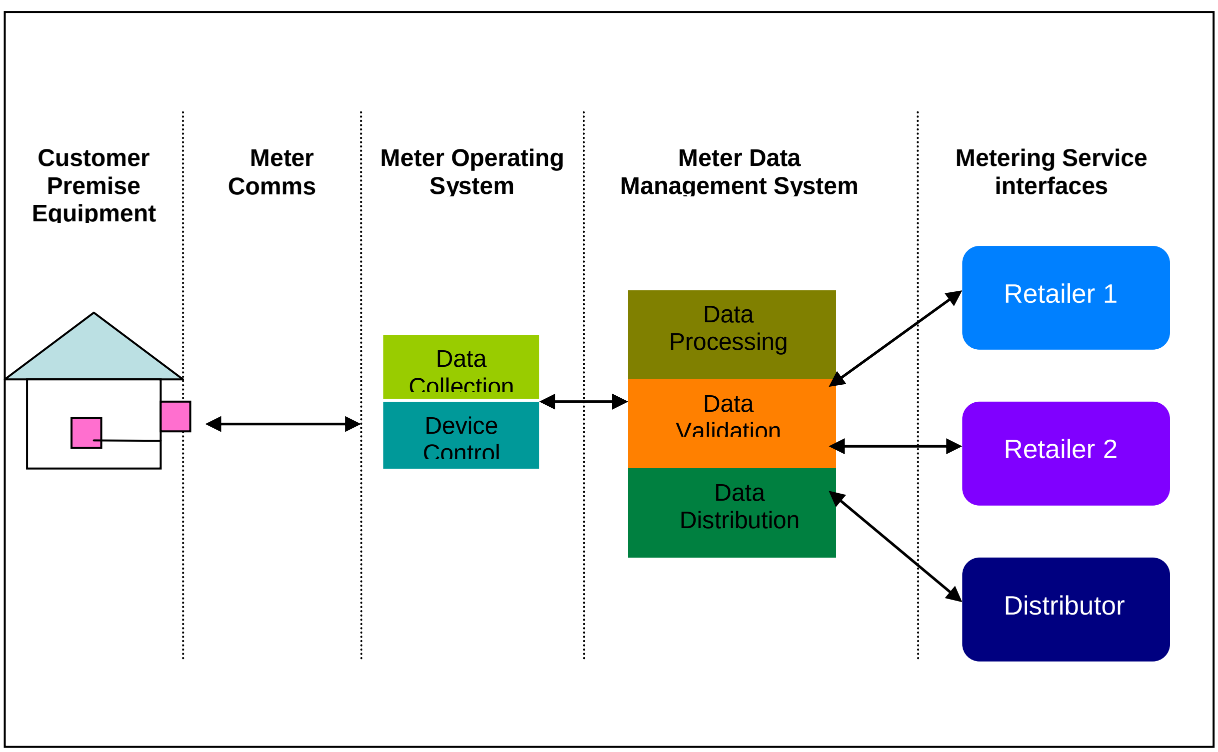
- Smarts and control resides in the prepaid meter.
- Customer's site are disconnected real-time upon reaching credit threshold
- Customer's site are reconnected upon loading of credit by the customer
- High interaction of customer with the meter or in-home display
- If with in-home display component, in-home display option is an additional device to manage during installation and faults management
- If without in-home display, HS&E of customer access to meter may pose some risks
- Multiple vending channel options
- Heavy reliance on back-office systems to dispense token in order to keep site energised. High availability infrastructure and redundancy is required otherwise customers will be disconnected.

5.2 Advanced Metering Infrastructure

5.2.1 AMI Components

There are 5 relatively generic components to any smart metering architecture that can be further broken down to a significant range of technology options. A simplistic view of the 5 components is depicted below and further described in detail.

Smart Metering Technology Components Overview



5.2.2 Customer Premise Equipment

This terminology is used to encompass the multiple components at a smart metering installation. Although it is possible that a single meter is the only equipment installed it is more likely that some form of load control device is also integrated, or connected to a meter.

Smart meters generally have the following functionality:

- (i) selectable profile data (1/2 hour, 15min, other interval options);
- (ii) supply connect/disconnect;
- (iii) at least one load control relay;
- (iv) regular and on-demand reading;
- (v) KW reading at the time interval selected;
- (vi) KWh computation;
- (vii) tamper detection;
- (viii) real-time remote disconnection, rearming and hard reconnection;
- (ix) power quality reporting;
- (x) Export measurement for local generation
- (xi) Under frequency load shedding capability
- (xii) capability to remotely update meter Time of Use (ToU) tariff tables and Time of Day (ToD) load control tables; and
- (xiii) post-pay and pre-pay functionality with the ability to switch remotely between modes while maintaining customer credits.

In addition to the above, some advanced meters will have in-built distribution line carrier or wireless interfaces for external communications and be able to receive remote upgrades of firmware or software.

5.2.3 Metering Communications Technology

In order to communicate with an installed metering base there is generally a core communications technology supported by one or two niche applications. These options will normally be integrated into the meter but some vendors do produce stand alone communications modules. Communications for smart meters are assumed to be bi-directional however uni-directional may be utilised where only meter reading is required. Uni-directional communications may be used with satellite or wireless drive-by data collection.

Meter communications technology options include:

- (i) distribution line carrier;
- (ii) power line carrier;
- (iii) GPRS/GSM;
- (iv) radio frequency mesh
- (v) broadband

(vi) PSTN dial-up
(vii) satellite
(viii) mini RF mesh
(ix) zigbee or similar protocol (used for drive by)

5.2.4 Metering Operating System (Headend)

Smart meter vendors generally develop an Operating System (also known as the Headend) that enables their meters to be managed and to undertake data collection activities. There are few, if any examples of vendors using open protocols being used in the communication between these Operating Systems and the devices they control.

