PRESENT & FUTURE OF SMART MICROGRIDS

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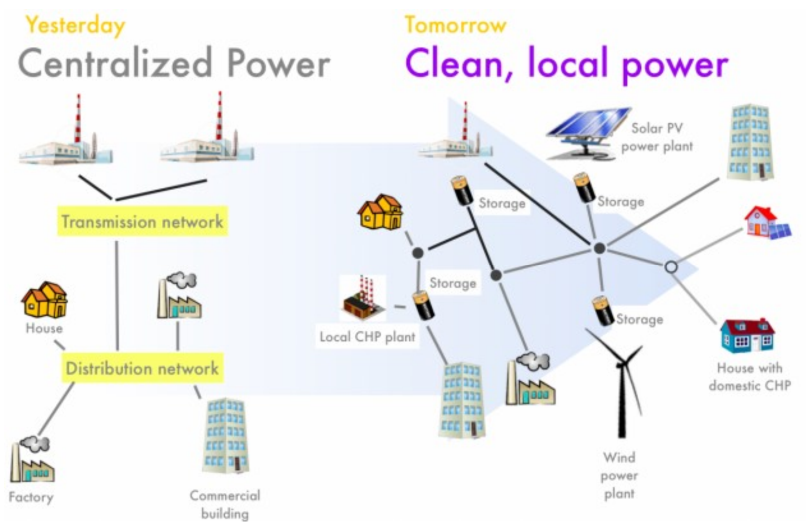
OUTLINE

1. Introduction – Centralized vs. Distributed
2. Business Case for MicroGrid: Shortcomings of Present Electrical Grid
3. Designing Smart MicroGrid for Different Objectives – DER-CAM
4. Detailed Configuration of MicroGrid – Designed by DER-CAM
5. Use Case of Large MicroGrid
6. Address Multiple Stakeholders
7. Future of MicroGrids
8. Use Cases – Building, Community & Smart Inverter (Device)
9. Scale for the Future using – Adapt Standards
10. Roadmap For Device Manufacturers

APEC

NeoSilica

CENTRALIZED VS. CLEAN & DISTRIBUTED



Key Resources to Manage –

A. Local Generation/DER (Solar/Wind/…)
B. Demand Response
C. Unused power in Batteries, EV & UPS
D. Use Smart Inverters that charge
E. Energy Management – at Peak Load
F. Grid Rates & Regulation

Evolving Smart Micro-Grids for Communities Integrating into Smart Cities

Towards "PERFECT POWER"

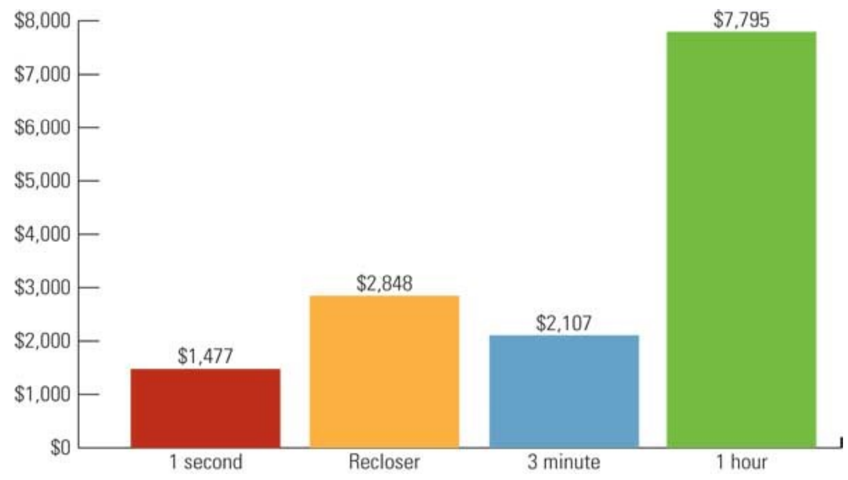
Proposed first by ***Motorola Chairman Robert Galvin*** after 2003 Northeast Power Outage that affected 50 million.

