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History of Prepayment in Eskom

⇒ 1988 - "Electricity for All" concept developed.
⇒ customers had to be supported by the smallest amount of Eskom personnel.
⇒ system to operate with a low level of management and maintenance.
⇒ the standard billed system required a lot of day-to-day management to process accounts and to maintain connections and disconnections.
⇒ many of the areas where potential customers reside had almost no infrastructure.
History of Prepayment in Eskom
(continued)

- no fixed addresses, high unemployment, no bank accounts and no postal services
- many customers were illiterate and did not understand bills
- Eskom started the development of the basic prepayment system which is still in use today
- more than 5 million prepaid meters installed to date in South Africa
  - 3.2 million for Eskom
  - increasing by 250 000 annually.
Overview of Prepayment

• Allows customers to pay for a credit token in advance
• Enables automatic switch off if credit meter expires
• This has the potential to:
  • Increase cash flow for utility
  • Lower operating costs and management complexity
  • Prevention of bad debts and recovery of arrears
  • Sustainable solution with community involvement
Prepayment Components

- Prepayment is a strategic tool in managing revenue within a utility

- Management System
  - Computer system with database, management tools, reporting and security features

- Vending outlets
  - Computer based terminals where tokens are sold.

- Prepaid Meters
  - Electronic meter with display, keypad and disconnect switch
Typical Prepayment System

Vending Systems (Dispense Tokens)
(CDU)

Credit Transfer Tokens

Prepaid Meters
Installed in customer’s house

Utility Management Systems (SMS)

Customer Data

Vending Transactions
Upfront Vending Model

- Vendor Banks upfront
- Bank deposits received
- Credit file sent to CDU via SMS
- Vending permitted

Bank

Financial System

Customer Database

Credit encrypted

Data transfers

Vendor Banks

CTMS

SMS

Vendor Banks

Customer Database

Customer

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Prepayment: Benefits to Utilities

- Potential to improved revenue collection and cash flow for service providers

- Facilitates transparency
  - Ease of self meter read by customer
  - Community involvement in vending operation auditing and public relations
  - Processes & activities are more visible building trust in the system and utility staff

- Sustainability
  - Operational complexity hidden by technology
  - Low operational cost and improved collections ensure sustainability
Prepayment: Benefits to Community

- Improved services & accuracy
- No cut offs & reconnection fees
- No deposits, no surprise bills and no bill discrepancies
- Significant economic and job creation potential
  - Skills development
  - Downstream SMMEs development for
    - Token sales
    - Meter audits
    - etc
Standardization of Prepaid Meters

**Proprietary Meters**
- Different meters from different suppliers
- Different tokens – proprietary tokens
- Each supplier had own vending system
- Different meter sizes
- When meter fails, same product used to replace product that failed.
  - Strong possibility of being locked into one supplier

**Standard Transfer Specification (STS) Meters**
- Standard Common Base
- Standard tokens
- Standard vending systems from different suppliers.
- Faulty meters can be interchanged
- Eliminated the possibility of being locked into one supplier
What is STS?

STS is a secure, standard, common communication language (protocol) used to transfer standard encrypted tokens between prepaid meters and common vending systems from different suppliers.

Don Taylor
What is a Key?

A secret random number

3-bit Key = 8 combinations

101

56-bit DES Key = $72 \times 10^{15}$ combinations

1001 1100 1011 1110 1101 1101 1011 1011 1110 1001 1110 0001 1000 1011 1010

64-bit STS Key = $18 \times 10^{18}$ combinations

1001 1100 1011 1110 1101 1101 1011 1011 1110 1001 1110 0001 1000 1011 1010 1011 1111

DES keys are still widely used in the banking industry

STS key is 256 times “stronger” than a DES key.
Encryption and Decryption

The Key is a shared secret between sender and receiver.
Current Meters in use

Meters from Different Manufacturers

Common Base for all Meters

Different meters fit on Common Base
Installation of Prepaid Meters
Factors that impact on performance of prepayment

- Meters installed not reliable – technology not proven
- Meter tampering and vandalism
- Database Integrity – slow system update
- Lack of real time or near real time data.
- Integrity of Sales - Data corruption
- Loss of cash from vending stations – poor security
- Shortage of skilled prepayment staff in the country
- Customers reject prepayment system.
- Lack of Revenue Management Skills
- Inability to measure energy delivered to all towns, settlements and customers accurately
- Poor vending management
Sustainable Prepayment System

- Internal
- External

Stakeholders
- Customers
- Vendors
- Suppliers

Processes

Technology
- Standard Protocols
CSF: Why do you want Prepayment?