These Headend technologies are used to load meter reading schedules, activate on demand remote services such as adhoc reads, reconnections or disconnection and also to remotely upgrade new functionality in the meter

5.2.5 Meter Data Management Systems

One of the essential components to a smart metering system is the Meter Data Management System ("MDMS"), also known as Meter Data Management Repository. This consists of some form of data warehouse and multiple interfaces to other parts of a utilities' operation such as its call centre. Based on the meter Data Manager's business model, these interfaces may also include links to retailers, asset management and job management systems as well as the Registry (or market data base of record).

Essentially the role of this technology is to normalise and house the vast quantities of meter data from multiple sources, so it can be verified, corrected(as necessary), processed for reconciliation and distributed to retailers and other interested parties.

There are a number of Meter Data Management system technologies achieving maturity in the international market including those of eMeter, Oracle, Itron and EDMI.

Given the relatively small scale of TPL's metering base, it may be more cost effective to use a Software-As-A-Service (SAAS) option or for TPL to develop its own bespoke MDMS?

5.2.6 Metering Service Interfaces

The last component in AMI system relates to the output from smart metering that is provided to the various users of the data. Given TPL is a vertically integrated business, the interfaces will only be to other TPL systems such as SCADA, asset management and financial systems.

5.3 AMI Communications Technology Options

There are three core aspects to technology selection (i) the metrology technology, (ii) the communications technology and (iii) the MDMS.

The metrology technology is related to the meter functionality as outlined in 5.2.2 but also to the basic requirements of accurately measuring electricity consumption.

Smart meter communications reflect the technology for backhauling the meter read data and also for communicating to the meter for firmware updates and for on-demand communications.

5.3.1 GPRS

Both Tonga Telecommunications Corporation (TCC) and Digicel operate 2G networks offering GPRS. GPRS is ideal for smart meter data backhaul because the quantities of data involved are very small and the data can be uploaded during non-peak periods. The big question around use of GPRS is the longevity of those networks. As smart meters are manufactured to have an economic life in excess of 15 years, it is important to obtain a guaranteed service life of at least 10 years from any telco offering a GPRS service for AMI.

TCC advised PBL that they are planning to replace their existing 2G platform with a 3G/LTE platform that will also support GPRS. Digicel operate a 2.75EDGE network and it is that their network will evolve in such a way as to be backward compatible with 2G and 3G systems.

5.3.2 3G and LTE (4G)

Current and next generation cellular networks will support AMI in relation to backhaul, however the cost of modems are still quite expensive by comparison with GPRS modems and can make the use of these options uneconomic.

5.3.3 Wireless Mesh

Unlike GPRS and 3G/LTE, wireless mesh, or RF Mesh as it is sometimes referred to, is a telco independent technology that uses the smart meter to communicate to neighbouring smart meters, and at various points the meter data is concentrated and backhauled to a central server. The technology is now relatively mature with substantial deployments in the USA and Victoria in Australia.

The RF Mesh data concentrators, or access points, are connected to a telco or private backhaul network so that the meter data can be brought back to the central office. The 3G networks as operated by TCC and Digicel are ideal for AMI backhaul if TPL did not wish to build its own wireless or fibre backhaul network.

5.3.4 Distribution Line Carrier

Whilst DLC is utilised in parts of Europe is has not found favour in the South Pacific largely due to cost and limited bandwidth and reliability under some conditions.

5.3.5 Satellite

Satellite smart meter technology could provide a ubiquitous solution covering all TP's ICPs however this would come at the price of significantly reduced of on-demand services functionality and relatively high cost. This technology basically receives a message-like format, similar to a cellular SMS message, of the meter data and re-transmits to a terrestrial base station.

5.3.6 Home Broadband and Dialup

Both these options require access to a consumer's home line, assuming they have one, and which may not then be convenient, as the customer may utilise the home line for other services. Consumers may turn off broadband connections and dialup can be slow and inconvenient.

5.3.7 Technology Recommendation

It is recommended that TPL only consider cellular or RF mesh for an AMI service.

If GPRS or 3G/LTE are considered a guaranteed service life of at least 10 years must be obtained from the telco. At this juncture only Digicel have provided pricing.

RF mesh is a good technical solution for TPL as it makes TPL more independent of local telcos. However RF mesh does require scale in terms of the numbers of meters to offset the relatively high headend costs.

PBL has partially evaluated both cellular and RF mesh options and both are economic but the Digicel offering is significantly better commercially. For the RF mesh option, budgetary pricing has been used from Silver Spring Networks but this is subject to confirmation.

5.4 Meter Data Management Systems

TPL has a limited number of economically viable options for a MDMS because of the relatively small scale of an implementation.

The established MDMS vendors include eMeter (owned by Siemens), Oracle, and Itron's Open Way solution. These are all mature platforms that are able to integrate to multiple head end applications and therefore are able to be metering agnostic.

Given the cost of acquiring, implementing and maintaining these platforms, it is unlikely that they will be viable for an implementation of the size contemplated by TPL.

On this basis there are two realistic options for TPL:

(i) Utilise a Software as a Service MDMS solution

There is at least one established SaaS provider based in New Zealand (Energy Intellect, owned by EDMI) that offer a service based proposition that can cover the reading of meters through to the meter data management activity required by TPL.

Energy Intellect has provided similar services remotely for customers in the Australian market from its Wellington base and is able to price a service on a fully variable basis, based on the specification of services that TPL may require. The Lines Company in New

Zealand has also recently selected this platform for their smart metering implementation.

(ii) Develop a bespoke MDMS solution

Given TPL's relatively modest MDMS requirements it is considered that it could rely on the functionality of the head end of the metering solution it selects and then develop some bespoke software for its MDMS processes that could be integrated into its wider business platform.

