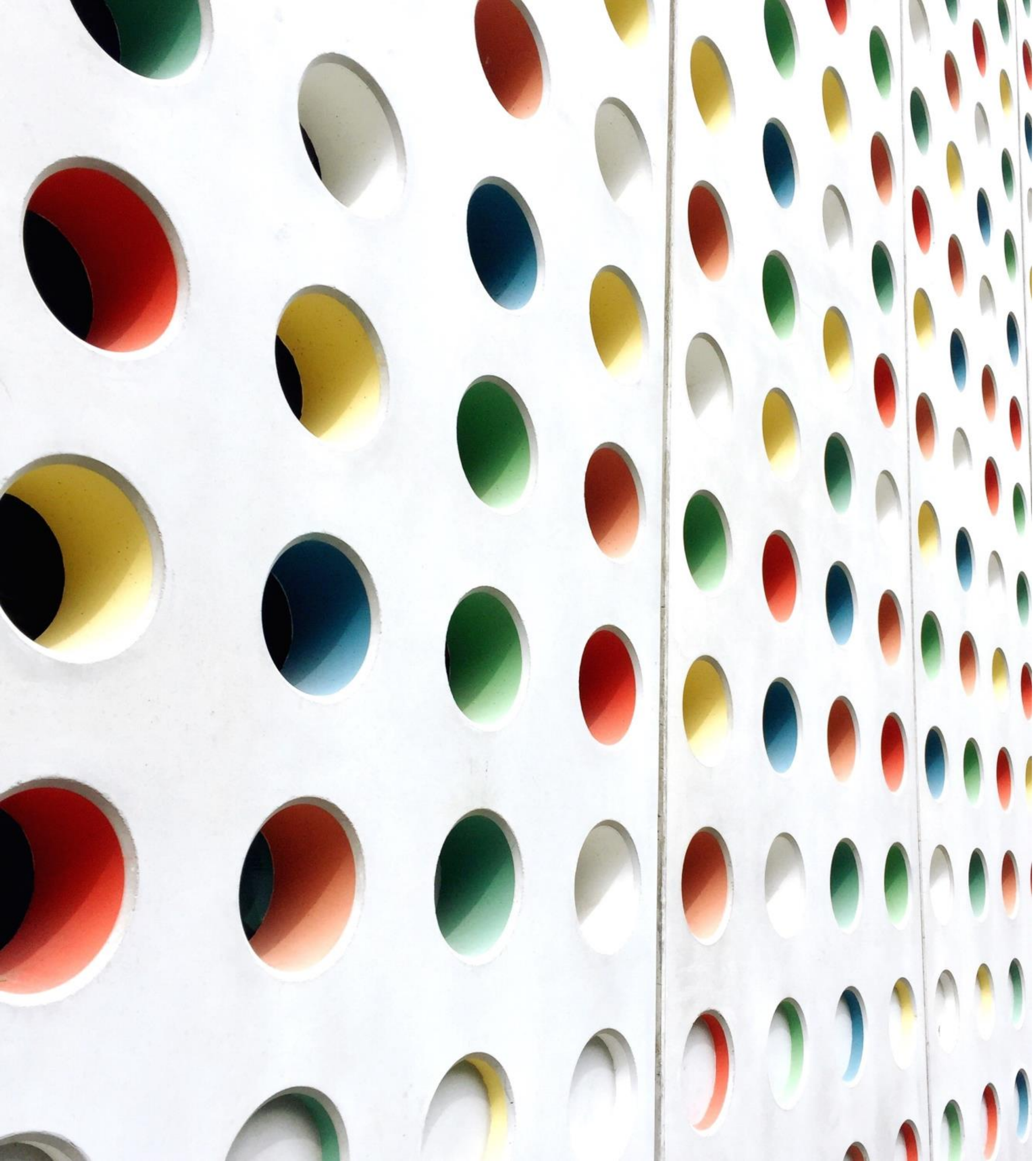


Past, present and future of metering.

