



Smart Grid at the Distribution Level

How Smart Grid Can Enable Storage,
Distributed Generation and Other Solutions

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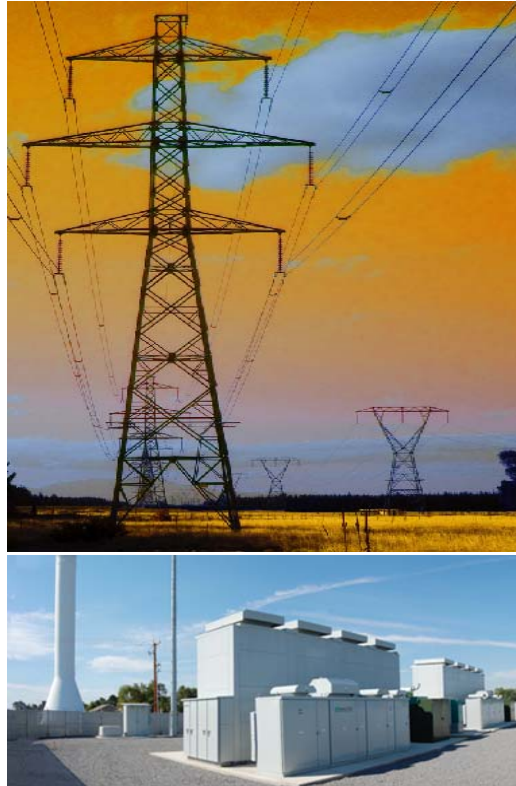
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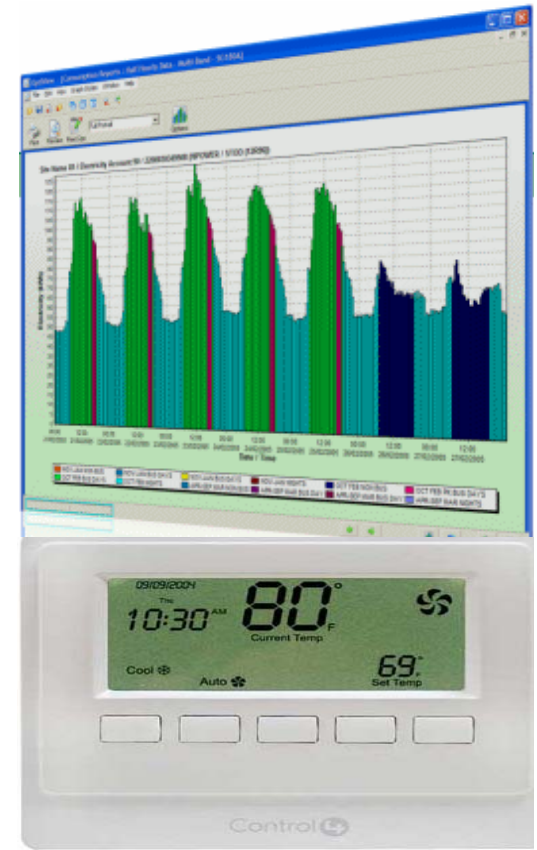
Building A Reliable, Affordable, And Sustainable Electric System



Renewable Electric Generation



Efficient Electric Delivery



Managed Electric Demand

A Smart Grid

Smart

Overlay with an “Intelligent” Infrastructure

- Pervasive sensing and measurement devices
- Pervasive control devices
- Advanced data communications
- Computing and information management



Power
Plants



Transmission
Networks



Substations



**Distribution
Networks**



Consumers

Potential Benefits From Smart Distribution With Adequate Investment

Reliability

Rapidly detect and respond to electrical outages

Affordability

Enable more efficient use of grid assets, reducing the need for expensive new generation

Sustainability

Enable a more sustainable energy mix by letting us automatically tap dynamic resources to balance fluctuations in intermittent renewable generation