While this would incur an upfront capital expense there would be limited ongoing licensing costs and TPL would preserve control over the future development of such an application as its requirements developed.

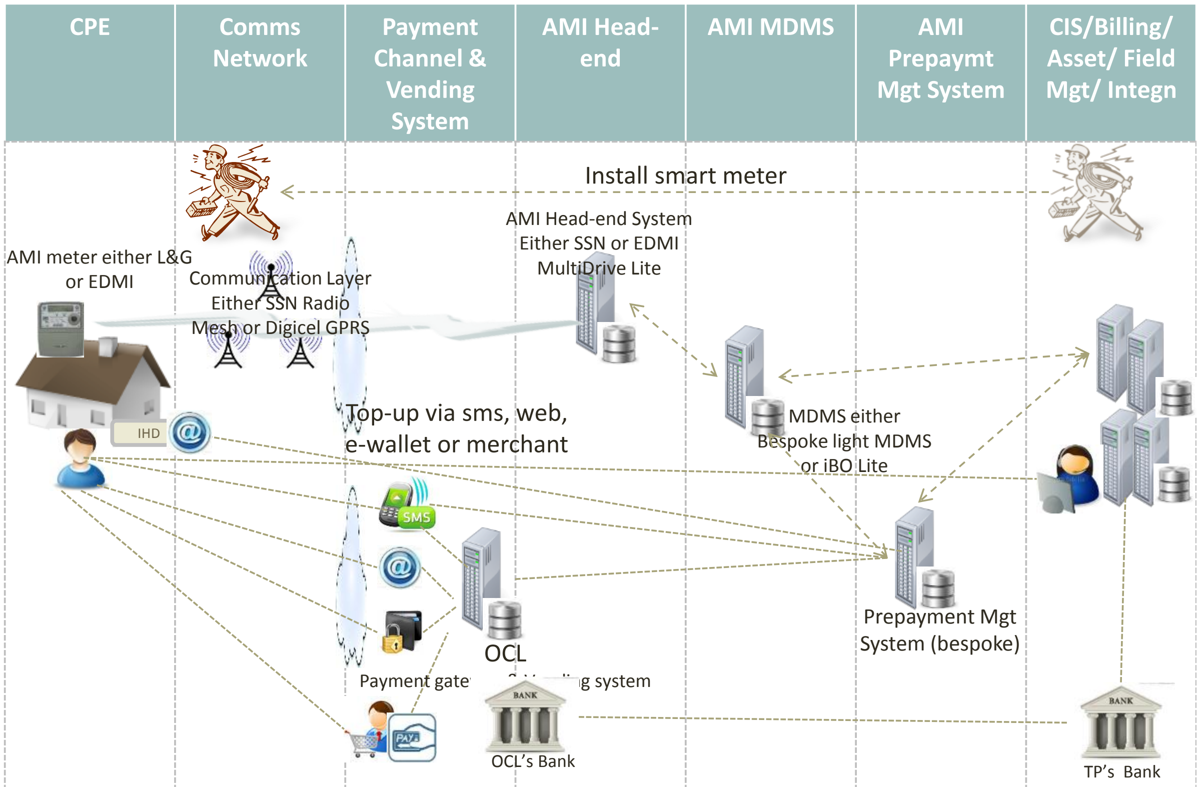
Given TPL will need to commission some level of bespoke development to manage the prepay components of an AMI solution there is likely to be a strong synergy, with including MDMS capability from both a cost and functionality perspective.

5.5 Prepay as part of AMI

The AMI prepay solution architecture presented in the following diagram builds on the key components of a smart meter, several vending channels, back-office vending system, headend, light version of MDMS and back-office prepayment management system that integrates with the MDM and TPL's ERP (CIS/Billing/Field Orders/Finance systems).

The diagram reflects illustrative candidate vendors for each of the components.

A high level description of the solution steps through the end-to-end process from procurement, provisioning, prepayment top-up, disco/reco, reading reconciliation, payments reconciliation and faults management.



5.5.1 Procurement of Smart Meters

Smart Meters procurement is assumed to follow the standard PR/PO and goods receipt process of TPL. Specification of what TPL would require to be presented on the faceplate of the meter, serial number or supplementary asset numbering, logo and tariff configuration set-up are all included as part of requirements specification pre-manufacturing phase.

5.5.2 Provisioning of Smart Meters

The provisioning process is assumed to follow TPL's standard customer sign-in and field orders process with extension of specific steps for Smart Metering set-up as follows:

- Either TPL offers the customer to move to prepaid electricity plan as part of Credit Management process or customer avails of TPL's prepaid electricity plan.
- TPL initiates customer sign-in process following its standard process.
- TPL raises Field Order to install Smart Meter or replace legacy meter with Smart Meter. During installation, commissioning process is triggered by the fieldman so that the Smart Meter sends the commissioning packet to the Headend. The Headend sends confirmation code that the fieldman notes in his field order. This ensures that proper comms has been established with the head-end.
- TPL Field Order gets completed and customer sign-in is completed
- TPL's Prepayment Management System (PMS) is updated with new prepaid customer and meter standing data either via a manual back-office process using the

PMS User Interface or via a file transfer process of extracted information from TPL's CIS Orion system that is picked up by the PMS for importing into its database.

- Daily synchronisation of CIS with PMS will be executed in order to ensure that PMS is up-to-date with new prepaid customer and meter standing data and also updated with inactivated customer and meter records.

5.5.3 Customer Prepay Top-up

Once the provisioning process is complete, the customer usually would have enough power for one or x days depending on TPLs business rule. Where emergency credit has been configured as per TPL business rule, the customer may see his credit on web or mobile app going to the negative value without being automatically disconnected.

