Making Smart Grids smart, makes Smart Cities smarter

Author & Presenter: Martin Kuhlmann BSc (Elec) Eng UCT
Siemens Digital Grid: Technical Sales and Support Professional
martin.kuhlmann@siemens.com

Introduction

This presentation leads into the topic of “Making Smart Grids smart, makes Smart Cities smarter”.

Smart Grid is the effective digitisation of field assets and respective communication of an Electrical Grid and Water Infrastructure into a central digital management system that:

- Manages Grid control systems such as Protection devices with SCADA
- Manages load / consumption systems such as Power Quality Meters and Commercial Smart Meters with MDMS
- The integration of the above to effectively unify data

MDMS load data will enable a typical SCADA system to understand load profiles etc in a “Electrical Digital Twin” system so that unnecessary overloads can be avoided as an example.

Smart Cities will use Smart Grid data to heighten operation management of the Smart City and provide feature rich data for Industrial Zones, Commercial Zones, Public and Consumer zones etc

Unified reporting and operation dashboard display of data in a “Smart City” will enable effective management and efficiencies, as well as encourage consumer behaviour and trust.

1. "Smart Grid" vs "Smart City"

"***A smart grid is an electrical grid which includes a variety of operation and energy measures including smart meters, smart appliances, renewable energy resources, and energy efficient resources.***"[1]

"Smart Grid" is the effective digitisation of field assets and respective communication infrastructure into a central digital management system that:

- Manages Grid Control systems such as energy protection devices with SCADA[2]
- Manages load / consumption systems such as Power Meters and Commercial Smart Meters with MDMS[3]
- The integration of the above to effectively unify data

"A Smart City is a designation given to a city that incorporates information and communication technologies (ICT) to enhance the quality and performance of urban services such as energy, transportation and utilities in order to reduce resource consumption, wastage and overall costs."[4]

"Smart City" effectively uses all available system data to manage an efficient and functional city.

2. "Smart Grid" overview

Smart Grid can be interpreted differently from one provider to the next. However, it is the effective combination of focussed areas in a typical grid as follows:

- Substation automation, protection, and smart communications
- Grid operation and control
- Grid applications and analytics
- Grid planning and simulation
- Grid Security

A short description of these topics above can be illustrated as follows:

Substation automation, protection, and smart communications

Flawless operation of an entire grid in an increasingly distributed energy landscape is the basic prerequisite for any network operator, electricity supplier, and industrial enterprise today.

[1] https://en.wikipedia.org/wiki/Smart_grid
[2] SCADA - Supervisory Control and Data Acquisition
[3] MDMS – Meter Data Management System
[4] https://www.techopedia.com/definition/31494/smart-city

Substation Automation
Today power system operation is becoming more and more dynamic – which requires flexible, tailored solutions for reliable operation and efficient project management.

Protection for digital substations
High-performance protection makes power supply future-proof and is essential for network operators, electricity suppliers, and industrial enterprises in every sector.

Optimization of power quality
The availability of energy is obviously an important contribution to power quality, but it's not the only one. In addition to the quality of service, quality of voltage is particularly crucial for an efficient power quality. More than €150 billion in annual losses due to downtimes in production and IT can be attributed to poor voltage quality in Europe as an example

Smart communication
Digitalization demands communication. Proactive response to digitalization and the decentralized structures in energy supply using end-to-end telecommunication networks for the digital grid provides communication solutions for transmission and distribution networks as well as for industry specific applications.

Grid operation and control

Digitalization and decentralization are transforming the energy landscape right down to its very foundations and at amazing speed. Smart solutions help exploit the benefit of grid operators by digitally enabling products, solutions, and services that enhance the operation of grids of any size with valuable information, this way ensuring economic and energy efficiency, reliability and resilience, and a higher degree of sustainability.