PRESENTED BY

ELRON B. AWASE

TESLA ENERGY SOLUTIONS

Table Of Content

Introduction

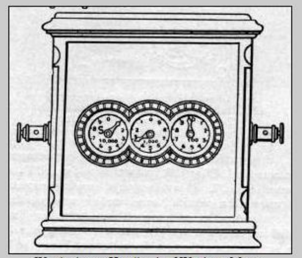
- **The DC Lamp-Hour Meter –152 years**

  Samuel Gardiner Patented a DC Lamp-Hour Meter in 1872 that utilized an actuator which recorded hours when current was present.

- **The AC Lamp-Hour Meter – 146 years**

  J.B. Fuller Patented an AC Lamp-Hour Meter in 1878 that utilized an armature which recorded hours when the two coils vibrated.

- **Tesla Energy Solutions Pty Ltd.- established in 2008** Walvis Bay based, 100% Namibian owned.



Westinghouse Handbook of Watthour Meters

Introduction

- Electric metering systems were predominantly based on analog technology.
- Mechanical meters measured total electricity consumption & required manual reading utility personnel.
- Labor-intensive, dependent and often prone to errors.
- Foundation of electricity billing for many years.

Metering Timeline I

The Rise of an Industry –1890's –1920's

Siemens & Halske

Diamond Meter Co.

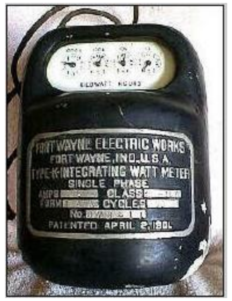
Stanley Instrument Co.

Federal Electric

Holcomb & Hoke

SEMCO -Sewickley
Elec. Mfg. Co.

Duncan



Fort Wayne

General Electric

Sangamo

Westinghouse

Metering Timeline II

The Depression Hits –1930's

- National Electrical Light Association (NELA) and Meter Committee disbanded in 1932
- Creation of Edison Electric Institute & Meter Committee in 1933 to continue the policy work of NELA
- **The Big 4 Emerge –Duncan, Sangamo, GE, Westinghouse**

Metering Timeline III

1950's & 60's –Standardization

- All Meter Companies benefited from the large economic expansion post war.
- **Standardization on S-Base, Commoditization, and Compatibility** became key themes.

Metering Timeline IV

1970’s & 1980’s –Modernization Begins

- Rise of the Electronic Meters –ABB E-1 Hybrid & The Legendary Scientific Columbus JEM-1
- Introduction of Solid State Electronics creates big opportunities for measurement
- **In 1975 Both Duncan and Sangamo sells**

Metering Timeline V

1990's & 2000's-Data

- Rise of the Electronic Meters
- AMR Systems begin to proliferate major cities
- L&G (formerly Duncan) becomes L + G
- Schlumberger (formerly Sangamo) becomes Itron
- Sensus enters market
- Westinghouse purchased by ABB, then Elster becomes Honeywell
- GE becomes Aclara then becomes Hubbell

Present: Smart Metering Systems

- Technological advancement revolutionized metering and lead to the emergence of smart metering systems.
- Key features of the present-day electric metering:
  - **Digital Technology**:
    - Smart meters leverage digital technology,
    - Enables accurate measurement and real-time monitoring of energy consumption.
    - Equipped with solid-state sensors and microprocessors for data collection.
  - **Two-Way Communication**:
    - Built-in communication capabilities allow smart meters to transmit data remotely between consumers and utility companies.
    - Eliminates the need for manual meter reading, reduces operational costs, and enables near real-time billing.

Present: Smart Metering Systems

- Key features of the present-day electric metering, cont.:
- **Data Analytics**:
  - Generation of Big data for analysis and gaining valuable insights into energy consumption patterns.
  - Optimization of distribution networks and
  - Implementation demand response programs.
- **Consumer Empowerment**:
  - Provide consumers with detailed information on their energy usage,
  - Enabling making informed decisions about energy efficiency and conservation.
  - Promotes sustainability culture and empowers end-users to actively participate in managing their electricity consumption.