Warning signs may be given to the customer via an SMS or email alert coming from TPLs Prepayment Management System. The customer has several options to top-up or purchase electricity.

The vending options presented in the Standalone Prepaid Model still applies to the AMI Prepayment model except that tokens are not released but either of two ways to manage credit:

- Pins/vouchers are still released from merchants, SMS or web for redemption at a later date via SMS or IVR when customer enters the voucher number and associate it with the customer's account and meter number.
- Customer simply receives acknowledgement of payment top-up and credit balance information. The vending system sends the confirmed payment transaction to the Prepayment Management System that performs credit balance versus unpaid usage calculation and returns the credit balance information.

5.5.4 Disconnection/ Reconnection

The Prepayment Management system receives payment details from the Vending System and receives remote readings details from the MDM and performs calculation of usage versus credits daily.

Customers that fall below the credit thresholds are flagged for disconnection. An SMS or web alert will serve as disconnection notice to the customer a day prior to the disconnection (depending on TPL's disconnection policy).

The disconnection report will be used by the TPL back-office to execute remote disconnection using the head-end. Otherwise, automated calling of the remote disconnection API may also be built to automate the process.

Once the customer tops-up, payment transaction is sent by the vending system to the

Prepayment Management System that then immediately performs calculation of new credit versus outstanding unpaid usage.

Where the balance still falls below the threshold the PMS will return the negative credit balance with appropriate message on insufficient credit to reconnect. Where the credit goes above the threshold, they PMS will confirm the positive credit balance and message for reconnection. The PMS flags the record for reconnection.

Reconnection requests can be alerted to TPL back-office for manual remote reconnection execution using the head-end. Automated calling of remote reconnection API may also be built to automate the process.

5.5.5 Meter Reading/ Data Collection and Data Processing:

The Headend has schedules that automatically dials and collects data from the Smart Meters. Data such as midnight cumulative kWh readings, interval consumption readings and events data are collected and stored into the Headend.

These data are exported and send to the Light Weight Meter Data Management system that performs basic data validation such as high/low consumption, backward reading, consecutive zero consumption, etc depending on TPL's business rules. Estimation rules and algorithms may also be defined in the Light MDM for execution.

Editing functionality may also be activated by allowing users to directly replace the value of the readings with audit trail. The information stored in the Light MDM are utilised by the Prepayment Management System for credit/usage calculation process.

5.5.6 Meter Reading Reconciliation

Report from a Light MDM system is used to reconcile energy sales.

5.5.7 Payments Reconciliation

A three way payments reconciliation may be done periodically (daily, weekly, monthly) based on the vending partner's payment transactions report, Prepayment Management System payments transaction report and the bank statement.

5.5.8 Faults Management

Meter faults is envisaged to follow the same process as the standard TPL's meter faults but may add to the type of metering faults e.g. Prepaid Meter Fault (positive credit but no power, etc).

Vending faults will be managed via the business continuity plan discussed with the vending partner.

5.5.9 Generic Features and Constraints

The generic features of the AMI Prepaid Solution are:

- Smarts and control resides in the Prepayment Management System and not in the meter.
- Customer's site is disconnected based on daily schedule and output from PMS batch process and remote disconnection process.
- Customer's sites are reconnected upon loading of credit by the customer after PMS immediate calculation and remote reconnection process.
- Low interaction of customer with the meter or in-home display
- Multiple vending channel options
- Heavy reliance on back-office systems to perform credit versus usage calculation and execution of remote disco/reco process.
- High Availability infrastructure and redundancy is required to support reconnection within timeframe.
- After-hours reconnection if remote reconnection process is not fully automated
- Escalation process for comms fault during disco/reco – field visit to fix comms
- Only sites with good comms should be allowed to go into AMI prepaid tariff

6. Prepayment Implementation considerations

6.1 Vending Arrangements

Irrespective of which metering option is implemented some form of vending arrangement is required for TPL customers to make payment for electricity before it is consumed.

While TPL currently provides a number of electronic and online payment options, so long as Tonga remains a significantly cash – based society an efficient means of handling physical top up transactions would seem a fundamental requirement.

Given the dispersed nature of the TPL network, meeting this requirement will most likely involve leveraging established, high availability agent network such as those used for mobile phone top up, where possible utilising existing terminal technology and cash management infrastructure.

It is considered highly unlikely that TPL establishing its own dedicated vending channel would prove to be economic.

Both a token based and smart meter (remote top up) solution could potentially utilise the full set of the customer payment options, with either tokens being returned to the payment initiator (by printout, SMS or email) once the transaction is verified for input into the specified meter, or the identified meter record having a credit balance against it in TPL's billing system.

Within any system design it is expected that Codes or transactions would be meter specific to avoid the theft or trade of tokens or top ups.

The costs of integration of each of these vending channels with either a standalone prepay management system, or with a smart metering infrastructure have not been specifically costed.

The additional benefit of the remote electronic channels for either solution is that providers of off shore remittances would be able to specify specific meters and make payments for top up directly.

Key risks associated with the vending implementation include:

- Ability to integrate existing channels into a prepay or AMI solution in a cost effective way
- Ability to offer sufficient availability of access to prepay top up services across the TPL network for TPL customers
- Establishing a suitable cash management arrangement with a network of vending agents

6.2 Telco Arrangements

Pre-payment of electricity can be vendored much the same as that of pre-pay telephony services currently offered by Digicel and TCL.

6.3 Back office integration

The following back office integration points must be put in place:

- TPL CIS – Orion system to generate Customer/Meter Standing Data file for consumption by the Prepayment Management System. This can be as simple as file transfer into a secure network directory that the Prepayment Management System can poll;
- vending System SMS or Web Service request and response to and from the Prepayment Management System for token release or confirmation of top-up with credit balance information; and
- headend meter data file generation file transfer to a secure network directory that the Prepayment Management System can poll.