- Old meters or obsolete meters?
- Vandalism?
- Move away from fixed accounts?
- Estimation of bills?
- Reduce administration costs?
- Socio-Political factors?
CSF: Service Philosophy

- Highly available commodity
- Take the point-of-sale to the customer
- Serve the whole customer base
- Choice of purchase method
- Range of points-of-sale
- Trustworthy Vending Agencies
- Security of purchase
CSF: Engage Customers

- Customer education
- Communication with customers
- Continuous community involvement
- Accessibility to customer query
CSF: Prepayment Procurement Overview

The number of suppliers is limited to only two or three bulk contract holders.

Award of supply contracts is based on:
- successful negotiation of price,
- contract conditions,
- compliance standards/specifications.

Quantities are determined and allocated in negotiated contracts based on:
- the basis of price,
- field performance during the previous year,
- accelerated life test results and specific area requirements.

The contract duration must be determined upfront with an option to extend subject to future requirements.
CSF: Prerequisites for Meter Manufacturers to Qualify for Tender

- Hold an SABS ISO 9001 for quality management system applied to their meter design and production facilities
- Must produce a product bearing the SABS mark (SABS 1524)
- Hold a valid Standard Transfer Specification (STS) license
- Have product certified as: STS compliant
- Meeting Particular Requirements for Prepayment Meters Supplied to Eskom.
- Have Eskom’s approval of their 6 monthly submissions for Software Producing Quality Assessment (SCSPVABS8) for at least a full year in advance
- Have manufactured and supplied product in excess of 30,000 units in the two year period immediately preceding the issue of the enquiry
- Existing production capacity must meet 33% of Eskom’s planned requirements
- All products offered will, at the discretion of Eskom, be subjected to ALT testing as part of the enquiry process.
- All modifications and upgrades of meters must be approved by Eskom
CSF: Database Accuracy

• Ensure meters and customers are correctly linked in Management System
• Ensure all vending machines are reflected on Management System
• Upload sales regularly to the Management System
• Non-prepayment points of delivery in an area are known for energy balancing purpose
CSF: Prepayment Supporting Structure
Non-Technical Energy Losses = Energy Delivered - Sales - Technical Losses

*technical losses usually estimated @ 10% in Eskom*
CSF: Vending Management

- Security Module failure
- Decommissioning of security modules
- Stolen vending units and security modules
- Stored vending units and security modules
- Key Management system
  - Vending key (SGC)
- Online Vending
  - Security Module centralized
Remarks on Prepayment Meters

- Customer requirements and environment must drive your prepayment project
- Clearly define the drivers for system implementation
- Prepayment solution is only as good as your management system
- Do not implement new technology until it is tried and tested
- Never implement a proprietary system!
- Engage with other prepayment system users to learn from their experiences
Online Vending
Eskom Drivers for Online Vending

• To comply with the requirements of NERSA (NRS047):
  • 1 vending station for every 2 000 customers, within a 5km radius.
• To significantly increase current vending footprint
  • improve convenience and introduce various purchase channels
• To increase control in the prepaid environment
  • centralise management of tariff, transactions and customer data
• To reduce opportunities for fraud
  • Centralised management of security modules
  • automate transaction uploads and phase out offline CDUs
• To improve vending efficiencies
  • Centralised management of vending business logic
Benefits of Online Vending

- Improved data integrity and management
- Improved tariff management
- Increased vending footprint
- Improved financial risk management
- Improved financial control
- Increased business opportunities for SMMEs
- Centralised management of transaction data
- Customers able to purchase tokens nationwide, enabling ubiquitous vending.
Online Vending Infrastructure

Secure Eskom Environment

Customer Care & Billing (Cordaptix) Database

Online Vending Server Database

SAP

Bank Deposit

Bank

TX Uploads

Credit Downloads

Customer Data Downloads

TX & Data Upload/Download

System Master Station

Firewall

External to Eskom

Terminals

Sub Agents/ATM’s

Offline Credit Dispensing Units

Future

Existing

Secure Eskom Environment

Current (to be phased out)

Future

Future

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Online Vending Model Configurations

Multi-Client Vending

Vending Client → Vending Client → Vending Client

Gateway Vending

Online Vending Terminals in all Regions

Region 1
Region 2
Region n

Client Vending

Vending Client
Potential Sales Footprint/Vending Outlets

Online Vending Server
- Meter number
- Tariff Index
- Supply Group Codes
- Account number
- Stand Number
- Connection fee
- Customer details
- Arrears balance