Ref: Institute for Local Self-Reliance ILSR.ORG

MICROGRIDS – INSURE AGAINST POWER INTERRUPTION

- Average Cost of Power Interruption is $80B (LBNL) in US
- As the time of interruption expands, so does the cost of power interruption
- Commercial and Industrial organizations incur most losses
- MicroGrids Are Designed To Insure Against Power Interruption – Irrespective Of Grid Condition & Quality

Cost of Power Interruptions



Ref: EPRI, US

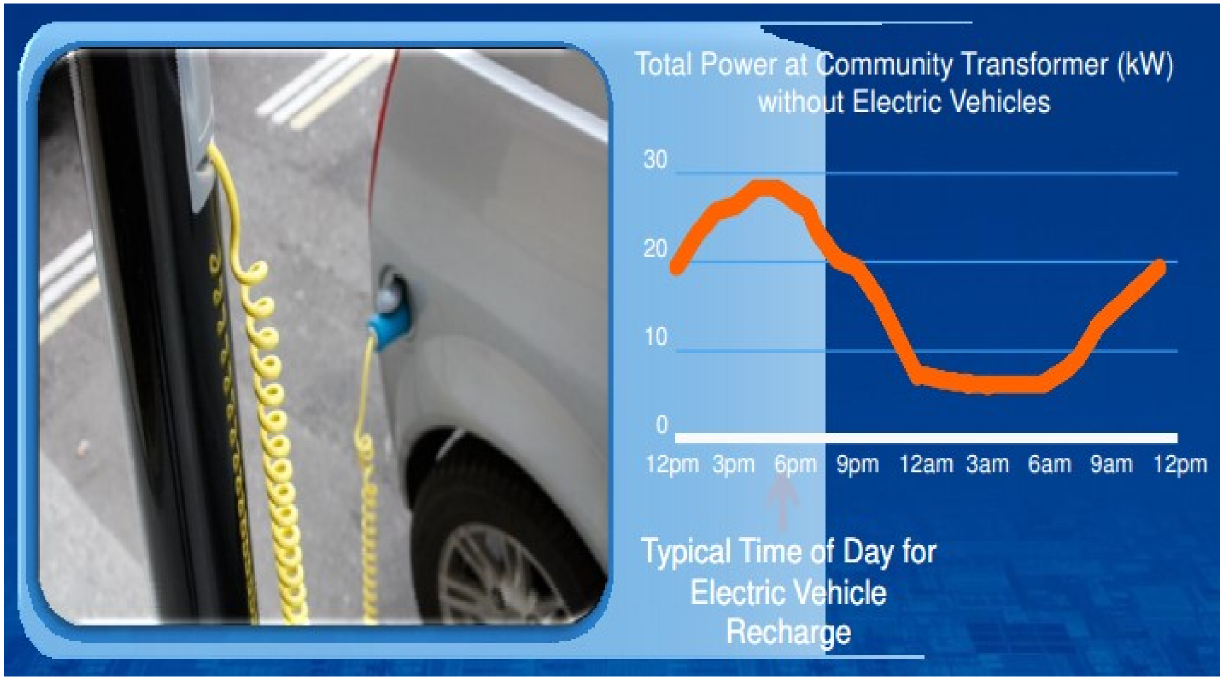
WASTAGE IN ELECTRIC SYSTEM

Waste Type	Wasted $, Billions	Wasted, $/MWh
Wasted fuel	~ $150	$40
Outages/Repair	~ $100	$25
Wasted Capital	~ $40	$10
Emissions Cost	~ $65	$15
Water Cost	~ $75	$20
Total Waste	~$430	$110

Existing Electric Grids need a Major overhaul – to reduce Losses, improve Quality and Reliability so as to achieve – **Affordable & Reliable Quality Power to Every Customer**