Future: Advanced Metering Infrastructure (AMI)

- **Microgrid Integration**:
  - Increase in adoption of renewable energy sources & microgrids,
  - Adaptation of metering systems to bidirectional power flow and complex energy management scenarios.
- **Internet of Things (IoT) Connectivity**:
  - Utilization of IoT technologies to connect various devices within the distribution network,
  - Enable seamless communication and data exchange.
- **Predictive Analytics**:
  - Advancement of algorithms and Artificial Intelligence (AI) to enhanced predictive analytics.
  - Enable forecasting of energy demands,
  - Optimization of grid operations, and prevention of system failures or outages.
- **Energy Storage Integration**:
  - Monitoring and optimizing energy storage systems,
  - Facilitating the effective integration of energy storage into the grid infrastructure.

Applications: Concepts

Clean Energy, alternative to steam engines

Everything moved on electricity. High dependability.

Power Quality issues plaguing customer's process reliability

kWh@ PowerQuality

Customers demand quantity & quality

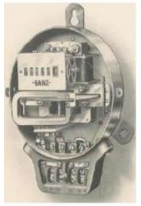
Time and Evolution

Alternating Current commercialised

Integrated Grid formed with fossil & renewable

Digitalisation, efficiency and control became the centre stage of economy.

Metering to expand its scope of measure Energy meter + PQ for invoicing.



Bláthy's meter in 1914

Commercial Use (1878 - 1925)

Measurements 1888 – Today ANSI Standard C12 (1910)

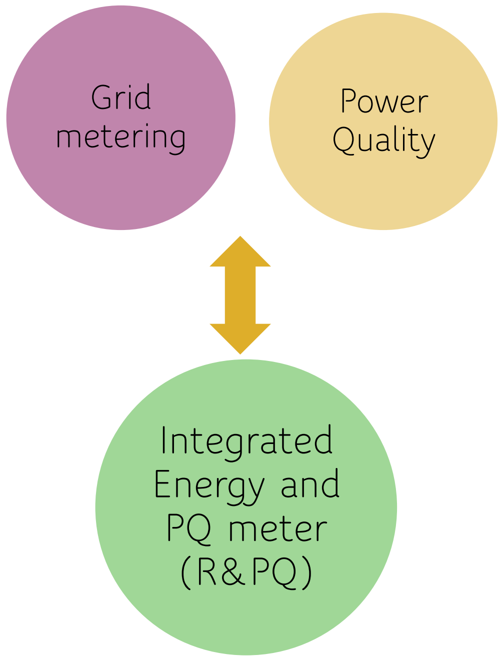
Quality of Supply 2003 – Today (IEC61000-4-30)

Applications: Integrated Revenue and PQ metering

Present Practices

- PQ is measured at PCC / Select Consumers
- Individual device for Revenue Metering and PQ Metering
- Devices work on multiple protocols
- Energy Consumption and PQ data is analyzed separately

- Advantages of Revenue combo Power Quality Metering **(R&PQ)**
  - Supports Revenue Grade Metering
    - Features like Time of Use/ Multi-Tariff Support
    - Integration with AMR systems over DLMS
  - “Class A” PQ measurements



Applications: Integrated Revenue and PQ metering standards and regulations

tesla

PQ measurement standard

IEC 61000-4-30
Measurement methods for PQ

IEC 61000-4-7
Harmonic and inter harmonic measurement

IEC 62586
Functional test and limit for PQI

PQ Regulation

EN50160/ Country specific
Voltage supply requirement

Country specific regulations
e. g. BIS, NRS, NVE etc.

