

# SMART GRIDS AND RENEWABLES

The power of the active grid





**Internet  
of Things**



**Integrating  
Distributed Energy  
Resources**



**Evolving Utility  
Business Models**



**Greater Customer  
Expectations**

SAFE, REMOTE, RELEASABLE, RECOVERABLE DELIVERY

Real-time data, rich digital systems, and intelligent algorithms are the key to excellence

## Optimize RDB services, Metadata, and File storage, DR infrastructure

# The Utility of the Future

“Experiential” service offerings: reliability, clean energy, time-based pricing, prepay

Infrastructure services to support public and government transportation, waste, safety offerings

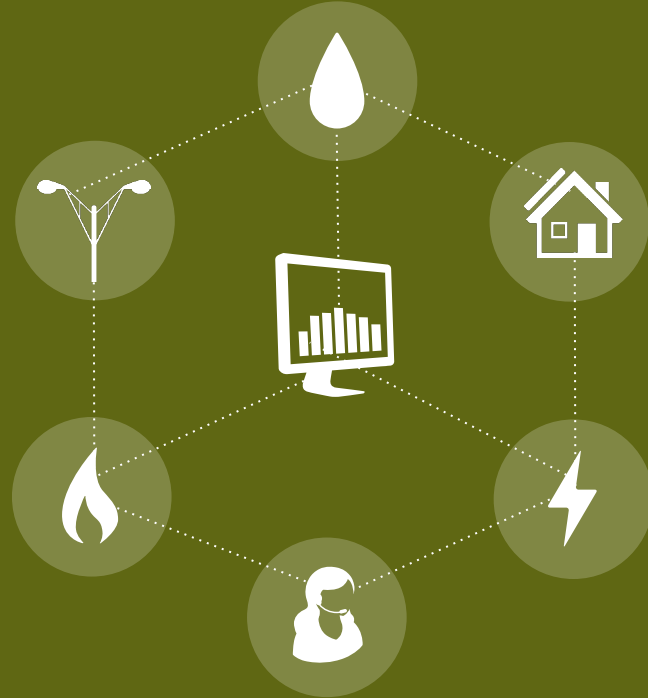
Distributed apps, data-driven services  
Compliance

WELCOME TO **THE ACTIVE GRID**  
Where the smart grid meets IoT

# HOW DOES THE GRID BECOME ACTIVE?

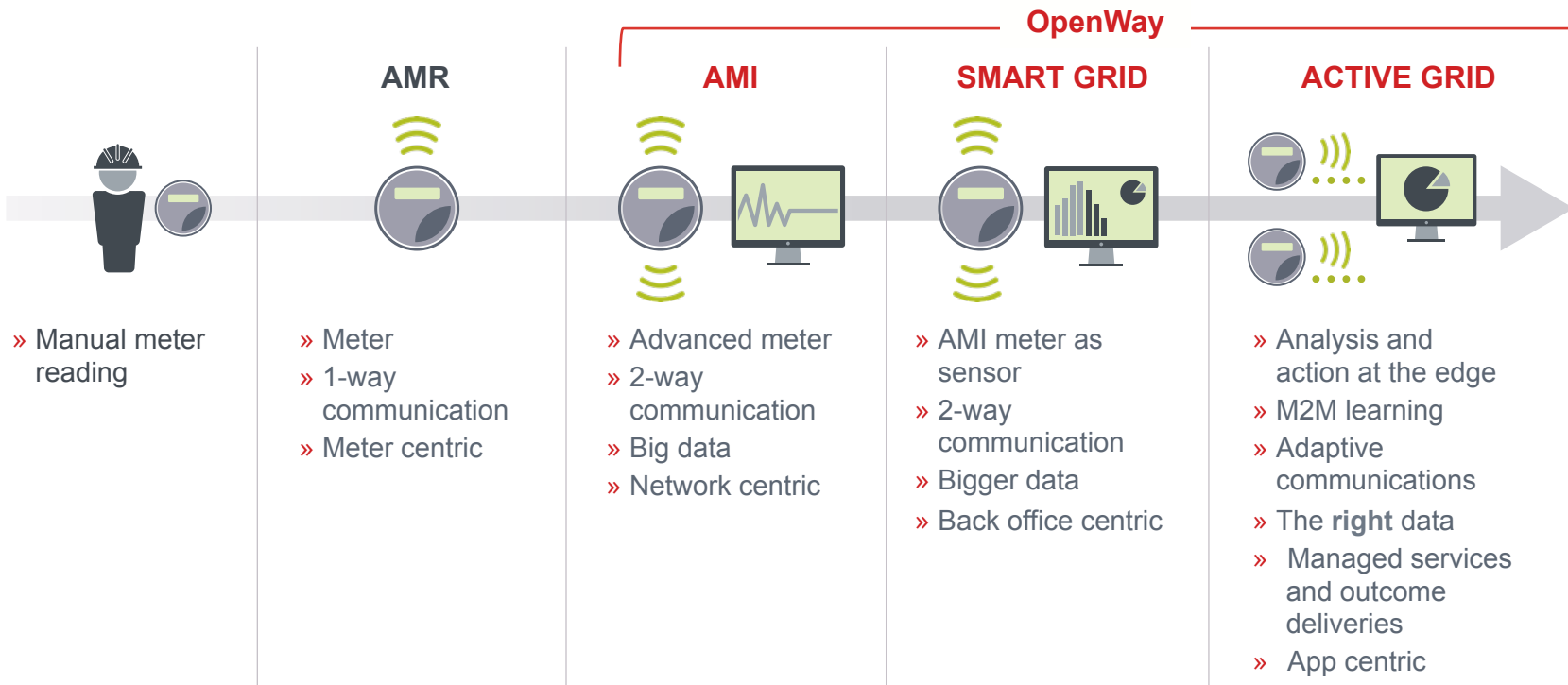
The smart grid is to populate these networks with devices that not only measure and communicate, but make decisions and take action in real time

