USTDA Senegal Solar Minigrids Project:

Considerations for Prepayment Meters and Suggestions for Improved Technical Standards

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Presented at the ANSI Mini-Grids Workshop:
Lessons Learned; Technological Advances;
Regulatory Framework & Quality Assurance

Dakar, Senegal
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Overview of MRIGlobal

- Over 70 years of engineering, science, and R&D providing services in energy, US national security and defense, and global health sectors
- Involved in managing & operating major U.S. national energy centers and facilities:
  - *U.S. National Renewable Energy Laboratory (NREL)*
- Design, installation, and field operations of minigrids for several US govt. agencies
- Doing business in Africa for the past 4 years
  - *East Africa (Tanzania, Kenya)*
  - *West Africa (Senegal, Sierra Leone, Guinea, Liberia)*

Outline of Presentation

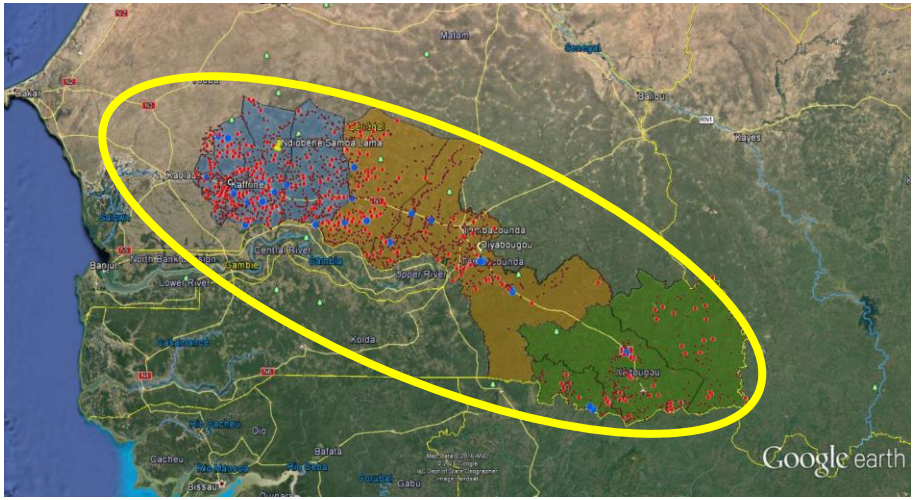
- Senegal solar minigrids project overview
- Considerations for prepayment meters
- Technical standards and gaps in addressing new technologies
- Benefits of improved standards

Overview of USTDA Senegal Solar Minigrids Project

Background, Scope, and Objective

- **Background** – Energie Rurale Africaine S.A. (ERA) has received a Grant from the U.S. Trade and Development Agency ("USTDA")

- **Scope** – MRIGlobal is providing technical assistance for the implementation of minigrids in 31 villages in three regions of Kaffrine, Tambacounda, and Kedougou