Integration Points	Standalone Prepaid Model	AMI Prepaid Model
TPL's CIS – Orion system to generate Customer/Meter Standing Data file for consumption by the Prepayment Management System. This can be as simple as file transfer into a secure network directory that the Prepayment Management System can poll.	Yes	Yes
Vending System SMS or Web Service request and response to and from the Prepayment Management System for token release or confirmation of top-up with credit balance information.	Yes	Yes
Headend meter data file generation and file transfer to a secure network directory that the Prepayment Management System can poll.	No	Yes
Light MDM data file generation and file transfer to a secure network directory that Orion Billing system can import.	No	Yes

7. Financial Evaluation

There are variety of benefits that can be quantified and several that are difficult to evaluate or will arise in the future from an electricity prepayment implementation and a full AMI deployment.

Budgetary pricing has been obtained from meter, pre-pay and MDMS vendors and these will need to be firmed up as part of an RFP process however the pricing is consistent with recent RFP's conducted by PBL for other clients.

7.1 Benefits Arising from AMI Deployment

7.1.1 Field Related Savings

Savings accrue through the use of the communications module in the smart meter to reduce the need for travel to consumers' premises. As well as routine meter reads, network operators and engineers can interrogate a consumer's meter remotely in real time undertake disconnections, reconnections and special reads as well as to establish the nature of faults and whether or not there is a fault.

The benefits from 3,000 pre-payment customers are also included in the following evaluation.

There are five categories of Field Savings:

(i) Meter Reading

There are currently some 15,430 ICPs and an equivalent number of meters to read each month for billing purposes. The cost of this activity is approximately TOP468,300 pa and requires full time 12 meter readers, 2 data entry operators and 2 linesmen for a week to read street light meters. The need to travel to read meters can be eliminated provided there is communications connectivity to meters. Given the topology of Tongatapu Island it is assumed that 95% smart meter connectivity can be achieved and the saving will be approximately TOP444,900 pa.

(ii) Special Reads
Meter readers have to revisit consumers' premises to re-read meters when accounts are queries or when a consumer relocates to another address. Currently there are about 450 special reads undertaken each month. This represents 35% of the total number of 15,430 meters pa. TPL has costed a special read at TOP31.25 each that includes labour and mileage. This equates to $168,750 per annum but is assumed that 5% of reads will still require a visit thus the benefit is assessed at TOP160,300 pa.

(iii) Disconnects and Reconnects
Smart meters have a 100A supply disconnect relay in-built that can be controlled remotely through the meter communications network. Consumer premises visits are also required to disconnect supply for non-payment or to enable electrical work to be done safely. There are approximately 1,500 disconnects and 1,300 reconnects each month in Tongatapu. This represents a staggering 218% of the meter population pa. Disconnects and reconnects are costed the same as for special reads at TOP31.25 each. This equates to $1,050,000 per annum but is assumed that 5% of reads will still require a visit and so the benefit is assessed at TOP997,500 pa. TPL recovers TOP406,850 pa for reconnection charges and net benefit is TOP590,650 pa.

(iv) Reduced Consumer Fault Visits
There is currently 7,454 consumer fault visits pa representing 48% of the total meter population pa. Of these visits there are 772 false call outs and TPL believes that having remote access to meters would reduce the number of visits by 50%. Cost of a visit is TOP31.25 and a saving of approximately TOP12,050 pa should be realised.

(v) Reduced Pole Fuse Visits
There are 461 pole fuse failures pa and it is estimated that approximately 50% of these visits can be avoided by load limiting within the meter. At a cost of TOP31.25 and a saving of TOP7,200 pa should be realised.

7.1.2 Reduction in Network Losses

Network losses are currently around 10.4% and it is expected that in a well-operated and engineered network losses should be around 8%. Power station parasitic losses amount to 3% and are considered unrelated to this work. The Tongatapu network is relatively compact and is well engineered it is expected network losses as low as 7% could be achieved. There are two categories of Network losses – non-technical (theft, and reconciliation errors, faulty meters) and technical (resistive and reactive).

(i) Reduced Non-Technical Losses
Non-technical losses are approximately 3.4% of energy supplied and TPL generates approximately 43.7GWh pa for Tongatapu. Thus non-technical losses are about 1,490MWh pa. It is estimated that approximately 50% of this loss can be eliminated – source expert opinion of New Zealand lines companies working group. Smart metering enables revenue assurance investigations to be undertaken in a timely manner as half hourly data is available in the back office and any tampering with the meter is immediately notified to the network operators through the meter communications network. Because all meters can be read within a day TPL will be able to reconcile network power flows more accurately and identify where losses are high and take the necessary action. The cost of diesel generation has been assessed by TPL at TOP0.52/kWh. Thus it is calculated that there could be TOP386,750 pa savings in diesel generation.

(ii) Reduced Technical losses
Technical losses are approximately 6.4%. TPL believes it can reduce technical losses by 25% resulting in a savings in generation of 700MWh pa. Improved reconciliation accuracy enables identification of relatively high-loss portions of the network and these can be investigated and power condition equipment installed, re-jointing undertaken or in some instances re-engineering of that portion of the network to reduce losses. In New Zealand expert opinion of a lines companies working group assessed the savings likely to be realised at 2% - 1.6% has been assumed for TPL in this category. Using the same cost of avoided generation this saving equates to the same as that of non-technical losses at TOP364,000 pa.

7.1.3 Reduced Costs of Technical Investigations

Network engineering investigations cost approximately TOP100,000 pa and assess to power quality information as is available from smart metering is expected to result in a saving of 50% or TOP50,000 of this cost pa. Technical investigations can involve the installation of data loggers and many hours of costly engineering time.