PQ guideline

IEEE 519-2014
Harmonic control in power systems

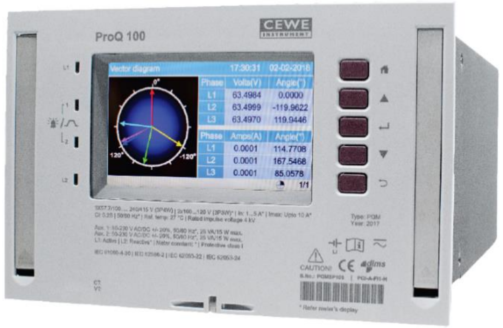
Revenue metering standards

IEC 62052-11
IEC 62053-22/24
General requirement, testing, accuracy

Communication standards

DLMS, IEC 61850, Modbus

Application: Revenue Metering Features



16 Time of Use (Multi-Tariff) , 16 Time Zones, 50 Special Days

Billing parameters - Import/ Export & net metering

Class 0.2s

Type Tested Revenue Meter, Large Graphical Display

Storage

Dual Loggers

600 parameter day storage

Optical, RS485, RS232, Ethernet, Fibre, USB Port

Inbuilt Webserver

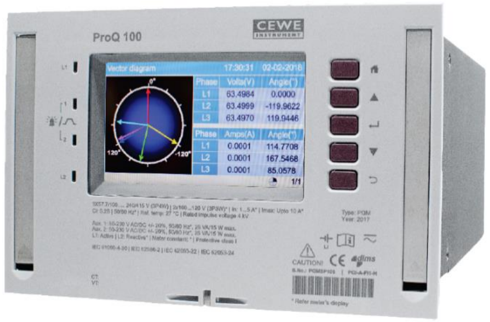
DLMS, Modbus, IEC61850

SNTP Time synchronization

Color Graphical Display.

4 O/P +4 Cnfg I/O, Alarm & Calibration LED

Application: PQ Features



THD, TDD, K Factor, Flicker, Unbalance, Sag/Swell

Reliability Indices, Harmonic Analysis, Transient Measurements

Class A Certified

(IEC 61000-4-30, Ed3, Instrument: IEC 62586-2)

EN50160, IEEE519, ITIC, Semi47 Reports

Customized Reports :NRS048

Reliability Indices, Harmonic / Transient Measurement

RMS, Waveform streaming, Waveform analysis

PQDIF

(IEEE1159-3)

Application: Integrated Metering

Revenue & Power Quality Meter : ProQ100

Energy accuracy: IEC 62053-22, 0.2S

Wide range

2 calibration and 2 alarm LED

Dual auxiliary supply

Extensive logging – dual loggers

Multi-tariff support

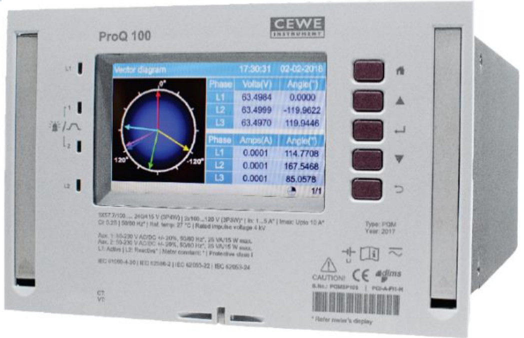
Event / alert recording

Flexible tariff configuration

Delta value logging support

Non-liner error compensation for CT ratio

- Design: IEC61000-4-30 Ed. 3, Class A
- Compliance report (eg **EN50160/ZRS)**
- K Factor / TDD/ Direction of Harmonics
- PQ parameters logging and reporting