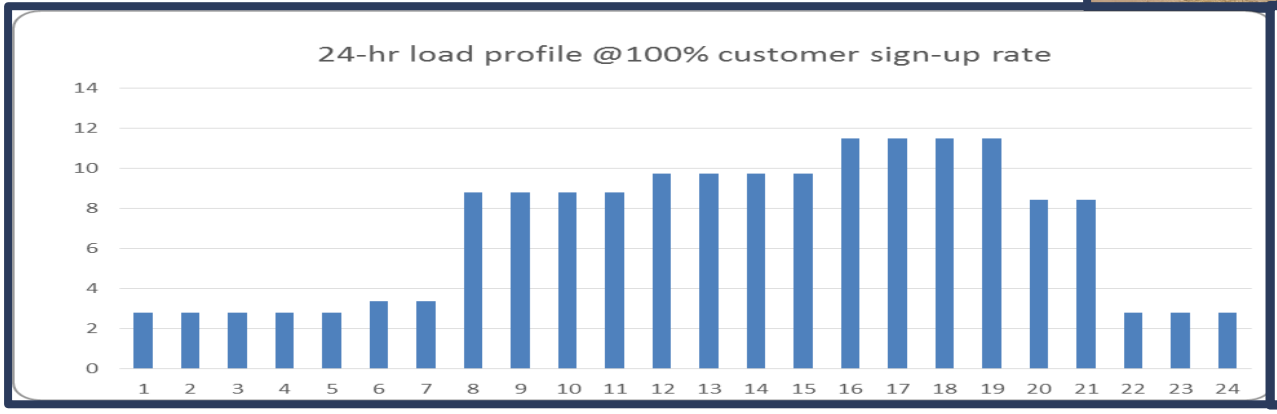


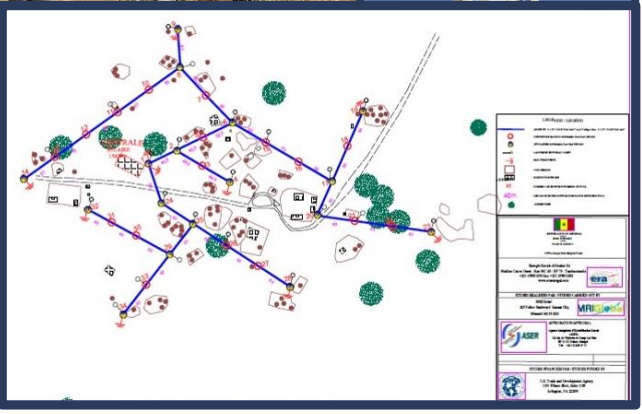
- **Objective** – Prepare a bankable feasibility study report that can be used by ERA to obtain financing for the project from one or more international financing institutions (e.g., US EXIM bank, OPIC)

Areas of Technical Assistance
(Tasks included in feasibility study)

Energy Evaluations and Conceptual Design of Minigrids for 31 Villages

- **Site Visits** to compile energy usage and requirements data and identify suitable locations for minigrid power plants
- **Energy Load Profiles** – Developed electricity load profiles over a 24-hour period for all 31 villages
- **Conceptual Design** –
  - Estimated optimum power plant configuration and size using HOMER
  - Prepared transmission and distribution network layout for each village minigrid





Advanced Metering Technology Evaluation and Pilot Project

- **Metering Technology Assessment and Recommendation for Pilot** – Reviewed, compared, and recommended metering technologies to pilot

- **Metering Pilot Project** – Installation and commissioning of Pilot project at a selected village using recommended metering technologies