Microgrids
Microgrids contain all the elements of complex energy systems, they maintain the balance between generation and consumption, and they can operate on and/or off grid. They are ideal for supplying power to remote or poorly developed regions with no connection to a public network. In addition, more and more industrial operators are using microgrids to produce the electricity they need cost-effectively, sustainably, and reliably.

Microgrids use a variety of energy sources, including photovoltaic and wind-power plants as well as small hydropower and biomass-power plants. Biodiesel generators and emergency power units, storage modules, and intelligent control systems ensure the security of supply.

Distribution Automation
Keeping your grids up and running. Distribution Automation improves significantly the reliability and availability of power distribution grids. The functionality ranges from remote monitoring and control to fully automated applications

Digitalized substations
The energy systems of the future are increasingly decarbonized, distributed, and digitalized. This fundamental transformation is in full swing and poses a wide range of challenges for all stakeholders. Only digitalization will allow us to master these challenges. Ensuring that the digital transformation succeeds in the energy sector requires decisiveness, flexibility, and intelligent investments in smart digital technology. This is the only way to manage current tasks while creating enough leeway to actively shape the future. Investments in innovative

technologies today create future-proof power grids characterized by reliability, efficiency, and sustainability.

Grid applications and analytics

Meeting the growing demand for power of our global, increasingly digital society is a challenge. On the other hand, digitalization helps DSOs and TSOs master this challenge in its entirety and at the same time create added value through optimized efficiency, transparency, and reliability.

Grid Applications

Decarbonization, decentralization, and digitalization are major factors driving the revolution of energy systems. Utilities, energy providers and industrial players all over the world need to adapt their technological base as well as their business processes to the new requirements of the energy sector.

Grid Analytics

Grid Analytics such as fault reporting requires a fast, flexible, and direct system. Fast and efficient fault management was previously bound to the control room, but with MDMS and SCADA system analytics makes it possible to send fault information – including the fault location – directly to the maintenance crews, without the need for a grid control center. The result is that fault messages are enabled even without a control room or complex IT hardware – making it a mobile and surprisingly cost-effective alternative.

Data Analytics

The energy system is changing dramatically – and this is posing new challenges but also new opportunities to distribution grids. Transparency about generation and consumption, costs, and power quality, are becoming increasingly important as a result. It is this knowledge that will pave the way for making the adjustments needed to optimize grid efficiency and supply security. Rolling out an advanced metering infrastructure is costly, but now the time has come to create value from this meter data. The key to this lies in analytics.

Grid Diagnostics

Grid diagnostics allows grid data to be processed transparently so that reactions to grid conditions behave more quickly and planning predictive maintenance is enabled.

Cyber Security

With the onslaught of Digitisation, Cyber Security has become a central planning aspect to any grid. Cyber attacks can happen directly to the central system, or via field devices and communication infrastructure. Strong Cyber Security is a must

Managed Services

In all IT systems, specialisation and application experience is very sought after. Unfortunately, utilities are constrained in providing suitably qualified engineers trained to manage and operate these complex systems. The question becomes: Can a utility afford not to engage in a Managed Services contract?

Grid planning and simulation

From power generation all the way to distribution, power systems have never been more complex than today, and demands are continuously rising. Grid operators and utilities require powerful, flexible, and intuitive software tools, expertise, and global experience to

compete in this dynamic environment and simplifying data maintenance and data exchange, as well as planning ahead, both in technical and business terms.

Power system consulting

Power system consulting services range across technical, economic and regulatory disciplines delivering power system studies, field measurements, disturbance investigations, e.g. post-event analysis. Power system consulting provides expert software tools for power system simulation and analysis.