Ref:
Galvin Electricity Initiative

UNCOORDINATED CHARGING OF EV – PEAK LOAD

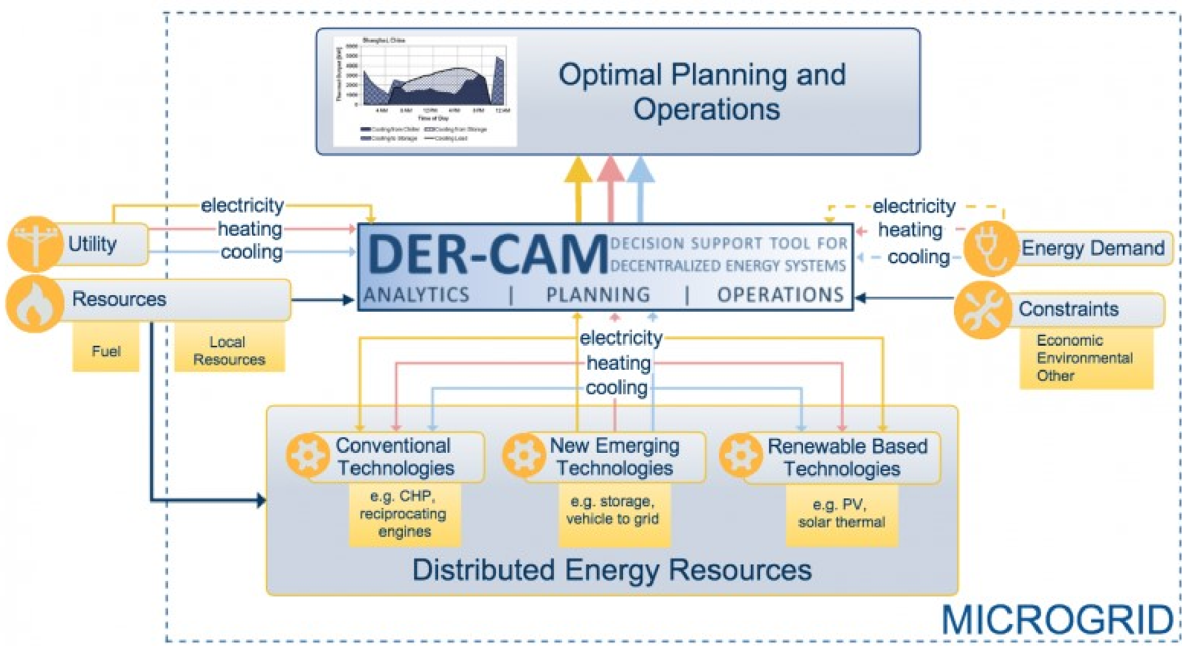


Need a **Smart Local System (MicroGrid)** to Smoothen Peak Loads – that can be Managed by **Load Shifting**

Ref:
Galvin Electricity Initiative
Intel

DER-CAM SW TO MODEL MICROGRIDS (LBL)

- Distributed Energy Resources Customer Adoption Model
- Open Software by LBNL – to design MicroGrid based on customer requirements
- Address - cost-optimal configuration of DER
- Smart Operating System – to minimize the total customer energy bill, and improve quality and reliability



Ref:
Lawrence Berkeley Labs

DER-CAM: KEY INPUTS INTO THE MODEL

1. **Customer's end-use load profiles (typically for space heat, hot water, gas only, cooling, and electricity only)**

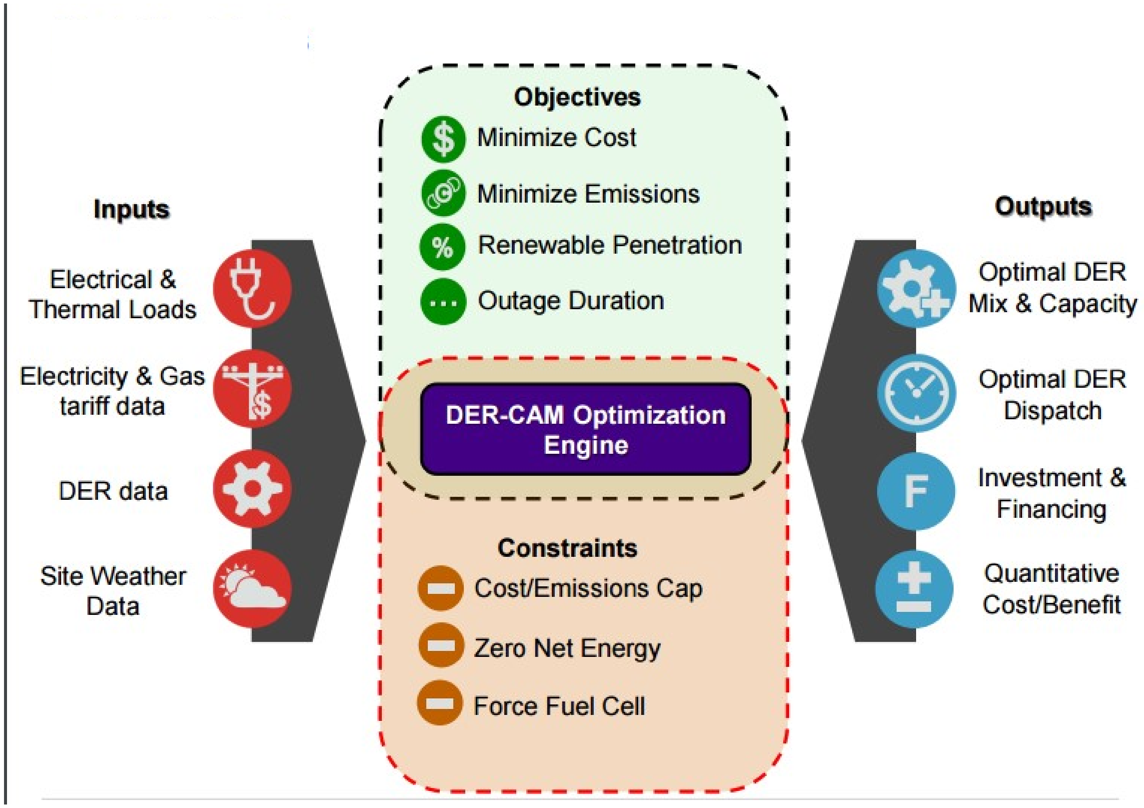
2. **Customer's default electricity tariff, natural gas prices, and other relevant price data**