Future Task Areas

- Economic and Financial Analysis

- Implementation Financing

- Environmental and Social Impact Assessment

- Development Impact Assessment

- Project Implementation Plan

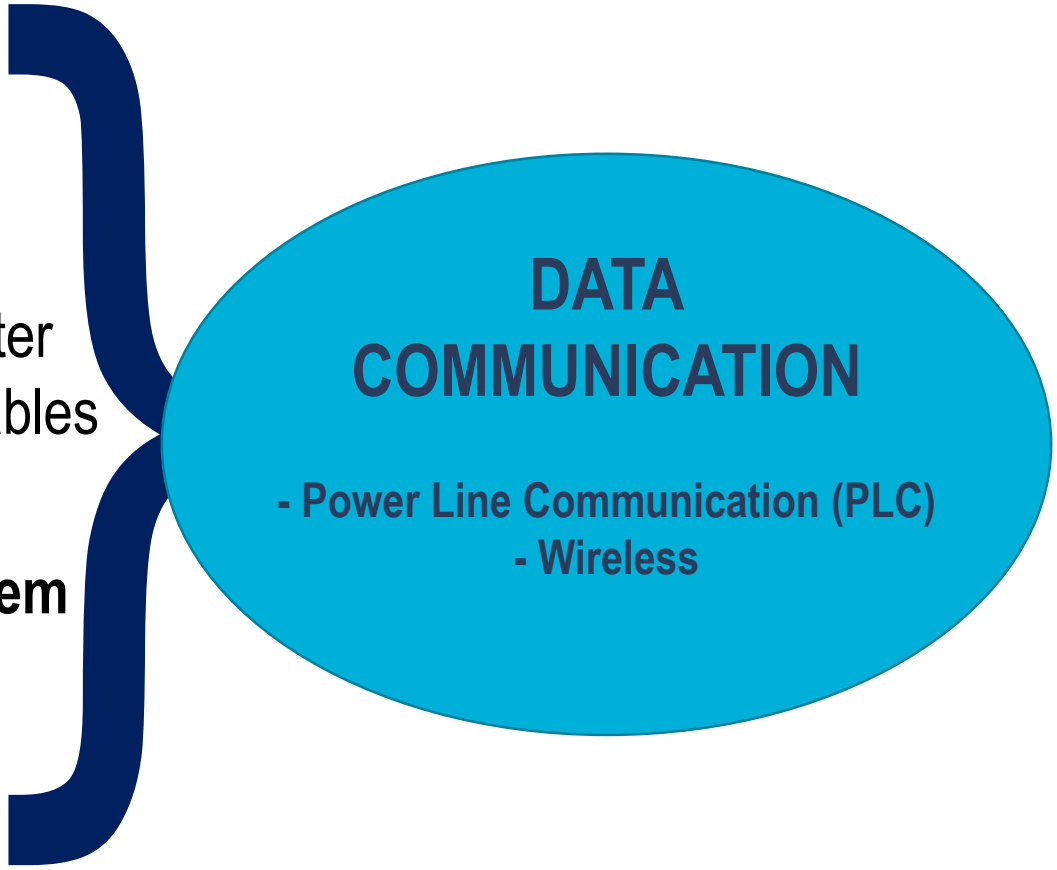
Considerations for Prepayment Meters

- Overview of prepayment systems
- Operator perspective

Basic Components of Prepayment Metering Systems

Prepayment systems typically have three components:

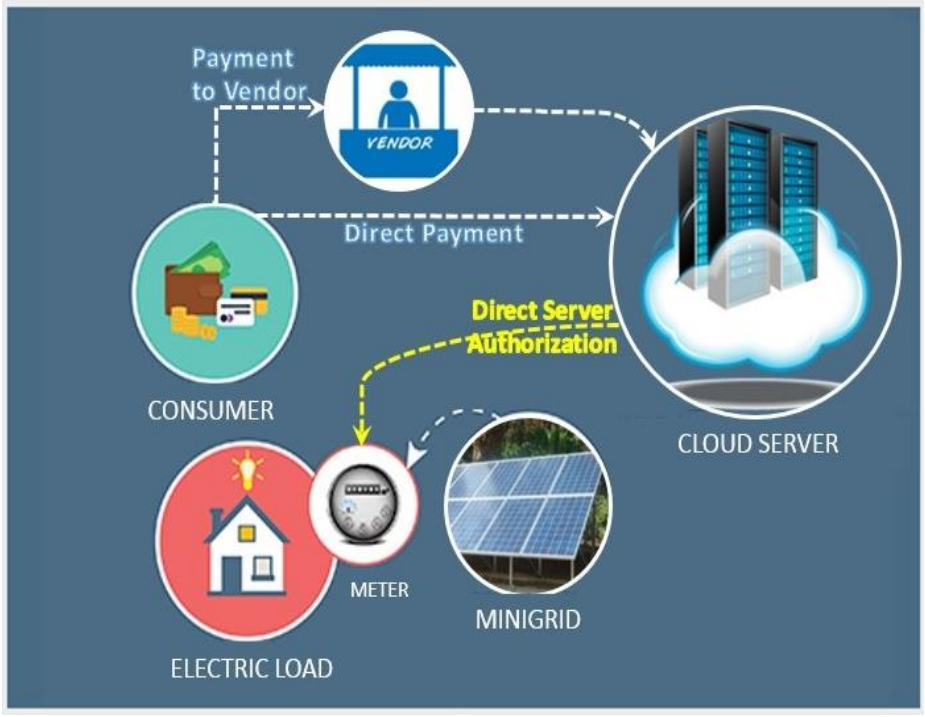
- **Prepaid meters**: the measurement and metering device
- **Vending / Server system**: a payment acceptance and meter authorization system that enables secure sales
- **Revenue management system (CRM)**: installed at the utility operator to manage the prepayment infrastructure and customer relations