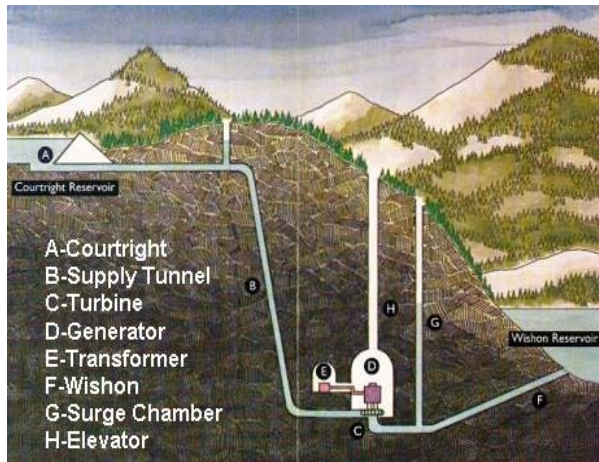
Smart Distribution benefits will not always be measured in hard dollar savings, but rather in the customer and social benefits they enable

Enabling Distributed Generation (DG)

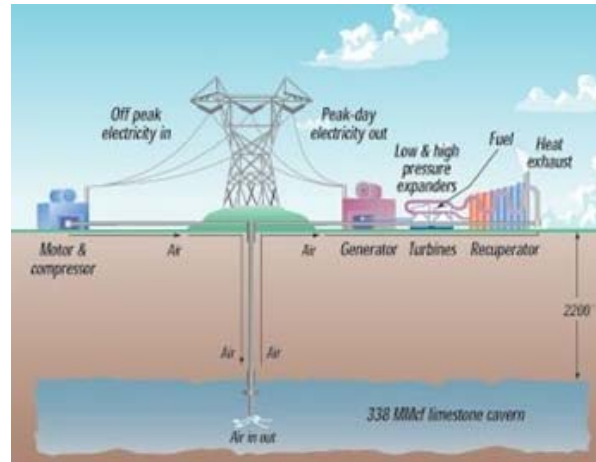


- DG includes solar, micro-wind, micro-hydro, fuel cells, combined heat and power
- PG&E has more than 30,000 solar customers (300 MW)
- At scale, intermittency and alignment to load become issues

Enabling Storage Resources



Pumped Hydro



Compressed Air



Sodium-Sulfur (NAS) Battery



Zinc Bromine Flow Batteries



Flywheel

PG&E's Utility Scale Storage Pilot



The NAS battery installation at Tokyo Electric Power Co.'s Ohito Substation is rated at 6 MW/48 MWh

- 4 MW sodium sulfur (NaS) battery
- Reliability and power quality improvement
- Test ability to provide ancillary services
 - Load-following
 - Frequency regulation
- Test ability to cost-effectively integrate intermittent renewable resources

Microgrid Pilot Project

- A collaboration with Alameda county and the Santa Rita Jail
- Leverage existing on-site generation equipment – solar PV, fuel cell, diesel
- Install a high-speed static transfer switch, generation monitoring and control system, and battery
- Demonstrate ability to:
 - Decouple from grid in milliseconds
 - Regulate generation
 - Provide electric service for 8 hours