7.1.4 Finance Savings

(i) Bad Debt Reduction
Bad is currently running at 0.072% which equates to TOP28,300 pa. The implementation of AMI is expected to reduce bad debt by 20 to 30% across all consumers. This includes those on prepay where it is assumed all bad debt is eliminated. Assuming a reduction of 25% the bad debt saving is TOP7,000 pa.

(ii) Debtor Days Reduction (prepay)
There is cash flow benefit of having the prepay monies, say, 5 days before the electricity is consumed versus 40 days after it is used. The average residential consumer uses 100kWh per month at TOP0.92/kWh equals TOP92 per

consumer or TOP276,000 per month for the prepay population. Interest rate on borrowings is 6% pa so the reduction in debtor days could be worth TOP21,800 pa.

7.1.5 Peak Load Reduction

The cost of TPL network transformer capacity is TOP2,155/kW as calculated from the TPL asset valuation. Several demand-side management studies have calculated saving from the introduction of smart metering together with a consumer education programme have identified saving in network peak load of 5%. Time of Use (TOU) tariffs and customer feedback from in-home devices that communicate directly with the meter or other devices that communicate with the back office meter data management system greatly assist in realising such savings. This saving is essentially a one-off cost and required periodic messaging to customers to reinforce the savings available. As the TPL network now has solar power generation there is some scope to modify power usage patterns towards lower cost of generation periods.

TPL's peak is approximately 8MW and so there is a potential saving at time of peak of 0.4MW. If it is assumed that saving commence in year two after a smart meters have been deployed and 50% of the savings is achieved in that year and 50% in the following years and those saving are sustained, then at a 7% discount rate that one-off saving equates to approximately TOP730,000. However given the costs of a programme to realise these savings and the magnitude of the savings are somewhat speculative this benefit will not be included.

7.1.6 Other Benefits Not Evaluated

The following benefits have been identified but not evaluated because there was insufficient technical, financial or market information available. Many of these benefits will be realised soon after smart metering has been deployed or at a time in the future as generation moves to greater proportions of renewable and as demand-side management programmes and technology is implemented.

- Reduced operational and network planning costs
- Smart meters, being 4 quadrant (import and export) will make the TPL network ready for solar power and other forms of local generation and the introduction of electric vehicles
- Smart meters can have inbuilt interruptible load control relays or slave relays that can control large external loads. If meters are selected with load control functionality this opens up the opportunity for TPL to introduce interruptible tariffs and achieve significant peak load reductions.

7.1.7 Benefits Summary

The benefits identified above and as will be utilised in the cost-benefit analysis are summarised in the table below.

Network Benefits	TOP pa
Field Related Savings	
Meter reading savings	444,900
Special Reads	160,300
Disconnects/reconnects	590,650
Reduced customer fault visits	12,050
Reduced pole fuse failure visits	7,200
	1,215,100
Reduction in Network Losses (diesel generation savings)	
Reduced non-technical losses	386,750
Reduced technical losses	364,000
	750,750
Reduced cost of Technical Investigations	**50,000**
Finance Savings	
Reduced Bad Debt	7,000
Reduction in Debtor Days	21,800
	28,800
Total	**2,044,650**

7.2 Benefits Arising from Prepayment Metering

Three thousand consumers are being considered for prepay out of a total of 15,430 or 19.44% of the total ICP population. These consumers are located on the Island of Tongatapu. A subset of the benefits for AMI solution above applies.

7.2.1 Field Related Savings

Of the benefits identified the following apply to the 3,000 prepay consumer set:

(i) Meter Reading
19.44% of the benefit evaluated above for avoided meter reading applies because with pre-payment meters manual meter reading would not be required. The saving is TOP86,490 pa.

(ii) Special Reads
Special reads will be proportionally reduced for the 3,000 prepay ICP consumer set. It is assumed that 30% of the 450 special reads per month will be represented in the prepay population. At a cost of TOP31.25 per special read this represents a saving of TOP50,625 pa.

(iii) Disconnects and Reconnects
Of the approximate 1,500 disconnects each month in Tongatapu it is assumed that this consumer set will be offered or moved onto prepay. Not all the disconnects

each month are the same consumers and so the introduction of prepay will not eliminate the disconnect and reconnect activity. For this study it is assumed that only 50% of the total savings identified in 1.1.1 (iii) above costs result. The disconnect/reconnect saving is calculated at TOP295,325 pa.

7.2.2 Reduced Non-Technical Losses

Non-technical losses are 3.4% of energy supplied and with a full AMI solution 50% of these losses are assumed saved. The prepay population is assumed to be over-represented when it comes to non-technical losses however it is assumed that the prepayment, compared to full AMI, only accounts for 75% of the loss reduction assumed of 1.7% which amounts in savings of 560MWh pa. At a cost of diesel generation at TOP0.52/kWh this equates to a savings of TOP290,065 pa.

7.2.3 Finance Savings

(i) Reduction in Bad Debt

Bad debt is currently running at 0.072% which equates to TOP28,300 pa. The implementation of AMI is expected to reduce bad debt by the proportion of consumers who transfer to prepay, which is 19.44% for the purposes of this report. The saving is TOP5,500 pa.

(ii) Reduction in Debtor Days (prepay)

As documented in 7.1.4 (ii) above the reduction in debtor days related to the introduction of 3,000 prepayment meters is assessed at TOP21,800 pa.

7.2.4 Benefits Not Evaluated

Reduction in back office costs associated with invoice preparation and payment related matters.

7.2.5 Benefits Summary

The benefits identified above are summarised in the table below.