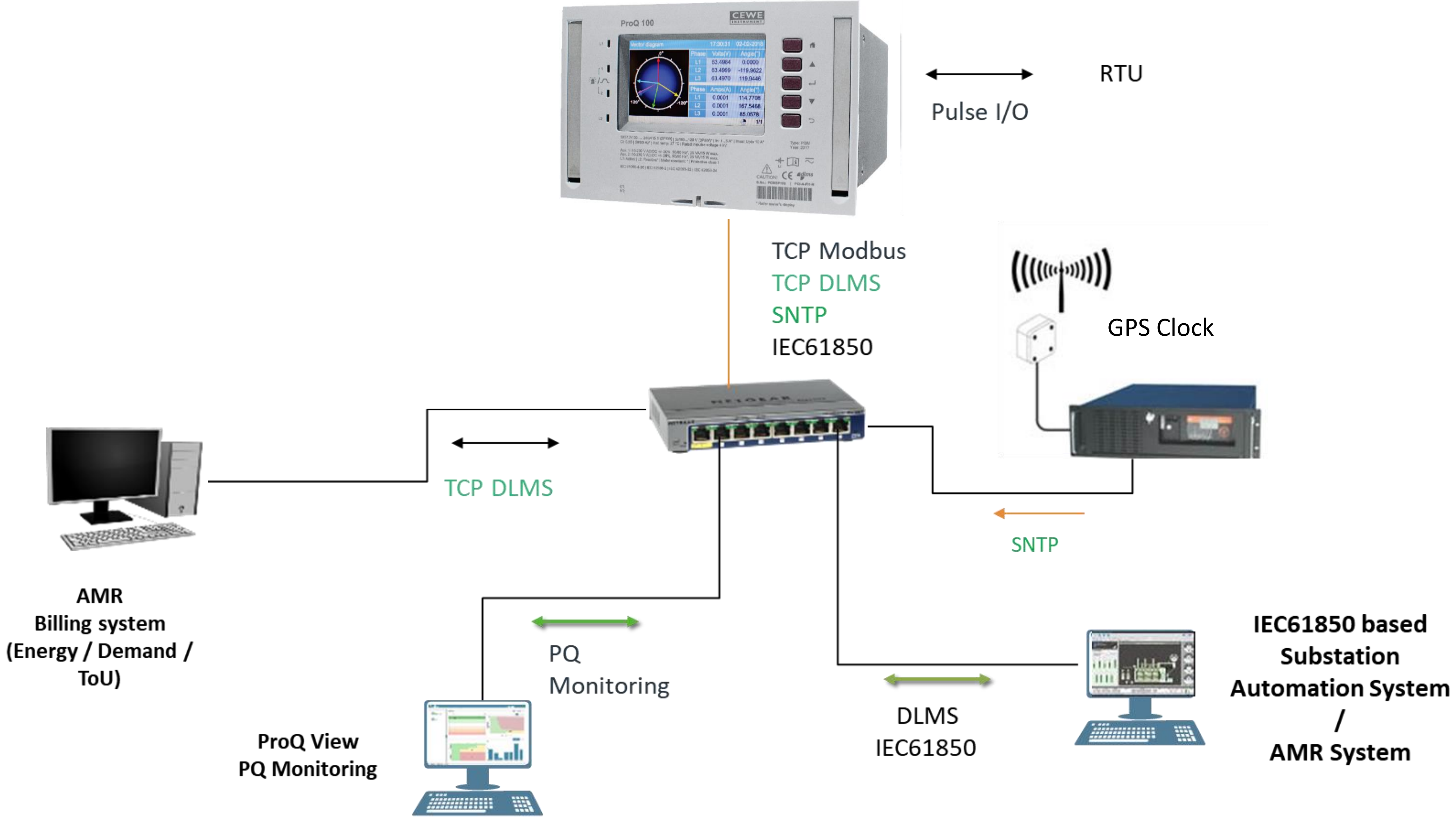


- Multiple Communications protocols: Modbus (RTU/TCP), DLMS (RTU/TCP), IEC61850, PQDIF, SNTP
- **Six** communication ports: Optical, RS232, RS485, Ethernet, Ethernet (FO), USB
- Pulse I/O: 4 pulse inputs and 4 configurable as inputs/outputs