3. **Capital, operating and maintenance (O&M), and fuel costs of the various available technologies, together with the interest rate on customer investment**

4. **Basic physical characteristics of alternative generating, heat recovery and cooling technologies, including the thermal-electric ratio that determines how much residual heat is available as a function of generator electric output**

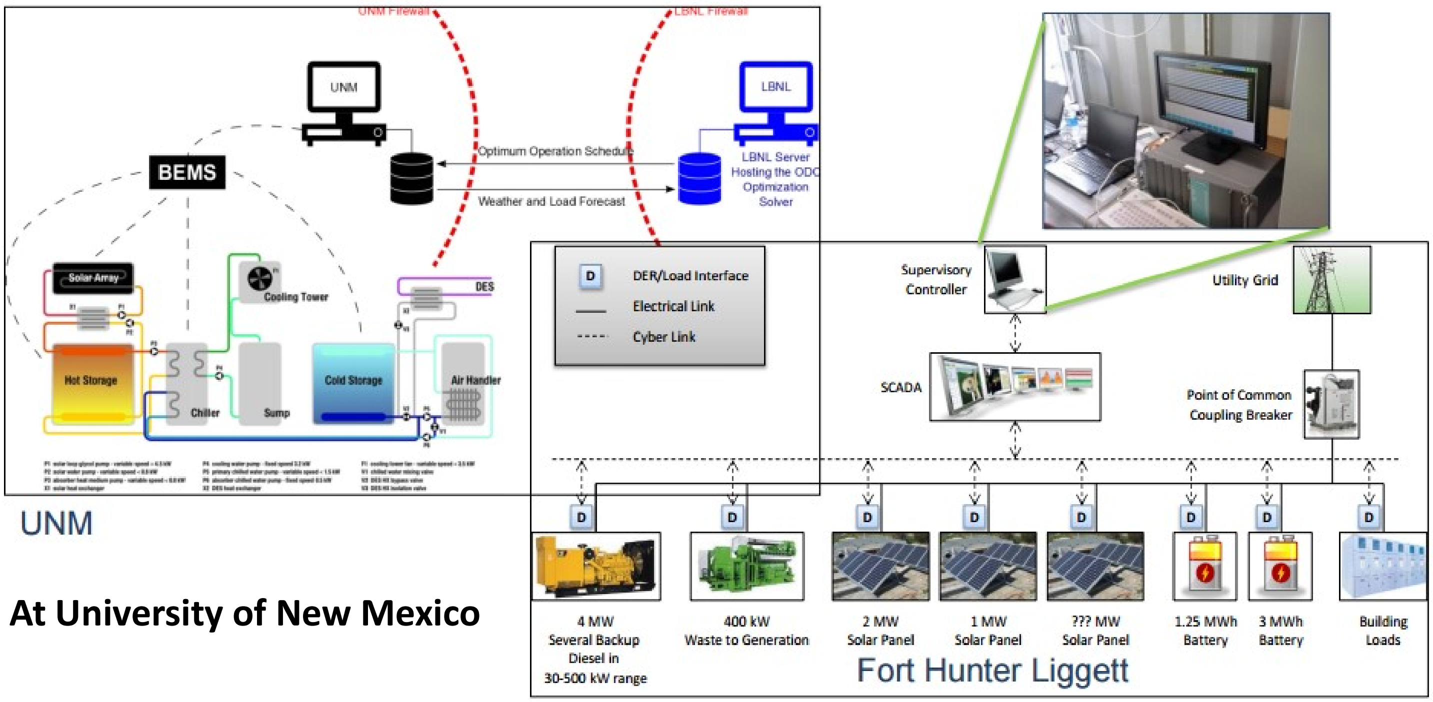
Ref:
Lawrence Berkeley Lab LInk

MICROGRID MODELING: USING DER-CAM



Ref:
[Lawrence Berkeley Lab LInk]