Network Benefits	TOP pa
Field Related Savings	
Meter reading savings	86,490
Special Reads	50,625
Disconnects/reconnects	295,325
	432,440
Reduction in Non-Technical Losses	**290,065**
Finance Savings	
Reduction in Bad Debt	5,500
Reduction in Debtor Days	21,800
	27,300
Total	**749,805**

7.3 Costs to Implement AMI and Prepayment systems

7.3.1 AMI Costs

PBL has evaluated two full service AMI offerings from vendors that both include the 3,000 meter prepayment requirement.

Meters:

Meter pricing was obtained from both EDMI and L+G. Both manufacturers' meters are of excellent quality and are widely used in Australasia and the Pacific. Moreover they are reasonably priced and readily available. The L+G meter pricing is better than EDMI's meter pricing but L+G do not provide a meter that will work with cellular backhaul offerings. So in this evaluation L+G meters are used for the RF mesh option and EDMI for the cellular or GPRS option. Any future RFP should invite both companies to quote along with other manufacturers.

Telecommunications Backhaul:

(i) Telcos

Both Tonga Telecommunications Corporation (TCC) and Digicel were asked to complete a TPL Power RFI but only Digicel has responded with commercial information at this time. Digicel has quoted TOP1/meter/month plus TOP0.01/kB data charge which is considered very acceptable give the Digicel establishment overhead and the relatively small volume of meters.

(ii) RF Mesh SSN

Only SSN was used for mesh pricing because they are active in Australia and New Zealand and PBL has a full set of recent pricing from that company. No direct contact was made with SSN in respect of TPL but PBL was advised that SSN recent pricing was applicable to other Distribution operators in the South Pacific region. A formal RFP will be issued to SSN and at least one other RF mesh vendor at a later time.

The meter data backhaul from the RF Mesh access points is assumed to use a 3G modem installed in the Access Point however Ethernet is an alternative should TPL require but this is likely to be more expensive. Budget pricing for data backhaul has been estimated by PBL and either of TCC or Digicel could provide this service.

Meter Headends:

The RF mesh solution will use the SSN headend, Utility IQ, to interface to the L+G meters whereas the EDMI cellular solution with utilise the EDMI headend, Multidrive.

Meter Data Management System:

As mentioned in section 5.4 above a Utility scale MDMS is not likely to be viable for a relatively small quantity of meters as these systems are designed for millions of meters and cost millions of dollars. However PBL has looked at a couple of practical solutions for TPL. One is to utilise the Energy Intellect's iBO/iE2 offerings and the other is to commission a bespoke system. PBL developed a brief and invited software house Point West to price a bespoke system and this has enabled the MDMS and headend interfacing costs to be estimated. The Energy Intellect MDMS has been assumed for the EDMI meter cellular solution and the Point West MDM costs for the RF mesh solution but there is not a lot of difference in price.

Cellular AMI (GPRS) Capital Costs:

Smart Metering Capital Costs Summary	**$**
Cost of Meters & mesh kit	3,762,297
Meter Priming Fee (N/A)	0
Field Installation costs	146,585
Backhaul Network (N/A)	0
Headend Cost	60,000
MDM & Headend Interfaces	450,000
Prepayment System	279,000
Deployment Management	30,860
Asset Management System	100,000
Other costs	53,000
TPL & consultant programme management	230,000
Contingency @10%	511,174
Total	**5,622,916**

RF Mesh Capital Costs:

Smart Metering Capital Costs Summary	**$**
Cost of Meters & mesh kit	3,589,823
Meter Priming Fee	100,000
Field Installation costs	163,185
Mesh Network (incl ext warranty)	215,873
Mesh Node Backhaul Network	2,700
Headend Cost	111,723
MDM & Headend Interfaces	556,875
Prepayment System	270,000
Deployment Management	30,860
Asset Management System	100,000
Other costs	73,250
TPL & SSN programme management	380,000
Contingency @10%	560,329
Total	**6,163,617**

<u>Cellular Operating Costs</u>:

O&M Costs pa Summary	Cost $/pa
Management	80,000
Headend/Mesh Operating Costs	146,585
Headend Licences & Software Support	34,659
Prepayment System	116,075
Backhaul network costs	198,769
MDM System	60,000
Meters Field Maintenance	1,331
Miscellaneous Costs	30,000
Contingency @ 10%	66,742
Total	**734,160**

<u>RF Mesh Operating Costs</u>:

O&M Costs pa Summary	Cost $/pa
Management	80,000
Headend/Mesh Operating Costs	146,585
Mesh Licences & Software Support	648,879
Mesh Maintenance	415
Prepayment System	116,075
Backhaul network costs	3,840
MDM System	60,000
Meters Field Maintenance	1,331
Miscellaneous Costs	50,507
Contingency @ 10%	110,763
Total	**1,218,394**

7.3.2 Prepayment Costs

Only budgetary costs have been obtained at this juncture and those costs were provided by the following vendors:

- EDMI - meters
- L+G – CashPower prepayment solution

The capital costs can be summarised as follows:

Smart Metering Capital Costs	TOP
Cost of Meters	606,292
Field Installation costs	30,000
Deployment Management	6,000
Prepayment system (hardware & IT)	146,813
Installation of prepayment system	30,000
Integration of prepay to finance system	42,188
Vending software & terminal development	50,000
Miscellaneous other costs	10,000
Project Management	50,000
Contingency @10%	97,129
Total	**1,068,421**

Prepayment capital costs include:

- Hardware
- Installation
- Integration to TPL's finance system
- Vending software and terminal development
- Training of staff

To operate the prepayment system the following indicative costs apply.

O&M Costs pa	Cost TOP/pa
Management & Operations	20,000
Prepayment System	116,075
Contingency @ 10%	13,608
Total	**149,683**

Prepayment operating costs include:

- License fees
- Vending system operation
- Prepay transactions costs (top up)

7.4 Cost-Benefit

7.4.1 Discounted Cash Flow

The smart metering and prepayment options are evaluated using a discounted cash flow (DCF) model over a 15 year period post installation that is assumed to be the economic life of the smart meters. The economic model appropriately models the time value of money, depreciation on a diminishing value basis and taxation.