analysis

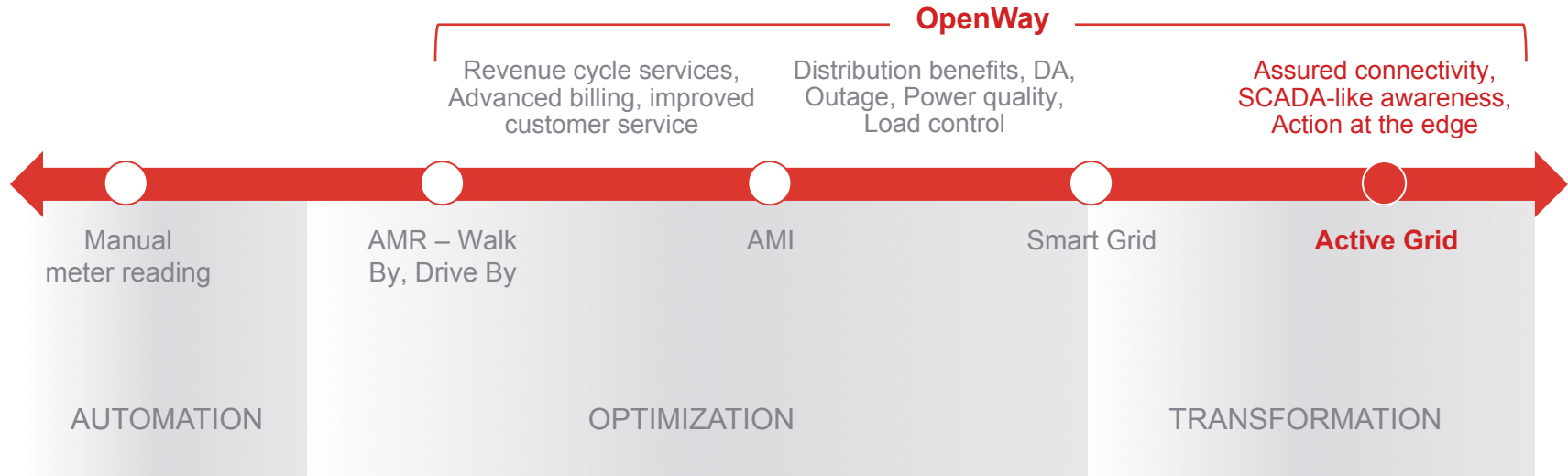




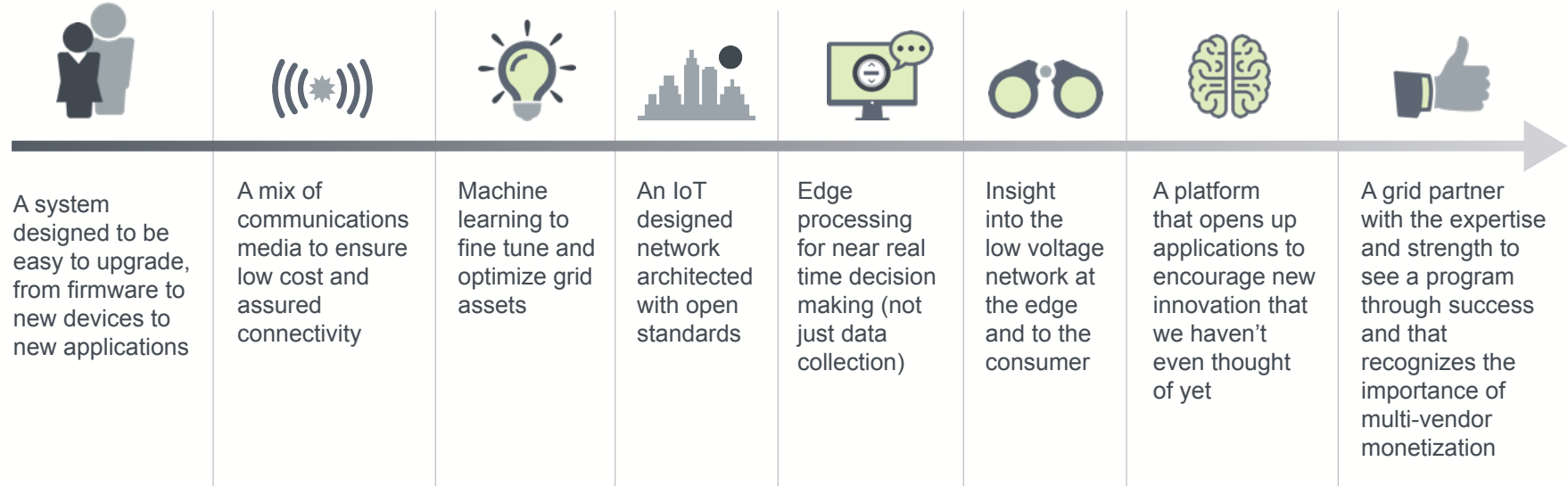
# TECHNOLOGY EVOLUTION



# THE BUSINESS CASE SPECTRUM



# WHAT'S NEEDED FOR THE ACTIVE GRID?





The background of the slide is a wide-angle photograph of a golf course under a clear blue sky with light clouds. In the center, there is a large, multi-story stone clubhouse with a clock tower. To the right of the clubhouse, a tall, thin stone obelisk stands on a small hill. Further to the right, a large, ornate red-brick building with many windows is visible. The foreground is a vast, green golf course with a few people scattered across it. The text "Section II: Adding Value Through Distributed Intelligence" is overlaid in the bottom left in a large, white, bold font with a slight shadow.

## Section II: Adding Value Through Distributed Intelligence

# WHAT IS DISTRIBUTED INTELLIGENCE?

***Distributed Intelligence*** –analysis, decision making and action-taking in a distributed, autonomous manner across all field devices and field networks.

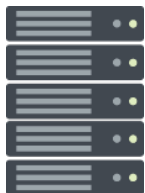
Distributed Intelligence **augments** back office decisions making.

Distributed Intelligence is about actions enabled by the ***right*** data at the ***right*** place (vs. only ***big*** data in the back office).

# INTELLIGENCE IN THE RIGHT PLACE

*Right Data vs. Big Data – Solving Problems Where and When it Matters*

## BACK OFFICE/CLOUD



**System Awareness**  
**Low Resolution**  
**Higher Latency**

*e.g.*  
*grid level planning*

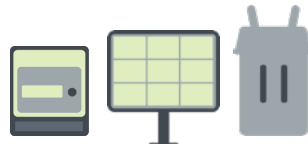
## NETWORK



**Area Awareness**  
**Medium Resolution**  
**Moderate Latency**

*e.g.*  
*Regional Outage Event*

## GRID DEVICES



**Local Awareness**  
**Very High Resolution**  
**Very Low Latency**

*e.g.*  
*Transformer Overload Event*

- What is the required breadth of knowledge?
- What is the required data resolution?
- What response time is needed?