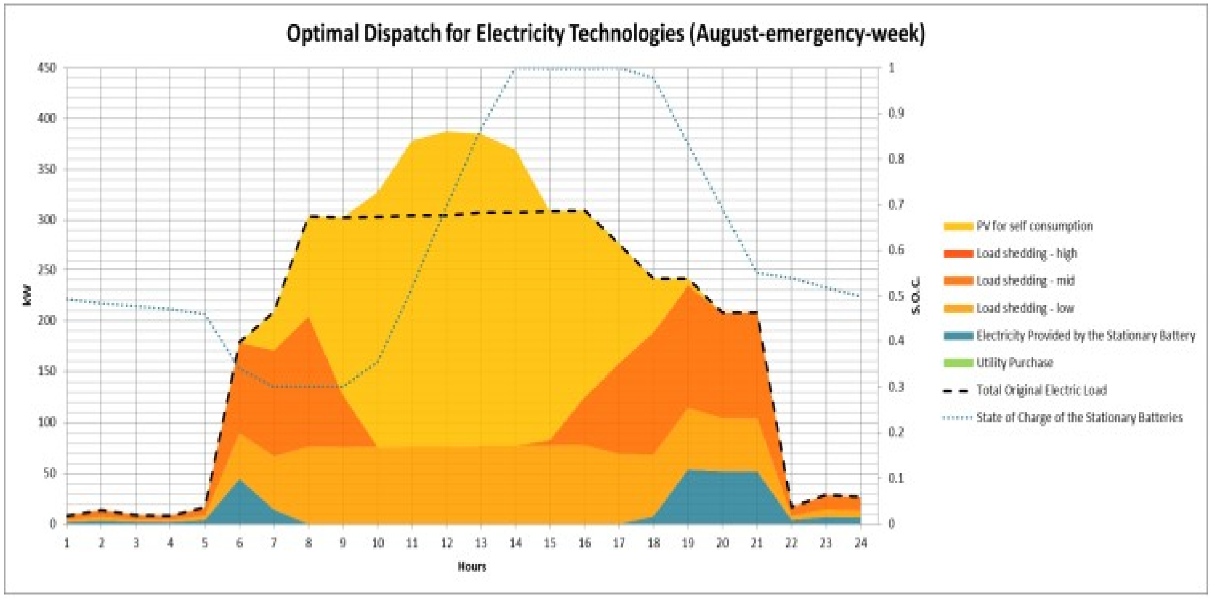
MICROGRID: A TYPICAL CONFIGURATION



At University of New Mexico

Ref:
[Lawrence Berkeley Lab LInk]()

DER-CAM MODELLING: USE CASE



- Large Office Building in Baltimore, Maryland
- Annual Energy Costs ~US$196K
- 400KW PV, 400kWh Battery
- Load curtailment as per DR
- Load and DER Modeling showing:
  - PV (during day time)
  - Load shedding/DR
  - Solar from PV at peak time – stored in the battery for later usage
  - Electricity from battery

Ref:
Lawrence Berkeley Lab LInk

MULTIPLE STAKEHOLDERS AT EACH LOCATION

1. End Customer

A. Different type of buildings and campuses (Home (Individual Home, Apartment), Office (SOHO, Commercial), University, Hospital, Mall, Industry, …) of various sizes & formats