Retail Chain Stores
Engage National Agents using Merchants
Contact Centre

ATM’s
Internet

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Split Metering
Drivers for split metering

- **Utility problem**
  - When the meter is installed inside the consumer’s house, Customer has full access to the prepayment meter
  - Fraud and tampering [with the meter in the house] is difficult to control
  - Limited or no access [for the utility] to the meter if the customer does not allow access
    - Making auditing and inspections a difficult task for the utility
BS Split Prepayment Meters

• BS Split Overview
  • **Wired and PLC communication** variants
  • Meter is typically installed remotely in a street kiosk
  • Customer Interface Unit is installed in a convenient location inside the consumer’s house

• Benefits for the utility
  • Split prepayment metering **reduces fraud and tampering**
  • BS housing makes it **easy to retrofit** a standard credit meter with a prepayment meter / **suitable for kiosk installations**
DIN Rail (split meter) family

• DIN Rail Split Overview
  • Wired and PLC communications variants
  • Meter is installed remotely in a pole-top enclosure or street kiosk
  • Customer Interface Unit is installed in a convenient location inside the consumer’s house
Principle of Operation: Wired Comms - BS

Communication
Communication wires required (Normally in the air-dac)
- Two core cable (non polarized)

Communication distance up to 130 m

Street kiosk

House

Customer Interface Unit

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Typical Installations
Principle of Operation: Wired Comms - DIN Rail

Communication
Communication wires required (Normally in the air-dac)
- Two core cable (non polarized)

Communication distance up to 130 m

Customer Interface Unit
Typical Installations
General Benefits: Split Prepayment Metering

- Meter is situated remotely (kiosk or pole top)
- Meter accessible to utility field technical staff for audits & inspections – at all hours
- No need to enter the customer’s premises to inspect the meter
- Proven world wide to reduce incidence of fraud and tampering
- Excellent technology to support revenue protection program
**Benefits**

- Split prepayment metering (Credit or Prepayment Mode)
- No additional communication wires required
- Communication by means of PLC (Power Line Carrier)
- Secure kiosk with remote access

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**Principle of Operation: PLC Comms - BS**

[Diagram showing the setup of the system with labels for the house, Gemini PLC, PLC Communication, and Customer Interface Unit.]

- **Customer Interface plugs into electrical outlet in the house**
- **PLC Communication between the meter and Customer’s Interface**
- **Customer Interface Unit**

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Typical Installations
**Benefits**

Split prepayment metering (Credit or Prepayment Mode)
No additional communication wires required
Communication by means of PLC (Power Line Carrier)
Secure kiosk with remote access

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**Principle of Operation : PLC Comms - DIN Rail**

Customer Interface Unit plugs into electrical outlet in the house

PLC Communication between the meter and Customer's Interface

Power-Rail PLC

House
Typical Installations
Benefits: PLC/RF Split Prepayment Metering

- Obvious benefits of split metering apply
- Uses existing installation cables, no changes required to wiring / installation
- Typical Installations:
  - Townhouse complexes, apartments, protective structures etc
- Power Line Communication
- Reduced installations costs & time
Remote Access Solution- Benefits for the Utility

- Fraud notifications / check status of the meter remotely
- Alerts to tamper conditions
- Two way communication with the prepayment meter
- Auditing prepayment meter installations remotely
- Remote access of meter parameters – consumption patterns, predictions, statistics, load profile – these are some of the benefits
- Remotely entering the STS token into the meter
Advance Metering Infrastructure (AMI)
Requirements for Smart Meters

- Real-time, two-way communications - Automated meter readings
- **Cater for various TOU tariffs and billing thereof**
- **Remoter load management** of various appliances in the customers’ home when required.
- Remote connect and disconnect
- **Load limiting (limit output power)**
- **Under frequency load limiting option as last resort**
- Tamper, Outage detection, Fault detection & Restoration
- Revenue protection, Credit & Device Management
- Modular Communications module (future flexibility) and accommodates multiple communication mediums.
- Separate in house display unit. (wireless (RF) or PLC comms)
- Reasonable costs of the meter and operations to yield a sound business case.
- Provision of ancillary services, e.g. VOIP, Internet, IPTV, Water & gas
1. Execute scheduled & system emergency load management functionality (conservation of power):
   • Approx. 3000MW\(^2\) of total SA suburban consumption can be reduced by smart meter load limiting device;
     • via single wireless broadcast, and
     • restore individually or in a group via a staggered comeback approach with advanced, intelligent master station.
   • Customer has electricity for a few essential appliances (lights, TV, microwave, security), but will not be completely load shed.
2. DSM energy efficiency (tariff drives and incentivises the efficient use of electricity, conservation of power, promotes changes in lifestyle behaviour).