General Architecture for Prepayment Metering Systems

Two types of architecture available for prepayment systems for electricity metering

Prepayment Metering with Vending Management/ Token System



Prepayment Metering Using Meter Authorization Without Tokens

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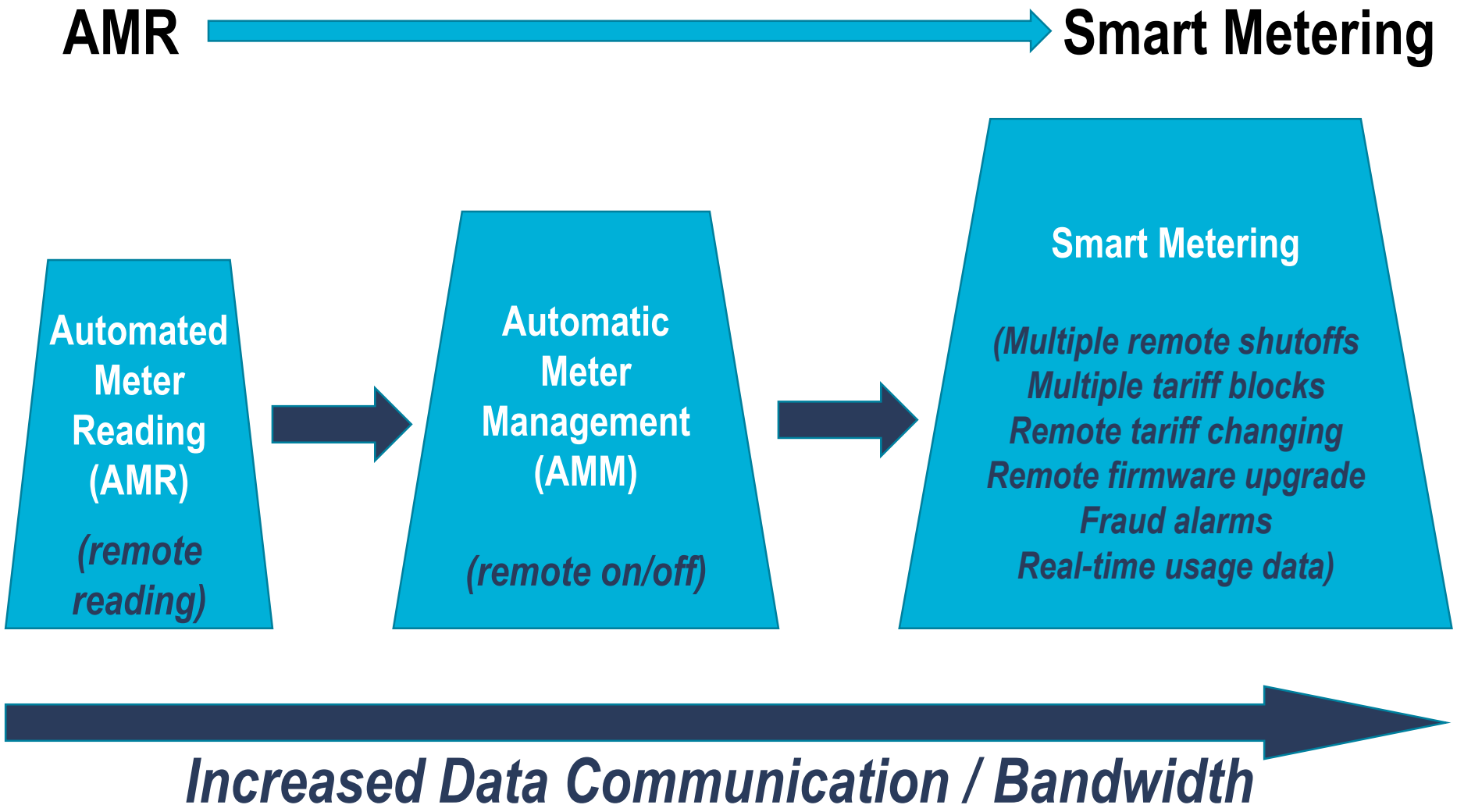
Prepayment Metering with Vending Management/ Token System