B. Different types of users with different purposes

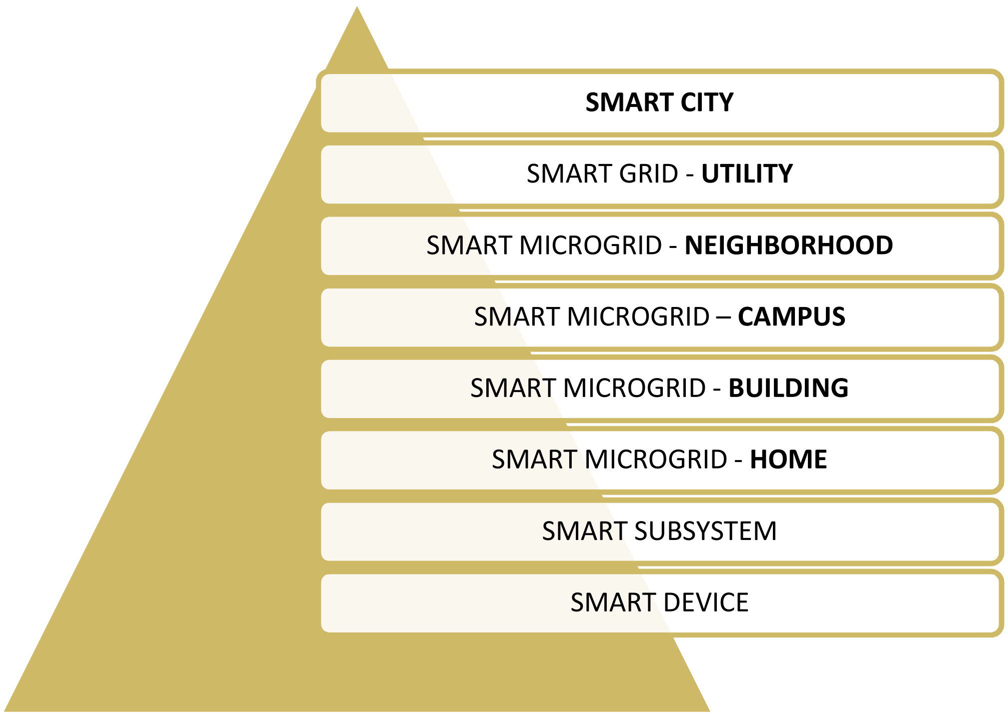
   - **A. Home** – Mother & Father, and children by age groups
   - **B. Office** – Management, Finance, Employees, Operations, Facility Maintenance & Field Staff
   - **C. University** - Management, Academic Staff, Students, Facility Management & Field Staff
   - **D. Hospital** – Management, Doctors, Patients, Support Staff, Facility Management & Field Staff
   - **E. Hotel** – Management, Customers, Facility Management & Field Staff

2. Multi-Purposing – beyond Electric

A. Combine "Microgrids" or other Subsystems for Singular Purpose

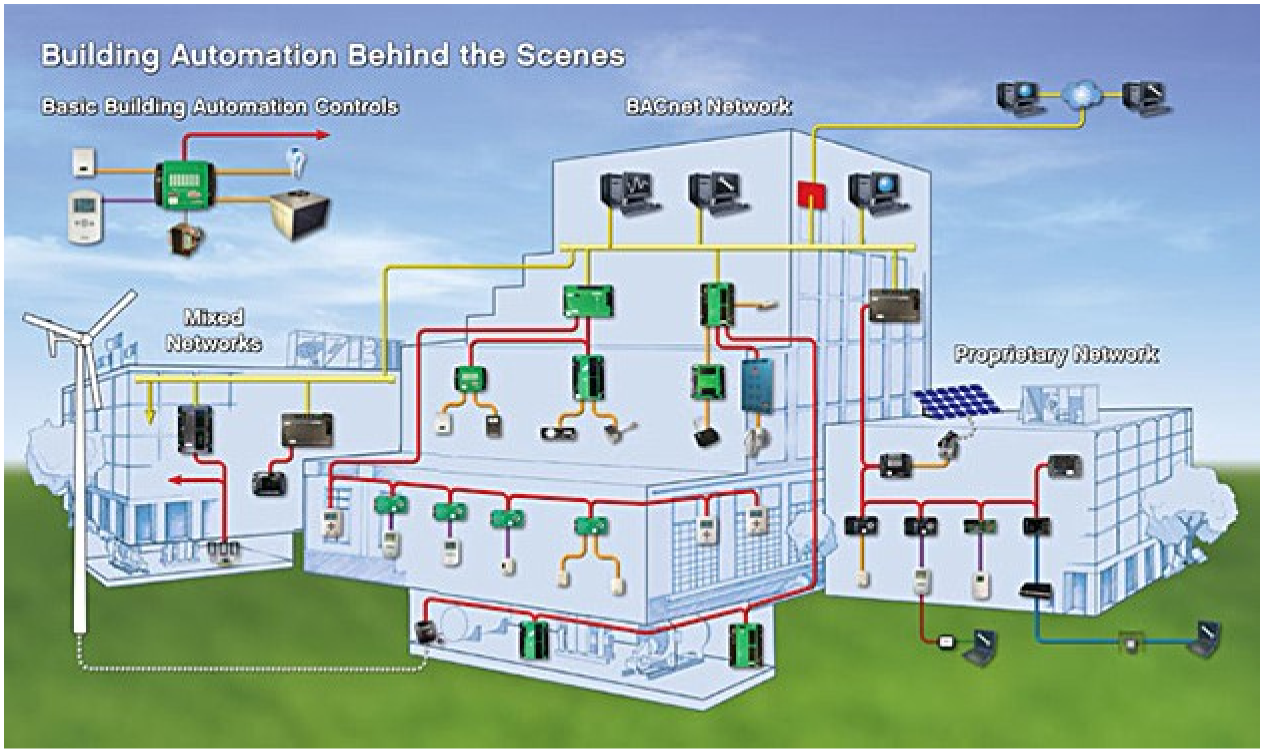
3. Integrate for Expansion – Building, Neighborhood, Campus, Utility, City