Power system simulation and modelling

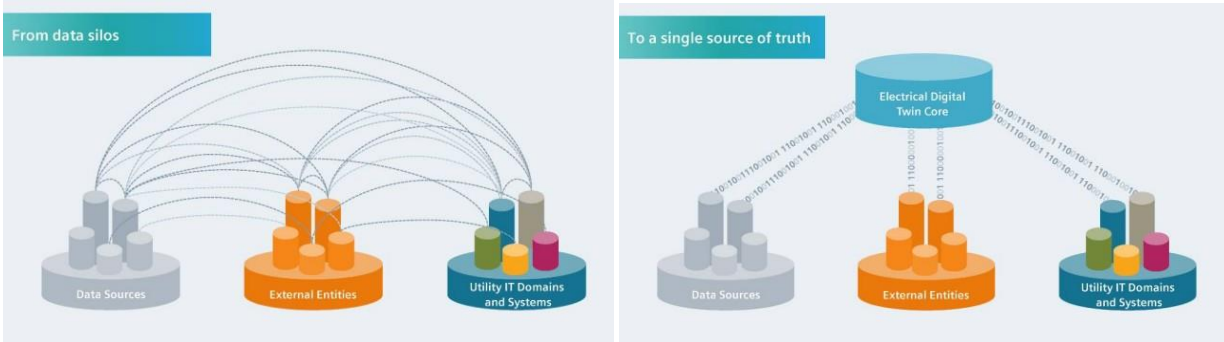
The utility industry is undergoing a transformation, and utilities need to adapt their business processes and tools in order to continue to achieve their objectives in a sustainable way. Power system planners and operators require powerful, flexible and intuitive software tools to support their daily grid simulation and analysis work.

Electrical Digital Twin

Data is at the centre of the power grid. It is exchanged between a large quantity of different software systems which enables utilities to properly plan, operate, and maintain their grid.

Utilities are spending a lot of time and resources to manually maintain, update, and exchange information amongst different systems. Inconsistencies during data exchange and even the lack of data exchange can lead to dramatic consequences, like excessive costs, duplicated labour, suboptimal system performance, and even system wide blackouts. Industry trends (such as distributed energy, renewables, and digitalization) are only increasing the number of data points that need to be considered to achieve optimal system performance.

In this new digital world, data accuracy, model complexity and automation are the foundation to maintain operational excellence and maximize future investments. That is why Siemens has developed the Electrical Digital Twin, utilities are able to harness the power of transparency with a single source of truth for data across their entire utility IT landscape.



Grid Security

Cyber Security is a highly sensitive area that demands a lot of trust. Technology providers need to understand how products, systems, and solutions integrate with the processes and people behind them and how people interact with them. From this, complex Grid/Cyber Security planning is developed to maximise overall security on all levels of Grid Operation and Management.

3. “Smart City” overview

What makes a city smart? Smart City solutions contribute to the effective management of urban areas, improving connectivity, sustainability, and liveability. Across all areas of city life, technology and data are used to analyse and optimise functionality and efficiency, thus enhancing outcomes and improve quality of life to those living in the City.

Dimensions of smart city development

Our cities continue to grow at unprecedented rates, and we are living in an increasingly urban world. How do we manage environmental impact, urban resilience and financing? Different dimensions of smart city development have the potential to guide cities in the right direction.

Unlocking the Potential of Cities

How can we improve city life? The quick answer is: Data.

Cities, in all their complexity, generate huge volumes of it, all the time. We can use these insights to optimize the systems that support our urban lives – from transportation and health, to energy consumption and safety. And these are real, tangible changes: by utilizing data, it’s possible to improve emergency response times, reduce greenhouse gas emissions, and improve commutes. Dedicated solutions help leverage smart data to maximize city potential.

City Air Management

City Air Management is designed to help conurbations reduce air pollution. It gathers emissions data in real-time and simulates measures that improve air quality – enabling decision-makers to remedy high emissions using reliable data. Highly accurate air quality forecasts are projected for the next five days, using a sophisticated algorithm based on historical data, weather input and current data.

City Air Management tools and consulting help cities identify methods to avert poor air quality in the short term and to build a strategy for longer-term technology change. City Air Management monitors and forecasts air quality and simulates actions that a city can take in the short term to avert breaches of air quality standards and limit respiratory stress on the most vulnerable citizens.