Prepayment Metering Using Meter Authorization Without Tokens

Evolution of Advanced Metering Infrastructure (AMI)



Possible Considerations for Operators in Rural Electrification

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National Solutions Worldwide Impact

Business Sustainability

- Interoperability
- Cost effectiveness

Communication

- Bidirectional
- Remote monitoring
- Speed / bandwidth
- Ability to use own server

Measurement Features

- Starting current
- Electricity theft detection
- General accuracy

Physical Features

- Tamper protection
- Split/combo
- Front display
- Keypad

Sales and Revenue Management

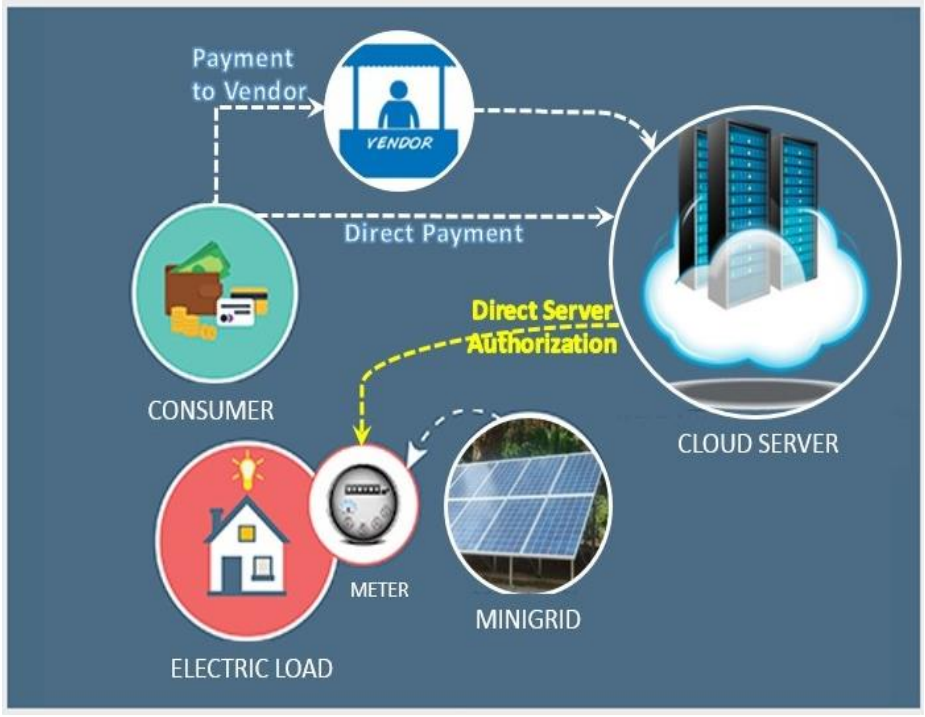
- Ease / speed of vending system
- CRM system capabilities
- CRM system ease of use
- Data reporting capabilities