FUTURE OF SMART MICROGRID



1. **Innovation each level**
2. **Iterative Adoption – based on successful pilots**
3. **Distributed & Standards based Integration**
4. **Connected & Independent**
5. **MACHINE LEARNING & AI AND ANALYTICS – DRIVEN FROM CLOUD**

USE CASE 1: BUILDING



Active Systems to Monitor and Manage For Automation, Conservation

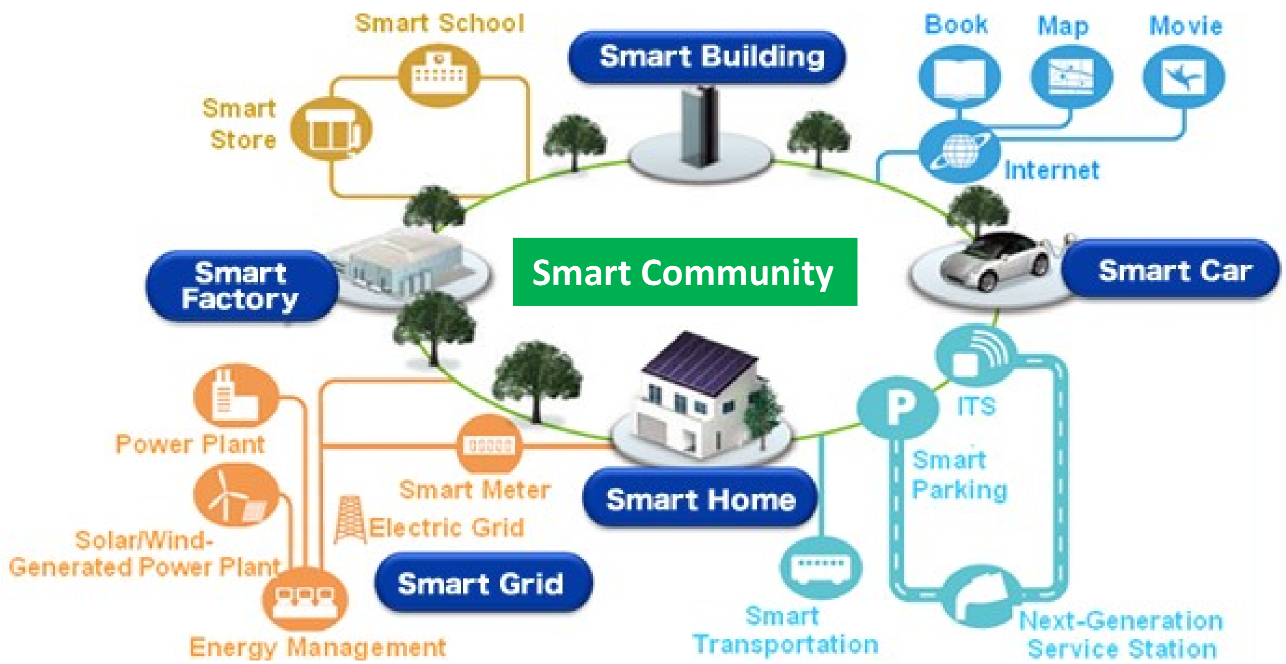
For Owners, Tenants In Connection with Smart Grid & Smart City