3. Savings to economy (avoid key industrial customer load shedding).

4. Contributes to restoring a workable reserve margin to alleviate strain on generation assets.

5. Avoids expensive and normal Generation costs.

6. More cost reflective recovery of costs. Improved business efficiency

7. Installation of integrated load management smart meter devices:
   • yields additional benefits to business (bi-directional, real-time communications to meter, tamper-detect, remote connect/disconnect).
9. Improved, dynamic customer messaging.
10. Effective implementation of Power Conservation Programme to residential and commercial customers
   • currently inaccurate metering estimations is not effective measurements for the implementation of tariffs incentives or penalty.
Future Meter Functionality

- Prepayment or Credit meter
- Remote disconnect & reconnect
- Outage & Fault Notification
- Power Quality (Voltage) Monitoring
- Remote Electricity/Water Meter Reading and load management
- Detection of Tampering and Load Shed Bypassing
- Two-way Wireless Communication
- Dynamic customer messaging
- Load Limiting/Reduction (Limits supply capacity size)
- Staggered come-back loads for load reduction
- Time-of-Use ENABLED
- Administer Free Basic Services
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Ideal Communication Technology

**Ubiquitous**
Available everywhere

**Easy Installation**
- No need to install additional cables
- Plug-and Play supported

**Cost Effective**
- Low cost to build network
- Indoor & outdoor solutions supported using single infrastructure
- Minimal or no maintenance at all

**New Business Models**
- Homenetwork service (IPTV/VoIP/Data)
- Many value-added services
- Easily embedded in home appliances

Adopted from Xeline
Communication Technologies

- FTTH (fiber to the home)
- XDSL
- UMTS
- HBR PLC
- GSM, GPRS
- Radio (TETRA)
- LBR PLC

Bitrate

- 1 kBit/s
- 100 kBit/s
- 10 MBit/s
- 1 GBit/s

Kaltenleithner

Suitability for full scale roll-out
Profitability of the solution
Safety of investment

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AMI Solution Architecture

Vendors tend not to use Oracle Database
Vendors tend not to use Java
Challenges of providing value-added Services

• The cost of the meter
• Service to be provided may not be a core business of the Utility
• Some services require licences e.g. telephone, TVIP, etc
• Bad service provided by one service provider could affect other services
• Utility may have to enter into a partnership with a third party?
• Customers may not understand who provides which services if different services providers are involved in an area
• Who owns the communication network?
Load Management & Limiting using SM

Load Management of Appliances
- Ownership of appliance management device
- Positioning of appliance management device (COC)
- Control of appliance management device
- Protocols between meter and device

Load Limiting (Adjust Power limit between 80A -10A)
- If customer is not at home - consider impact of switching on/off appliances.
- Meters locks out & Switches off
- Dynamic control of appliances?
- Ownership
- Protocols between meter and device
Prepayment AMI

**Challenge:** Most prepayment AMI Systems are not STS based

**Way Forward**

- Use of split meters in Eskom
- Enhancement and standardization of communication port for prepayment meters
- Use of one communication device to support multiple meters in the same enclosure
- Remote controlled disconnect & connect mechanism at feeder or transformer level for DSM & Load Shedding
- Integration with Online Vending Server & sending of STS tokens to meters from central locations
- Prepayment TOU as defined by STS2 specification
- Third party services like Voice-Over-IP (VOIP) or broadband internet can be introduced
AMI Impact on Staff

- Maintenance of smart meters requires advanced skills
- Who will do data acquisition?
- Response to meter events & alerts, tamper alarms
- Process for remote reconnects/disconnects
- If we go for hybrid telecomms option - i.e. PLC with GPRS - this will also need to be maintained
- Detailed impact to processes & OD impacts - will be determined during Homeflex and split meter project implementation
Conclusions

• Clearly define the drivers for system implementation
• Decision to implement smart meters must align with Utility Vision & Strategy
• AMI processes are not always integrated into the existing operations
• Do not fully implement new technology until it is tried and tested.
• Never implement a proprietary system! Insist on some international standard.
• Unique Utility requirements could inflate cost of meters
• Best project management practice is critical to the success of an AMI project