# WHY NOW?

## KEY CATALYSTS ENABLING DISTRIBUTED INTELLIGENCE



Maturity of open and interoperable communication standards-



Rapidly expanding smart city and “Internet of Things” ecosystems



Software vs. firmware based low-power computing



Highly affordable and available embedded platforms



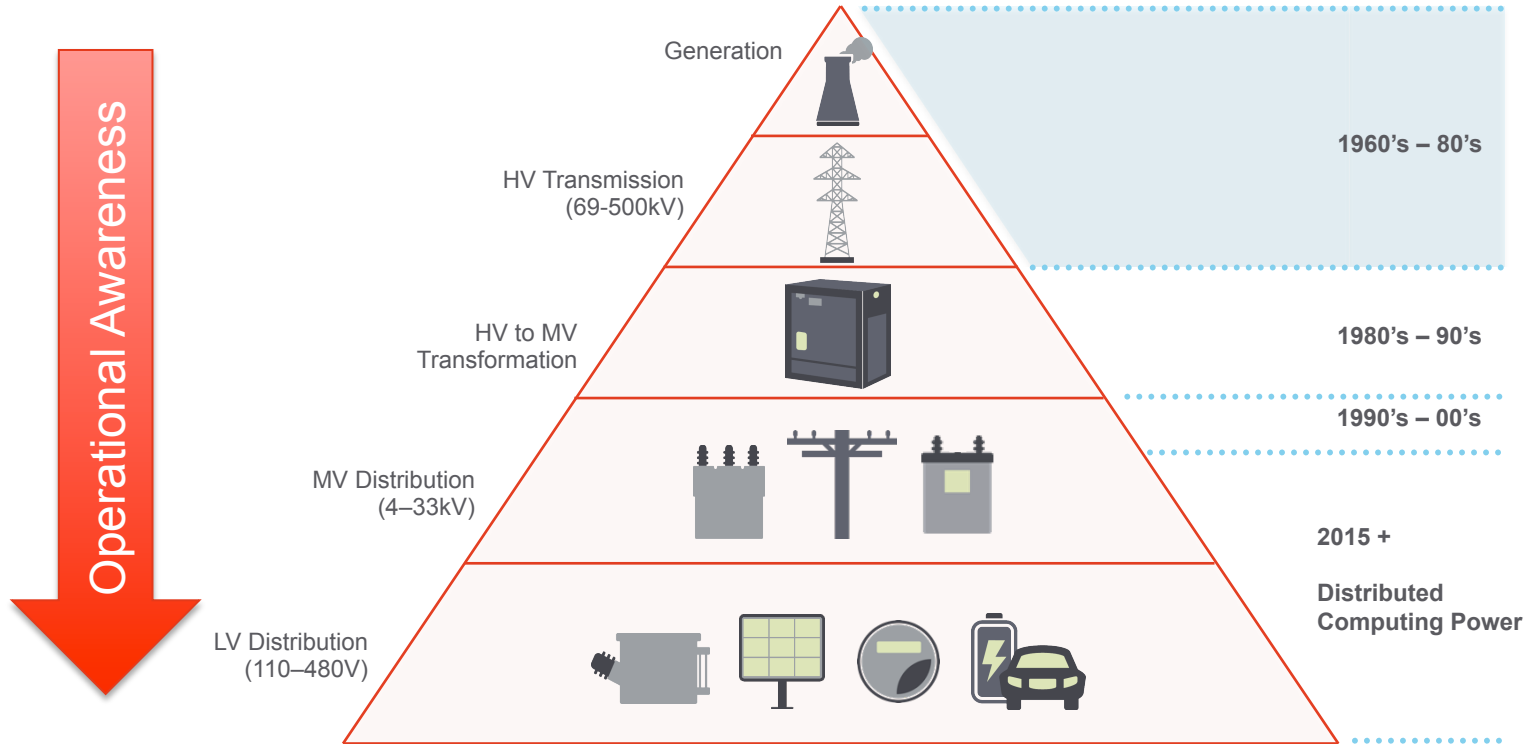
# IN THE CONTEXT OF SMART METERING?

**A COMPUTING  
PLATFORM  
WHERE “SMART  
METERING” IS  
JUST ONE  
AVAILABLE  
APPLICATION**



# THE IMPACT FOR UTILITIES?

*Awareness and Control to the edge of the Grid*



# OPERATIONAL AWARENESS & AUTONOMOUS ACTION - AT THE EDGE OF THE DISTRIBUTION GRID

## WHY IT MATTERS FOR UTILITIES



Significant improvements in Operational Efficiency



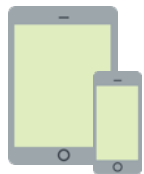
(Autonomous) Low Voltage Grid Stability and Management



Ability and agility to evolve and augment services: maximizes stakeholder engagement (regulators, consumers, shareholders)

*Outage / Fault detection, Load Management, Demand Response, Theft Detection, Safety, End-user Engagement, EV, DER, ....*

# HOW - WHAT'S REQUIRED?



## Computing Power at the Edge “Edge Computing”:

- A computing platform on every meter and grid device
- A unified software platform running multiple apps and protocols
- High resolution of data: e.g. *per second* voltage data



## Robust, Low Latency, High Availability Communications

- Multiple physical media (PLC, RF, Wi-Fi, p2p)
- Adaptive modulation to cope with noise and distances
- Peer-to-Peer communication
- Local broadcast



## Location Awareness

Where am I on the distribution grid?

