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The History of the Smart Grid Evolution at Southern California Edison

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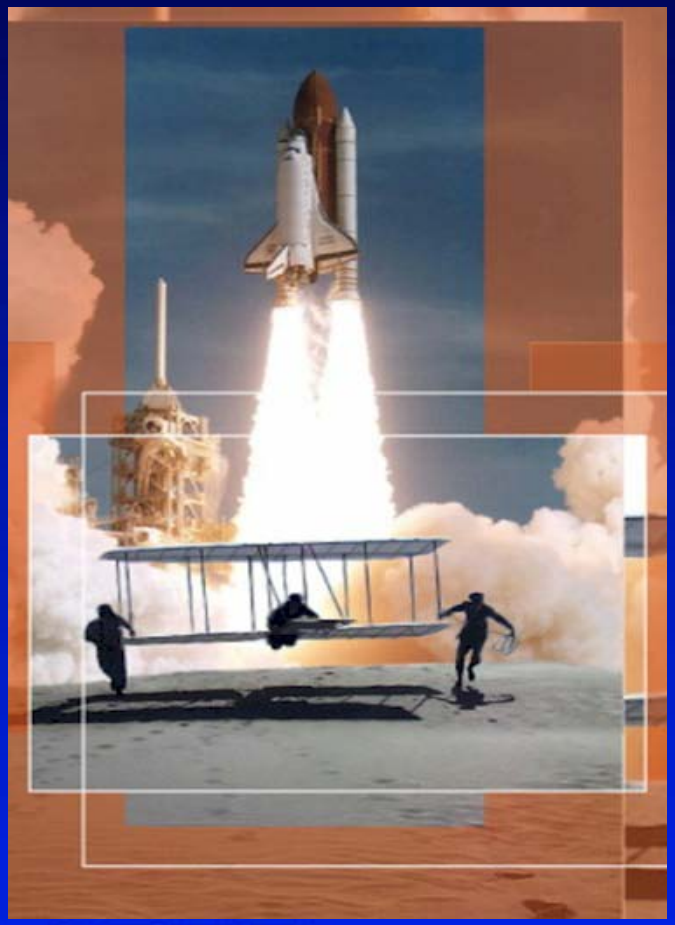
Visions of the Future, Looking to the Past



- Revisiting past accomplishments and examining today's technologies will inspire future Smart Grid advancement.
- SCE's past efforts provide a substantial foundation for future Smart Grid development. Its long history and visionary efforts have led to the utility's forward thinking strategy.

- Picture from www.wright-brothers.org

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In the Beginning

The evolution of the Smart Grid has its roots in SCE's early history. Understanding the utility's continuing efforts and accomplishments in this area will help determine just what a Smart Grid is and roadmap its future development by:

- clearly defining a Smart Grid
- explaining SCE's comprehension of a smart grid
- investigating the evolution of smart grid advancements