The nominal economic life of the smart meters is 15 years in the Tongan environment and that time the meters are assumed to be scrapped with no salvage value.

The base economic parameters assumed for the DCF model are set out in the following table.

Discount rate	8.5%
Inflation Rate	3.0%
Economic life – AMI	15 years
Economic life – Standalone Prepay	10 years
Tax depreciation rate	10%
Taxation rate	25%
Debt funding	0%
Present value date	1 April 2014

7.4.2 Standalone Prepay

Base Case:

Applying a discounted cash flow, using the parameters in 7.4.1, to the capital costs, operational costs and the projected benefits (revenues) streams the IRR and net present value figures are derived.

Venture IRR (pre-tax)		73%
Venture NPV (pre-tax)	$	3.39m
Equity IRR (post tax)		54%
Equity NPV (post tax)	$	2.40m

Discount Rate Sensitivity:

	7%		10%	
Venture IRR (pre-tax)		73%		73%
Venture NPV (pre-tax)	TOP	3.72m	TOP	3.09m
Equity IRR (post tax)		54%		54%
Equity NPV (post tax)	TOP	2.66m	TOP	2.18m

Debt Financing Sensitivity:

	30%		50%	
Venture IRR (pre-tax)		73%		73%
Venture NPV (pre-tax)	TOP	3.39m	TOP	3.39m
Equity IRR (post tax)		77%		113%
Equity NPV (post tax)	TOP	2.46m	TOP	2.50m

7.4.3 AMI GPRS Cellular Option

Applying a discounted cash flow, using the parameters in 7.4.1, to the capital costs, operational costs and the projected benefits (revenues) streams the IRR and net present value figures for the GPRS cellular AMI solution are derived.

Venture IRR (pre-tax)	31%
Venture NPV (pre-tax)	$ 8.05m
Equity IRR (post tax)	24%
Equity NPV (post tax)	$ 5.68m

Discount Rate Sensitivity:

	7%	10%
Venture IRR (pre-tax)	31%	31%
Venture NPV (pre-tax)	TOP 9.47m	TOP 6.84m
Equity IRR (post tax)	24%	24%
Equity NPV (post tax)	TOP 6.86m	TOP 4.68m

Debt Financing Sensitivity:

	30%	50%
Venture IRR (pre-tax)	31%	31%
Venture NPV (pre-tax)	TOP 8.04m	TOP 8.04m
Equity IRR (post tax)	32%	44%
Equity NPV (post tax)	TOP 5.98m	TOP 6.19m

7.4.4 AMI RF Mesh Model

Applying a discounted cash flow, using the parameters in 7.4.1, to the capital costs, operational costs and the projected benefits (revenues) streams the IRR and net present value figures for the RF Mesh AMI solution are derived.

Venture IRR (pre-tax)	13%
Venture NPV (pre-tax)	$ 1.65m
Equity IRR (post tax)	11%
Equity NPV (post tax)	$ 0.85m

Discount Rate Sensitivity:

	7%	10%
Venture IRR (pre-tax)	13%	13%
Venture NPV (pre-tax)	TOP 2.42	TOP 0.99m
Equity IRR (post tax)	11%	11%
Equity NPV (post tax)	TOP 1.55m	TOP 0.27m

Debt Financing Sensitivity:

	30%		50%	
Venture IRR (pre-tax)		13%		13%
Venture NPV (pre-tax)	TOP	1.64m	TOP	1.64m
Equity IRR (post tax)		13%		15%
Equity NPV (post tax)	TOP	1.18m	TOP	1.39m

8. Conclusion

TPL has some pressing issues related to revenue assurance and the possibility to reduce network losses as well as opportunities to implement a smart network that is capable of demand side management and which can accommodate and increasing amount of renewable generation.

PBL with the assistance of TPL have established that the benefits of a prepayment system for 3,000 Tongatapu consumers amount to some TOP750,000 pa. Whereas the costs of a prepayment system are approximately TOP1.1m with ongoing operating costs of TOP150,000 pa. When these costs and benefits are evaluated in a DCF model it is established that the post-tax return of 54%. This high return suggests that electricity prepayment will be a viable option for TPL to encourage those consumers who struggle to manage their electricity consumption in relation to their income to modify their approach in the way they pay for electricity.

Two AMI options that include 3,000 prepayment ICPs have been evaluated utilising (i) GPRS and (ii) RF Mesh communications technologies and both these options are viable. In particular the GPRS option is outstanding but this must be tempered with the caveat that the longevity of support for GPRS needs to be confirmed by Digicel in writing. The GPRS economics produce post-tax return without recourse to debt financing of 24% for an outlay of TOP5.6m and TOP735,000 pa opex. The RF Mesh economics produce post-tax return without recourse to debt financing of 11% for an outlay of TOP6.2m and TOP1.2m pa opex.

9. Recommendations

Given that the stand alone pre-payment option and both AMI options appear viable, the following is recommended to bring this analysis of prepay and AMI to a conclusion:

1. Complete discussions with TCC to obtain an alternative GPRS offer to that of Digicel and enter into discussions with both telcos to understand the planned evolution of their respective cellular system platforms and in particular to understand the longevity of their technology offerings;

2. Engage with RF mesh vendors to obtain firm budgetary costs for standard mesh technology and the mini mesh offerings;

3. update the economic modelling of the AMI options; and for those options that remain viable; and

4. issue a set of RFPs for smart meters, telecommunications technology, MDMS and pre-pay systems with view to implementing and AMI environment for TPL.