By ensuring data-driven decision making, cities are able to save on costs, maximize efficiency and foster long-term air quality improvements.

Smart City Digital Hubs

Smart City Digital Hubs allows researchers to gather data and develop solutions in the fields of data analytics and smart infrastructure. The aim? To create a technology ecosystem that will benefit Smart Cities in the future.

Typical Smart City Digital Hubs digitalize its urban infrastructure as much as possible. The digitalization hub brings together data specialists, software engineers, solution architects and domain specialists to pilot digital innovations.

Urban Mobility Solutions

Connected Mobility data, and AI-driven applications and services, are developed for an even smarter management of road traffic, fleets such as eBikes and intermodal mobility. The goal is to optimize mobility for citizens.

Digital Logistics - Airports

Aviation industry in Smart Cities facilitate the development of future-oriented analytics and Internet of Things (IoT) solutions for airports, airlines, cargo service providers and ground handlers. It supports customers to continually improve the passenger experience, simplify processes and increase efficiency.

IoT Services

The world is rapidly changing...Digitalization and the Internet of Things (IoT) have a tremendous impact on our world. It is obvious that organizations need to address the issue of digital transformation, yet few have a concrete strategy. Those that tackle digital transformation and IoT will be the leaders of tomorrow, shaping the future of their industries.

City Performance Tools

All over the world, cities are shaped by profound forces: their population, their technologies and their infrastructures. Even today, these forces collide, and urbanization and climate change will spur dramatic changes in metropolitan areas. Cities need to pave the way for constant evolution: digital technologies are becoming increasingly important and urban infrastructures and buildings require a more efficient and sustainable setup.

These changing environments set free a swarm of urban challenges: Developed cities for instance need to focus on cutting carbon emissions, improving efficiency in infrastructure and buildings, stimulating a market shift towards cleaner vehicles and more efficient and environmentally friendly public transportation. At the same time, infrastructure quality in many advanced economies is deteriorating. Looking forward to 2030, more than $50 trillion will need to be invested in infrastructure globally to keep up with GDP and population growth.

Cities in emerging markets on the other hand face issues such as power outages and inadequate public transport and roads, which brake on growth and development. Infrastructures cannot be built fast enough to keep pace with economic and urban development. In times of constrained budgets city leaders carefully need to identify their infrastructure investments ensuring that their investments address their environmental and economic priorities. Technologies need to be adapted to serve local needs to ensure that the right technologies are applied in the right environments, tailored to the specific characteristics of the individual city.

Creating resilient cities

Population growth, rapid urbanization and climate change put our urban infrastructure under pressure. Siemens' technologies can help cities respond to these challenges with innovative solutions and our expertise in the areas of electrification, automation, and digitalization.

4. Making Smart Grids smart, makes Smart Cities smarter

The topic of this paper is an interesting one, as an immediate question comes to mind – "Aren't Smart Grids smart anyway"?

We have seen from Sections 2 and 3 above that there are a lot of similarities between Smart Grids and Smart Cities.