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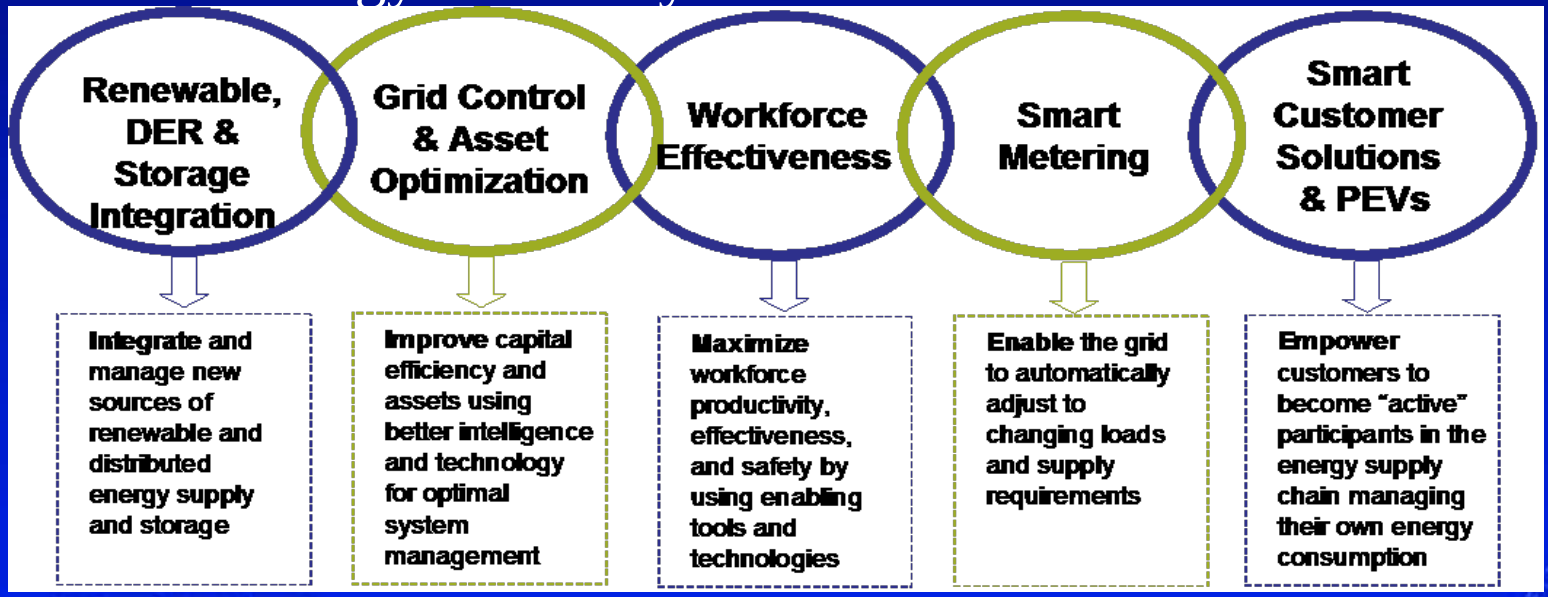
SCE's 21st Century Smart Grid Vision

Under the stewardship Paul De Martini, vice president of SCE's newly formed Advanced Technology Organization (ATO), an SCE Smart Grid vision has been defined as a smarter Grid that will provide the environmental benefits associated with improved asset, system and energy efficiency.



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SCE's 21st Century Smart Grid Vision

Addressing SCE's 5 key themes will:

- Prepare the utility for a new Smart Grid world
- Modernize its grid to improve reliability, safety and cost effectiveness
- Allow it to deliver more customized solutions and an environmentally friendly energy supply to meet the customer's energy management needs

The History of the Smart Grid Evolution At Southern California Edison – Anthony P. Johnson Edison's History in Renewable, Distributed Energy Resources and Storage Integration

- **1899** – Edison begins operating the Santa Ana River hydroelectric plant transmitting power over the world's longest transmission line – 83 miles.
- **1903** – A first, Edison establishes a record by transmitting electricity via steel towers 118 miles from the Kern River to the LA area.

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- **1907 –** Big Creek, at the time the largest hydroelectric project, is developed by Pacific Light and Power Company and later purchased by SCE.
- **1927 -** The first geothermal power production well in the U.S. is built by another company that would become part of SCE.