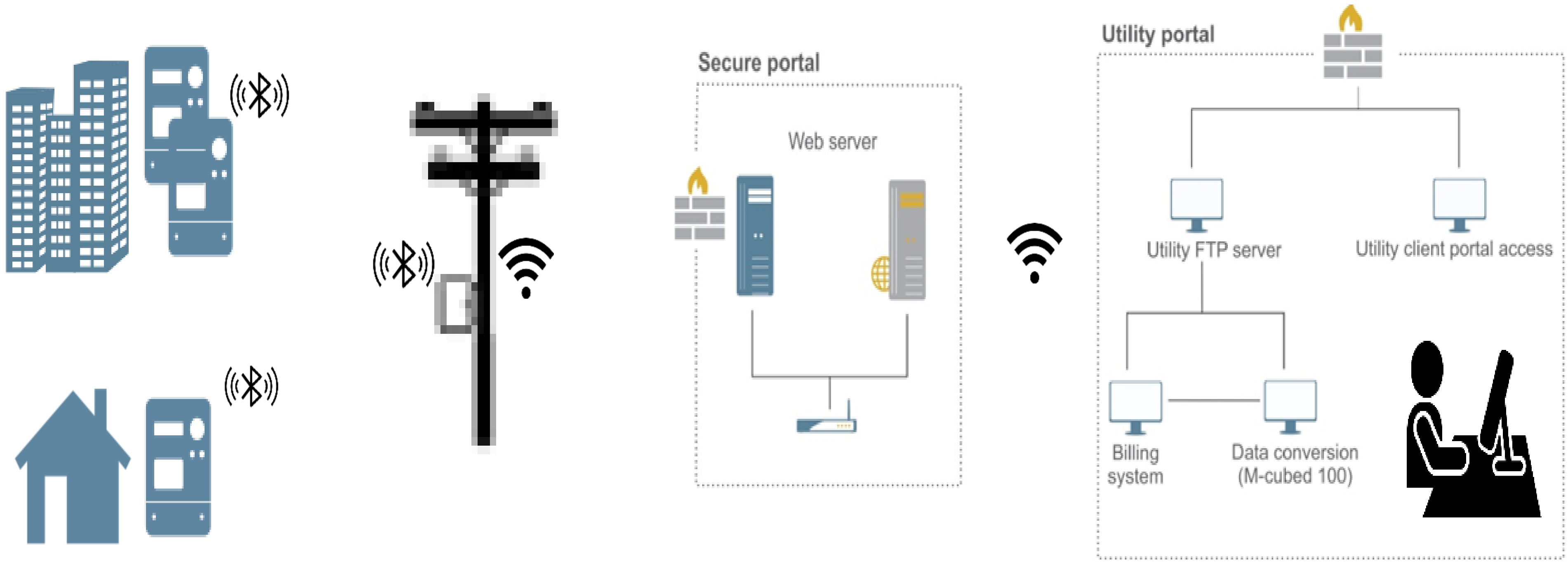
dlms IEC 61850 BS EN 50160:2010 IEEE 519 NMi SGS

PROQ helps in achieving an Integrated metering solution (R&PQ metering)

Application: Integrated Metering Concept Diagram



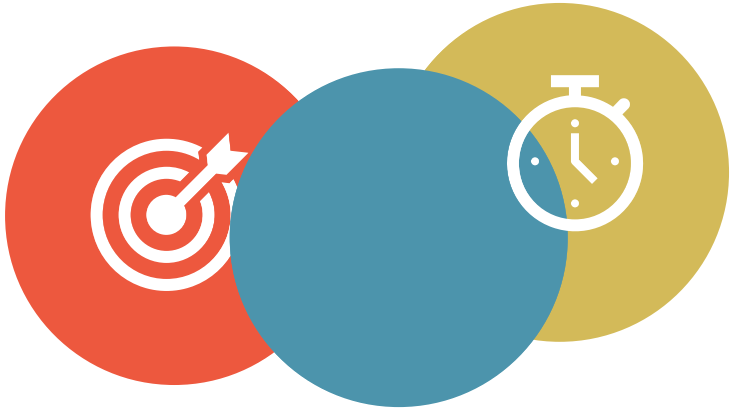
Application II: Smart Reading via Bluetooth based solution



Conclusion

- Remarkable advancements in distribution networks.
- Pushed innovation envelopes and concepts:
  - IOT
  - Predictive analysis
  - Big Data
  - Machine Learning
  - Artificial Intelligence
    - Artificial Neural Networks
  - Industry 4.0
  - Condition Monitoring and Diagnosis (CMD)

Thank You!



THE FUTURE BELONGS TO THOSE WHO
GIVE THE NEXT GENERATION HOPE.

PIERRE TEILHARD DE CHARDIN