- Relative mapping
  - Transformer
  - Feeder
  - Phase
  - Relation to other meters/device

*Continuously updated*



## Open-Application Environment

Support for multiple Communication and Application protocols

- Smart metering
- Distribution Automation
- Load Control
- Demand Response
- Home Area Network

*With the partner ecosystem to support!*



A wide-angle photograph of a golf course under a blue sky with light clouds. In the background, a large, multi-story stone clubhouse with a central clock tower stands prominently. To the right of the clubhouse, a tall, dark obelisk monument is visible. Further right, a tall, multi-story brick building with many windows is partially visible. The foreground is a vast, green golf course with a few small figures of people scattered across it.

# Section III

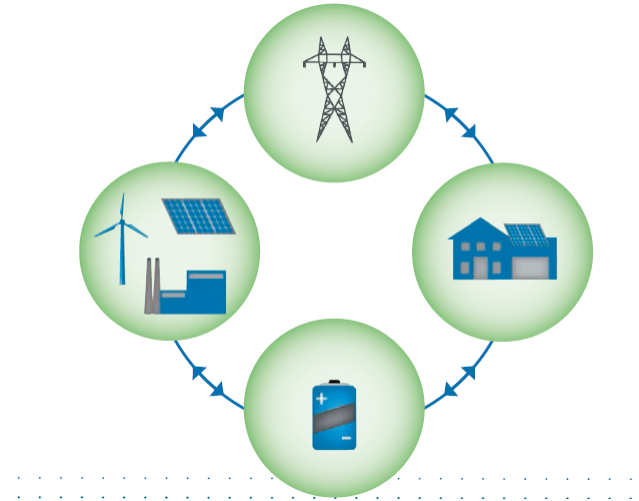
## SMART GRIDS ENABLES RENEWABLES

# EXECUTIVE SUMMARY: SMART GRIDS & RENEWABLES

## IRENA, NOVEMBER 2013:

Electricity generation from renewable sources will need to increase significantly to achieve the Sustainable Energy for All (SE4ALL) objective of doubling the share of renewable energy (RE) in the global energy mix by 2030.

Fortunately, there is growing evidence in many countries that high levels of renewable energy penetration in the grid are technically and economically feasible, particularly as solar and wind technologies increasingly reach grid parity in economic terms.



# SMART GRID TECHNOLOGIES IN RENEWABLES

In a detailed review of smart grid technologies for renewables, including their costs, technical status, applicability and market maturity for various uses, IRENA roughly divided Smart Grid technologies into three groups:

- *Well-established:* Some smart grid components (Distribution Automation, Demand Response) are well-established, cost-effective technologies that directly enable Renewables
- *Advanced:* Smart inverters and renewable forecasting technologies are already used to increase efficiency and productivity of renewable power generation, yet with additional costs. They start to help noticeably when renewables capacity exceeds 15%, and become essential as capacity reaches 30%
- *Emerging:* Distributed storage and micro-grids are generally not “entry level” smart grid technologies and thus are less well-developed (lots of research and investment needed).