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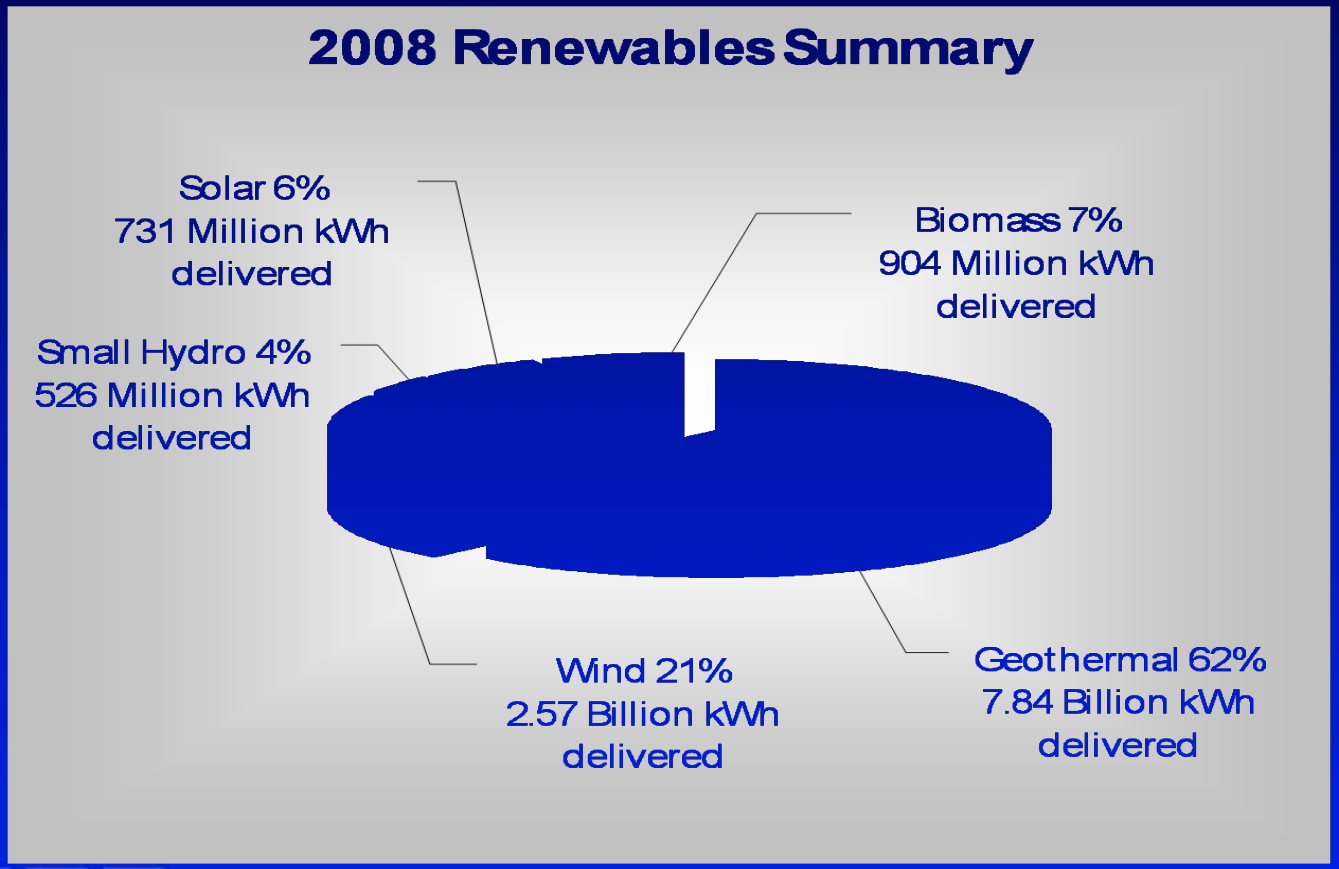
Renewable, Distributed Energy Resources and Storage Integration



The History of the Smart Grid Evolution At Southern California Edison – Anthony P. Johnson Renewable, Distributed Energy Resources and Storage Integration

The 1980s saw SCE become strongly dedicated to the development of renewable and alternate energy resources.

- Late 1980s – established a large battery storage test facility.
- 2006 – signed the largest wind energy contract, 1500 megawatts (MW) more, ever to be signed by a U.S. utility.

The History of the Smart Grid Evolution At Southern California Edison – Anthony P. Johnson Renewable, Distributed Energy Resources and Storage Integration

The 1980s saw SCE become strongly dedicated to the development of renewable and alternate energy resources.

- 2008 completed the installation and commissioning of a major commercial rooftop solar project to lead a 500 MW solar initiative, 250 MW by SCE and 250 MW by independent power producers.

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Grid Control and Asset Optimization

SCE grid control equipment spans several generations.