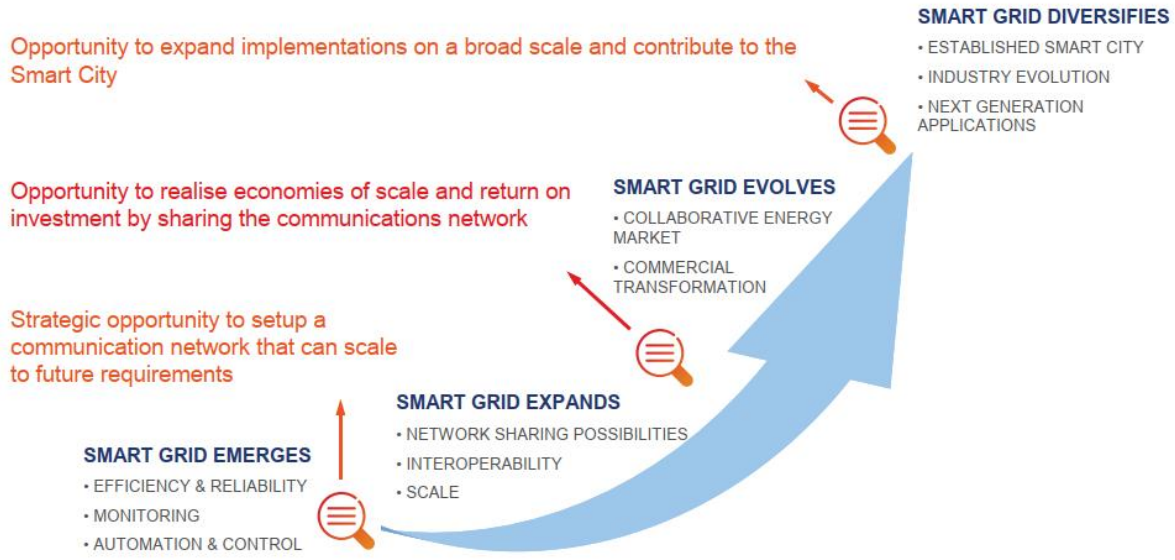
However, it is clear that Smart Cities without any Smart Grids have a limited functionality and benefit.

Smart Grids enhance Smart Cities.

So, to what level or proportion does the "smartness" of a Smart Grid make a Smart City smarter? The answer is simple, a Smart Grid provides a direct and 100% proportion to the 'smartness" of a Smart City.

"To meet the goals of a smart city in supporting a sustainable high-quality lifestyle for citizens, a smart city needs a smart grid.

To build smart cities of the future, Information and Communications Technology infrastructure will be a key enabler, and strategic choices made by utilities today have the power to transform society tomorrow."[5]



[5] Discussion Paper – Ericsson – March 2012

5. "Security of Revenue" business model for Smart Grids and Smart Cities

"Security of Revenue" is a powerful term and is a big focus on Utilities in South Africa, Africa and the world.

The Utility business is changing:

- The end-to-end energy business value chain is affected by change
- Technology and ICT are playing a huge role in modernisation within the industry
- In the last 10 to 15 years we have seen emerging international trends focused on:
    - Better service delivery
    - Improved system operation
    - A greater customer centric focus => the 'Energy Prosumer'
    - Big Data – the Internet of Things (IoT)

In today's world a lot of Utilities (Electricity | Water | Gas) in Africa are struggling to make ends meet, blaming electricity/water/gas theft and "Non-Technical Losses" (NTL) as a main contributor to their negative financial issues. This has a direct impact to a Smart City.

"Security of Revenue" is really a term that ensures maximum revenue for a utility is secured so that the Aggregate Technical, Commercial and Collection losses (ATC&C) is minimised and profitability and financial viability of the Utility enhanced!

To make this a reality, the Utility needs to tighten up its administrative and technical departments so that every "cent" is accounted for. Administratively, this is easy to do, but technically this is a major challenge.

One key point is that Utilities are moving from an OT (Operational Technology) centric strategy to an IT (Information Technology) strategy – this means a huge shift in resource focus and management.

- **IT:** refers to anything related to computing technology. Some examples are: CRM, ERP, Email, etc.
- **OT:** Gartner refers to OT as *"Hardware and software that detects or causes a change through the direct monitoring and/or control of physical devices, processes and events in the enterprise."* Some examples of OT is: SCADA, PLCS, HMIs, etc.

For Smart Cities, Smart Metering is the latest buzz word to fix the technical and revenue divide, but is it financially viable? Well, the easy question is: if ATC&C losses are dramatically reduced by implementing a smart metering system, can the Utility afford not to have such a robust and proven system?