Interoperability Considerations in Metering Systems

Advantage - Flexibility to switch between meter manufacturers

Requirement – Standardized compatibility with vending systems

Prepayment Metering with Vending Management/ Token System



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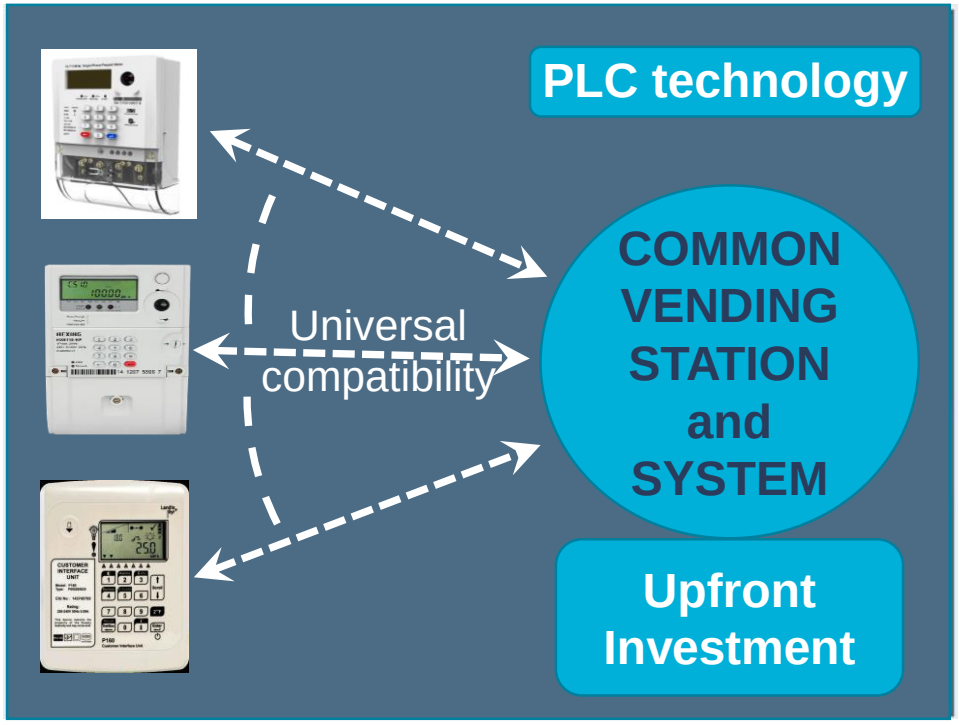
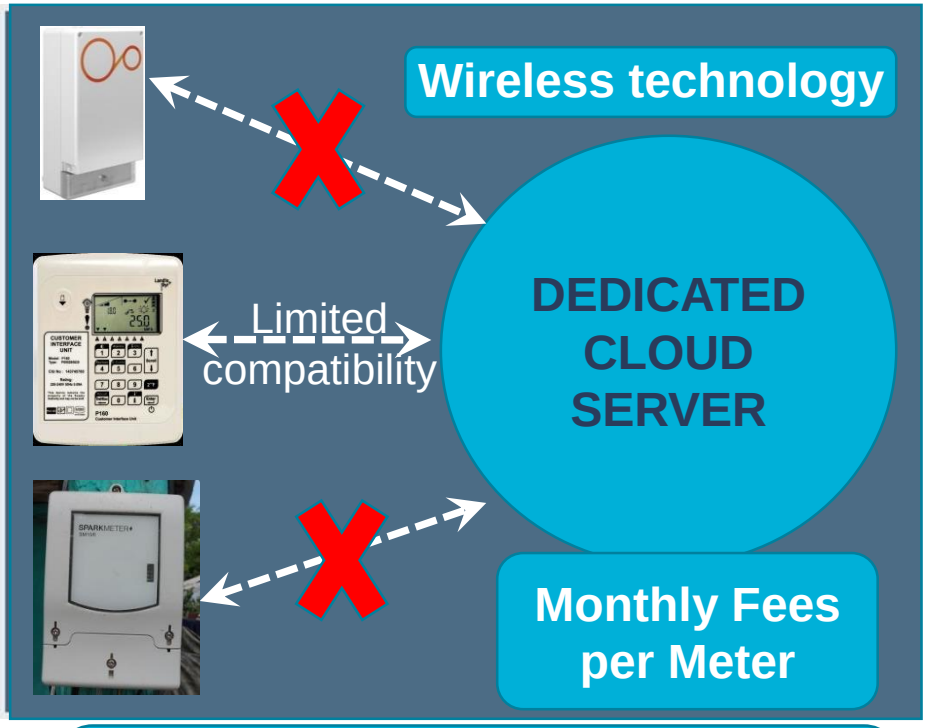