- The earliest, inside substations provided automatic control performed by electro-mechanical relays to:
  - de-energize the circuit and reclose it once
  - test the circuit to see if the fault was momentary.

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Grid Control and Asset Optimization

SCE grid control equipment spans several generations.

- The next generation, based on the automatic telephone switchboard equipment of the 1940s, was supervisory control or *supy* equipment that:
  - used communications equipment in a substation
  - allowed the operator at a remote location to read and have control of the local substation

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Grid Control and Asset Optimization

- In the late 1960s *supy* was replaced by the Supervisory Control and Data Acquisition System, or SCADA.
- SCADA slowly expanded in the 70s and 80s to include monitoring bulk power (220 kV or higher) and was installed at some distribution substations.
- It would add mainframe applications to support the control room and a remote terminal unit (RTU) for data collection and control in the substations.

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Grid Control and Asset Optimization

- The RTU would then be cross-wired to a programmable logic controller (PLC).
- As technology progressed the original inputs, hardwired in parallel, were replaced by communication links.

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- In the mid-90s SCE replaced the RTU/PLC configuration with new architecture, a network configuration with relays, PLC and other devices that talked to each other over a network to coordinate operations or substation automation system(SAS).
- Presently, SCE is on its second generation SAS or SA2 and is looking to transition its backbone communication protocol to IEC 61850.

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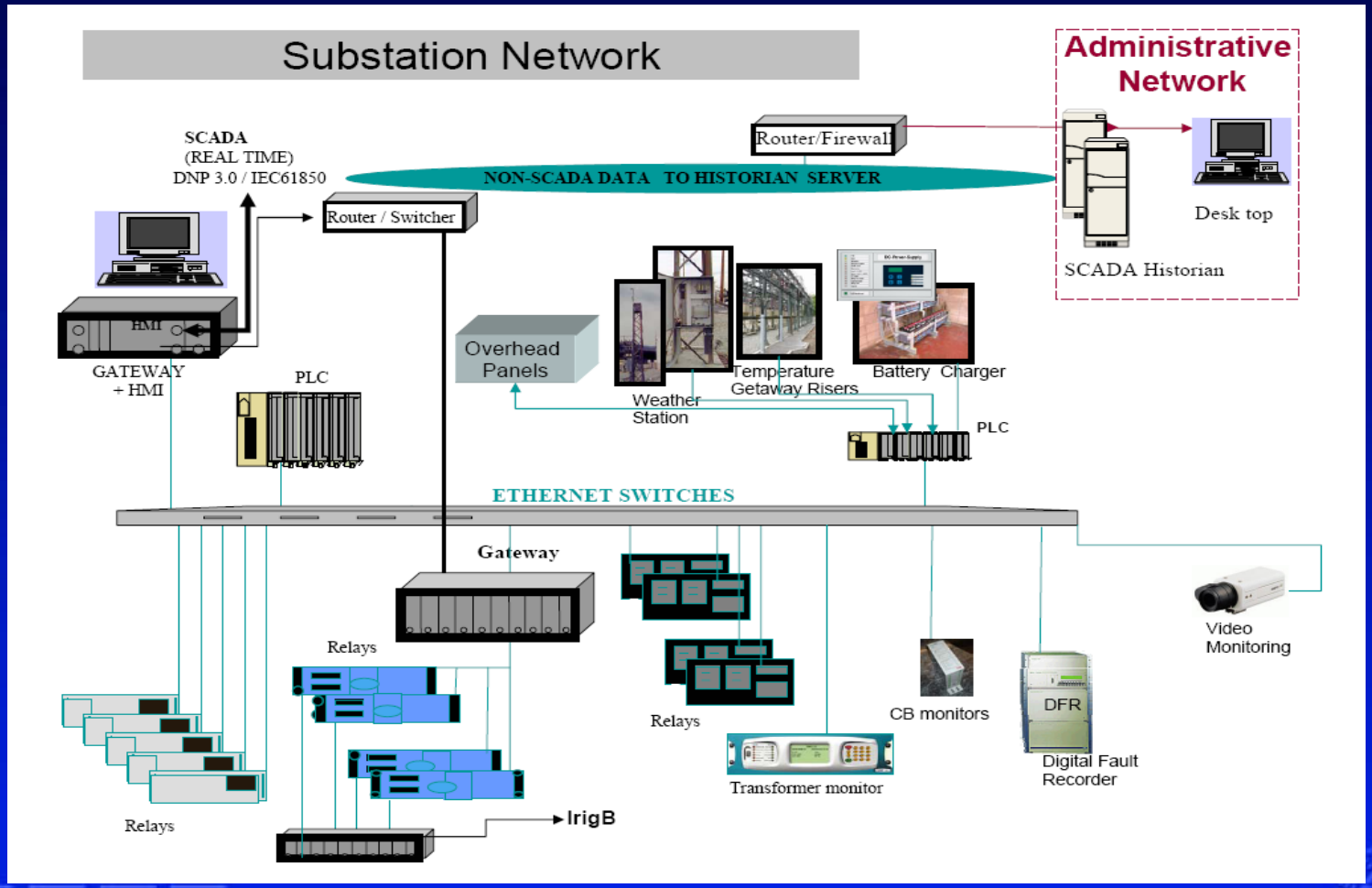