DER: Solar & Wind

Ref: electrical-knowhow.com

USE CASE 2: SMART COMMUNITY

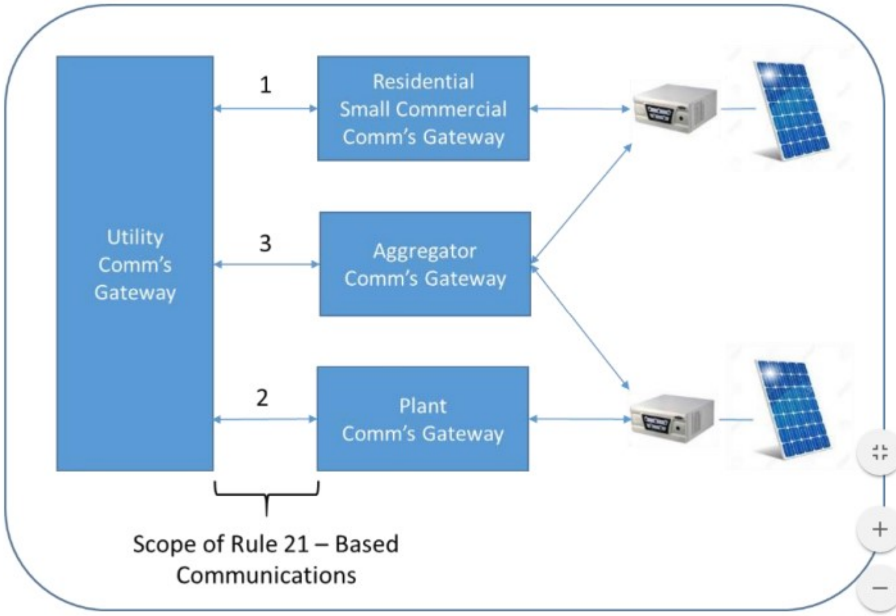
Smart City is A Network of Smart Communities. 75% of World Population will be in Cities by 2030.



Ref: Renesas.com

USE CASE 3: SMART INVERTER/DER RULE 21/CALIFORNIA

- **Premise**: defining interfaces from utility to 'smart inverters' in Local Generation (DER)
- **Utility's Purpose:** Continuous monitoring to balance the utility supply and generation; and provide 'net metering' and tariff for local generation using Rule 21
- **Consumer Purpose:** Get paid for energy put back into the grid
- **Key Standards:** IEEE 2030.5 for Smart Inverter Profile; IEEE 1815/DNP3 for SCADA Real-time Monitoring and IEC 61850 for integration with grid infrastructure.
- **Scope:**
  A. Utility & individual DER System
  B. Utility & Facility "Microgrid"
  C. Utility & Retail Energy Aggregator/Provider



Ref:
Presentation by Sara Biyani
IEEE Standards Association

IEEE 2030.5 FOR DER

- **Local Generation (DER) Functions**
  - Monitor generation, local weather, eqpt status, errors and alarms, and O&M support
  - Ability to be part of multiple groups (neighborhood)
  - Control/Manage to participate in local demand and reactive power controls
- **Technical Architecture**
  - Popular RESTful & HTTP API (over IP) to interface with rest of IoT, cloud, other local devices & systems
  - Security: TLS 1.2, Strong Authentication and Access Control – as per NIST Requirements
- **Open Standard**
  - Builds over IEC 61850 and SunSpec
- **Extensibility**
  - Can support different programs (Tariff, DR, Virtual Plants) and stakeholders (Residential, C&I, Aggregators, Facility Management, Utility), and with other devices (Storage, EV, Energy Management, …)

Ref:
Presentation by Sara Biyani
IEEE Standards Association

IEEE 2030.5 – SAMPLE DEVICES THAT CAN USE

1. **User Interface Devices**
   Mobile, Tablet, TV, Computer, Device Displays
2. **Meters**
   Smart Meters for Electric, Gas and Water
3. **Loads/Consumption Devices in Consumer Locaiton**
   Air Conditioner, Water Heater, Pool Pump, Refrigerator, Other Smart Appliances
4. **Smart Advanced Systems**
   EV, Storage, Smart Solar Inverter
5. **Smart Management Systems on Premise/Facility/Neighborhood**
   Microgrid System, Building Energy Management System (BEMS/BMS)
6. **Sensors**
   Thermostat, Humidity, Weather Sensing for DER

Ref:
Presentation by Robby Simpson, GE
IEEE Standards Association

FOR POWER DEVICE MANUFACTURERS

1. ***No device will be an island*. They will all be connected, into single or multiple systems, for different stakeholders.**
2. **Design for Maintenance, Monitoring & Management. Every new hardware should be designed for easy diagnostics and management, individually or through a subsystem.**
3. **Build Smart Subsystems around your devices. Allow easy monitoring of all internals of your device.**
4. **Consider IP Networks and IPv6. Using IIoT, more field gateways are transforming networks to IP based, away from legacy.**
5. **Derive New Revenues and Business Models. Leverage IoT platform to deliver new business revenues.**

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THANK YOU

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