- Meters more expensive ($105 - $120)
- Slower communication
- Higher starting currents (>20 mA)
- Requires vending agents

- Meters less expensive ($40 -$45)
- Faster communication
- Lower starting currents (10-20 mA)
- Electricity theft detection

Technical Standards for Meters

- Updates necessary to address improvements in technology

General Categories of Standards for Prepayment Metering Systems

As a general rule, outside of North America, IEC and European Standards (EN) provide quality assurance for electricity meters:

- **Safety and mechanical standards**
- **Metering accuracy**

All commercially available meters adhere to one or more of these standards

- **Standards to ensure data security of prepayment systems**
  - customer payment data must be both securely and accurately communicated to the meter
  - meter should be able to turn on and turn off electricity supply when the payment credit has been used up

STANDARDS HAVE NOT KEPT UP WITH TECHNOLOGY

Security Protocols (Standards) for Prepayment Metering Systems

With Vending Systems (PLC communication)

- **Use the Standard Transfer Specifcation (STS) Protocol**
  - ✓ Designed with the goal of interoperability in the 1990s
  - ✓ Open standards independent of a particular supplier
  - ✓ Prevents fraudulent use, generation, and tampering of tokens
  - ✓ Certification by STS is required
  - ✓ Meters must have a keypad and display

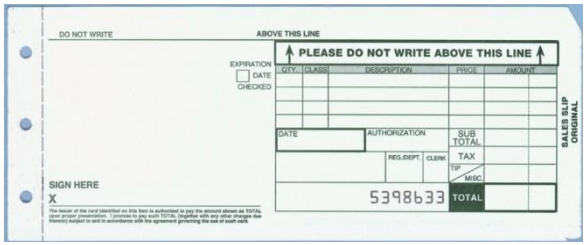
Without Vending Systems (wireless communication)

- **Use transport layer security (TLS) protocol for security of the payment data**
  - ✓ TLS is the successor to SSL
  - ✓ Provides data security between client/server applications for internet communications
  - ✓ Interoperability is not possible because of unique client/server security
  - ✓ Not necessary to have a keypad or a display

The Gap Between Standard and Technology

Payment Data Transfer Evolution for Credit Cards

1980s → ***1990s***



No standards → ***SSL*** → ***TLS***

2000s → ***Present***

The Problem with STS Payment Standard

1997 → 2006 → 2018

No major updates in STS standards from the 1990s →

- Achieves interoperability at the cost of the latest technological advances
- STS payment protocol needs to be updated to address 21st century improvements in communication with wireless technology

No interoperability
$40 - $45

Satisfies Interoperability
$105 - $120

Interoperability for Customer Relations Software

- **Many meter manufacturers have dedicated CRM software**
  - Operator will have to track multiple screens for meter data from different vendors
- **Software integrating CRM output from multiple meters into a single interface for the operator will help interoperability**

Summary and Observations

- Meters used in rural electrification are based either on PLC communication or wireless communication
- Meters based on wireless communication have several advantages but lack interoperability
- Updating of STS protocol to address wireless meters could have a significant positive impact on rural electrification
  - Interoperability between all types of meters
  - Faster communication at a reduced cost
  - Data transparency for regulators, if desired
  - Standardization of bidding specifications
  - Better guidance for meter manufacturers
- Interoperability will also improve with CRM software integration

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THANK YOU

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