1.5 MW solar installation



1 MW fuel cell

Required Functions To Support Expanded Distributed Generation And Storage

Safety

Adaptive protective systems

Bi-directional flow protection

Visibility

Generation status

Forecasting

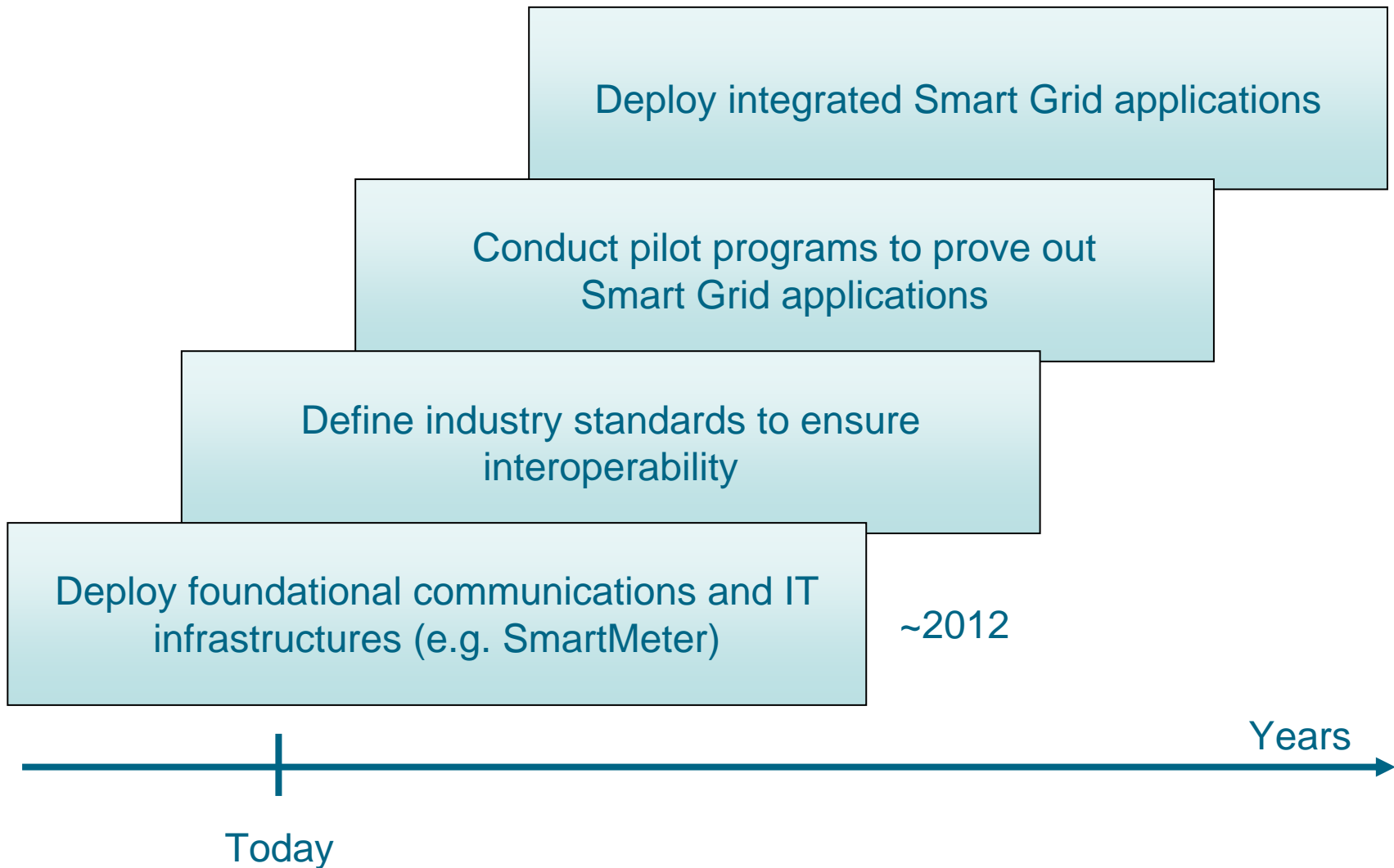
Operability

Increased automation

Integration

Grid Flexibility

Smart Grid Is A Journey



Summary

- A Smart Grid is an essential component of a modern electric system that is **reliable**, **efficient**, and **sustainable**
- The Smart Grid is a journey, not a destination
- The **SmartMeter** program lays the foundation for a smart grid
- PG&E is actively piloting a range of Smart Grid technologies within its distribution network, including **storage** and **distributed generation**
- **Benefits** can include greater integration of renewable resources, improved service reliability and overall grid efficiency