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Grid Control and Asset Optimization

The distribution system is important to grid control and asset optimization on a Smart Grid.

- For much of SCE history it was manually controlled, but manually operated switches and fuses do not lend themselves easily to the Smart Grid.
- In the late 1980s and early 90s SCE had several programs in place to begin deployment of intelligence to the feed to enhance voltage profiles of the circuit and speed isolation of faults.

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Workforce Effectiveness

- The workforce effectiveness component of the Smart Grid will build upon SCE's experiences with renewable integration and grid control and optimization.
- SCE has always valued a well-trained effective workforce and its training and experience with back-office systems allows it to optimize its productivity and prepare for the future.

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Workforce Effectiveness

- In the early 1990s SCE used work management systems to optimize its maintenance and construction activities and practices.
- SCE first introduced these practices in its power plants, and then implemented them into its T&D system to help optimize asset maintenance and the construction of new facilities.
- SCE is in the process of integrating its work management system into the rest of its back-office enterprise software.

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Smart Metering

SCE piloted automated meter reading (AMR) in the 1990s.

- AMR did not lead to full-scale implementations at the time, but were valuable for identifying important requirements for later pilots and in the implementation of a fully automated AMI system.
- In the 2000s, the CPUC asked utilities to investigate using AMI/AMR technology and SCE initiated its SmartConnect program.
- In 2009 SCE plans on installing smart meters for all of its customers and integrating them with the utility's customer conservation and incentive programs.

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Energy Smart Customer Solutions

Informing and educating SCE customers in the use of electricity has been the company's goal since its early days.

- SCE originally operated at 50 Hz
- In the 1940s, SCE was growing and wanted to interconnect with its neighboring utilities requiring it to convert to 60 Hz.
- The conversion impacted SCE customers, so the utility responded with an exchange program clocks that could run at 60 Hz.

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Energy Smart Customer Solutions

With the 1970s energy crisis came an increased awareness of the need to conserve.

- The CPUC encouraged its utilities to work with their customers to encourage energy conservation.
- California consumers led the nation's energy conservation efforts.
- SCE continues to investigate methods to help its customers to reduce their energy usage, lower their power bills, and take full advantage of all the Smart Grid has to offer.

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Smart Grid 2009 and Beyond

The newly defined Smart Grid incorporates:

- Advancements in communications and information technologies
- Interacting geographically dispersed equipment being able to perform coordinated operations
- Telecommunications and computer processing power allowing the transmission of greater amounts of data to provide accurate information for facilitating appropriate actions.
- Uses innovations and available technologies to solve complex and seemingly impossible problems

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For more information on SCE's Smart Grid strategy, news, and updates, go to: **www.sce.com/smartgrid**