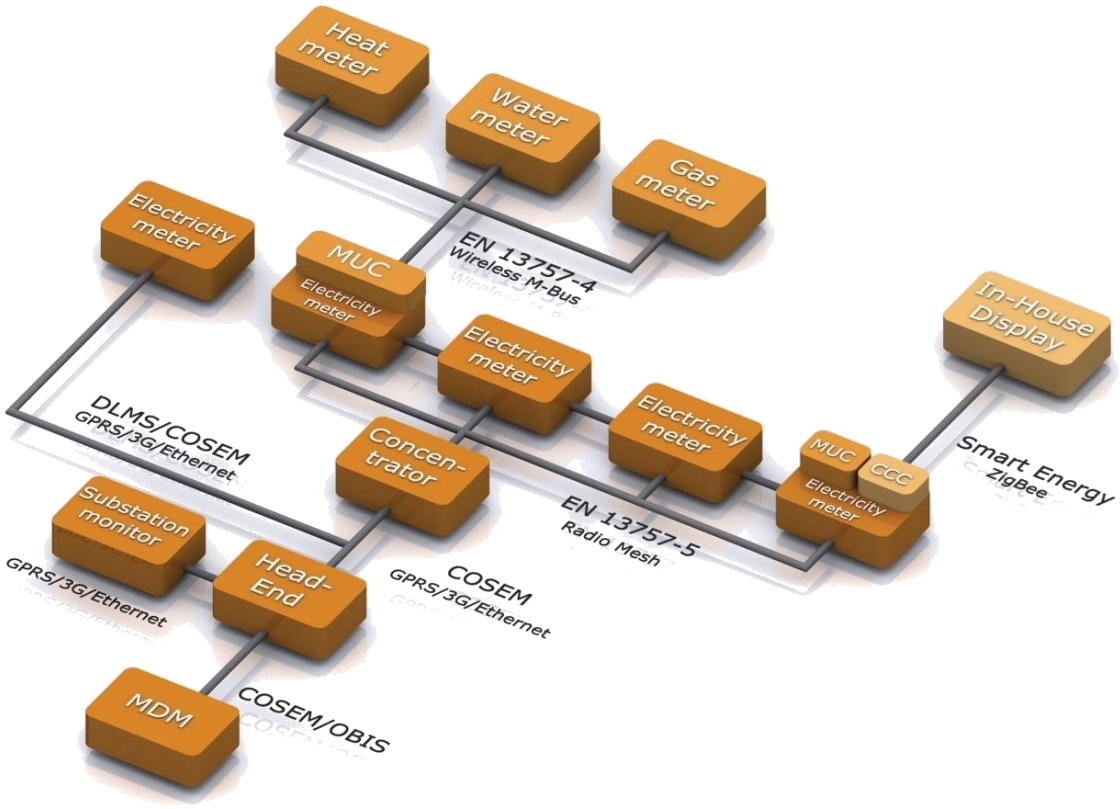
Both "Security of Revenue" needs careful planning and strategic understanding, but if implemented well, can instantly bring in much needed results.

Smart Grid | Smart Cities – why is billing important

Technology really enhances the "Smart Grid" world by introducing the concept of "Smart Billing". Making Smart Cities smarter is not only the technical and digital management of a Smart Grid, but also making sure hat the services delivered to a consumer and the eco-

system of the Smart City enjoys the features and benefits of a “Smart Billing” business model to enable accuracy, affordability, easy-access, trust and efficiency.

Examples of a “Smart” Electricity and Water metering infrastructure



The above diagram shows how both electricity and water meters are integrated into a communication infrastructure so that the MDMS receives both data, allowing for “Security of Revenue” models using a single back-end system incorporating both Electricity and Water Data.

6. Conclusion

The buzz word of today, “Smart City”, is a very intricate, technical and a concept to deliver a new heightened the level of efficiency, human and environmental benefit, and a functionality that installs positive behaviour and trust in the new Cities of the future.

To make Cities smart, the reliance of digitalisation and the effective management of data is crucial.

Smart Grids contribute to this model by making the Utility supply of respective services modern, data enriched and most of all efficient – a must in the new world!