# HOW CAN ELECTRICITY SYSTEMS BE FLEXIBLE AND SMART?

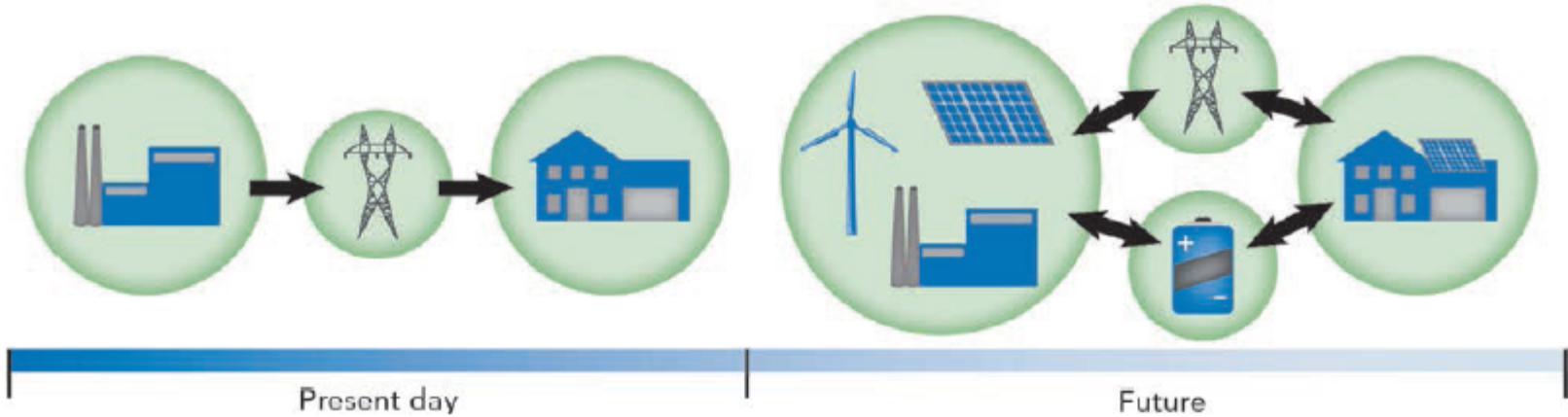
Smart grids use technologies from level of Generation to home appliances to instantly relay information to 1) match supply with demand, 2) support well-informed decisions, and 3) keep systems operating at optimal efficiency. Examples:

- *“Smart home-appliance”* switches on/off in response to varying electricity prices;
- *“Smart grid-transformer”* allocates power to industries at more reliable prices;
- *The same “smart transformer”* automatically notifies grid operators and repair personnel if its internal temperature gets too high;
- *“Smart meter”* measures and tracks the output of a rooftop photovoltaic (PV) system and sends that data back to the utility (surplus/gaps due to solar variability)

*Smart Grid technologies benefits:* include 1) a more efficiently operated electricity system, 2) reduced operational costs, 3) enabling high levels of renewables in electricity system (primary benefit).



# VISIONS OF THE ELECTRICITY SYSTEM: PRESENT AND FUTURE



Courtesy of IRENA report, November 2013 (A Guide for Effective Deployment)

# MAKING THE TRANSITION TO A SMARTER GRID

Smart grid technologies enables renewables, but the lack of experience and associated uncertainties — 1) technology cost and performance, 2) costs and benefits, and 3) non-technical issues such as privacy — make it challenging.

- *Pilot Projects (demos & PoC)*: to try and test various smart grid technologies (their performance), to ease concerns about how they affect reliability and about how Consumers would react within such environment
- *The Business Case*: Regardless of regulation, smart grid investments must make economic sense, although the benefits of smart grid technologies consistently outweigh the costs.
- *Other key elements*: 1) Effective project planning and execution, 2) successful integration with legacy hardware/systems, 3) the value of the generated data

## MAKING THE TRANSITION TO A SMARTER GRID (CONT'D)

- *Resistance to Change:* new technologies seen as introducing risk: performance, financial, legal, political and economic. Smart grids threatening the Utility's fundamental business model
- *Leverage the Need for Private Sector Investment:* Significant investment needed to upgrade legacy systems for the future. Capital unlikely available from governments. By enabling distributed renewable generation, smart grid technologies attract private sector investment in electricity generation (investors, individual users, C&I users)
- *Continuous Technological Change:* A challenge in smart grids is the continuous and fast technology evolution, particularly in communications and data management. The right approach: employ a flexible smart grid strategy that balances Risk and Returns
- *Regulation:* devise a regulatory framework that ensures that benefits flow to the investors. Put structures of financial incentives that rewards smart grid investments.

# SMART GRIDS – THE NON-TECHNICAL BARRIERS

- *Data Ownership and Privacy:* large amounts of data created, transmitted, and processed. Who owns it? Who can access it?
- *Grid Security:* The vulnerability of electricity systems to natural disasters and malicious attacks
- *Control of distributed resources:* Who controls a distributed renewable electricity source? Is it the supply owner or the utility/network owner?
- *Private Sector Grid Players:* The implications of opening up the electricity system to companies and individuals (system reliability, power quality, cost, others).
- *Deciding on communication standards:* The smart grid components must be able to communicate together in full interoperability. Languages? Technologies? Protocols?



# THANK YOU



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