Distributed Generation in the New Millennium

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Distributed Generation

Solar-PV

Wind

Fuel Cells

Micro-Turbines

Distributed Generation is a Disruptive Technology

(Bower & Christensen, HBR, Jan 1995)

- One of the most consistent patterns in business is the failure of leading companies to stay at the top of their industries when technologies or markets change

- Most well managed, established companies are consistently ahead of their industries in developing and commercializing new, next generation technologies

Edison Technology Solutions Intends to Lead Our Industry in Distributed Generation

Edison Technology Solutions (ETS) is the remaining core of Southern California Edison Company's R&D Organization. Over the last decade, ETS employee's have been the drive in implementing the worlds' most diverse utility generation portfolio on behalf of the utility.

- Edison International (EIX), is the parent company
  - 1997 Revenues: $9.2 Billion
  - Net Profit: $0.7 Billion
  - Assets: $25.1 Billion

- Other affiliate companies include:
  - Edison Mission Energy
  - Edison Capital
  - Edison Enterprises
  - Southern California Edison

Edison Technology Solutions

- Vision

  "Develop and commercialize technologies, products and services to meet the needs of emerging competitive energy and electricity markets"

  - Developing distributed resources for enhancing reliability of the grid and creating the "grid of the future"
  - Deploying renewable distributed applications
  - Developing technologies to increase power quality
  - Developing and demonstrating "hybrid" technologies with high efficiencies and low emissions

Why Distributed Generation?

- The evolution of Fuel Cells for stationary power applications, micro-turbines, PV and wind all figure prominently in this emergence of “disruptive technologies”
- The US market is moving towards distributed generation based on emerging technology, time of day pricing and restructuring incentives
- International market is based on high demand and liberalization of the energy markets

Movement to Distributed Generation

- In the developing country markets, Distributed Generation is to the energy sector what the cell phone has been to the telecommunication's sector

- Regulatory reform and technology has made the energy commodity more accessible and less expensive to a large market segment that has previously been poorly served

World Energy Council

- The World Energy Council, on behalf of thirty-five energy ministers and five thousand energy executives from nearly 100 countries, issued on September 18, 1998 their conclusions and recommendations from on the world's energy sources should be used

  - *"The accelerated development and use of renewable energy resources must be given high priority as a means of supplying commercial energy services to people without previous access to energy sources"*

World Energy Council

"Both traditional and new renewable energy sources have an important place in future energy supply. While fuel, wood and coal will remain the principal energy supply resources for many developing countries, distributed generators -- micro-turbines, diesels, and fuel cells -- and renewable technologies, specifically wind, biomass and solar, may provide a viable option for areas operating independent of power grid and fuel pipeline systems".

Edison Technology Solutions and Solar Photovoltaics (PV's)

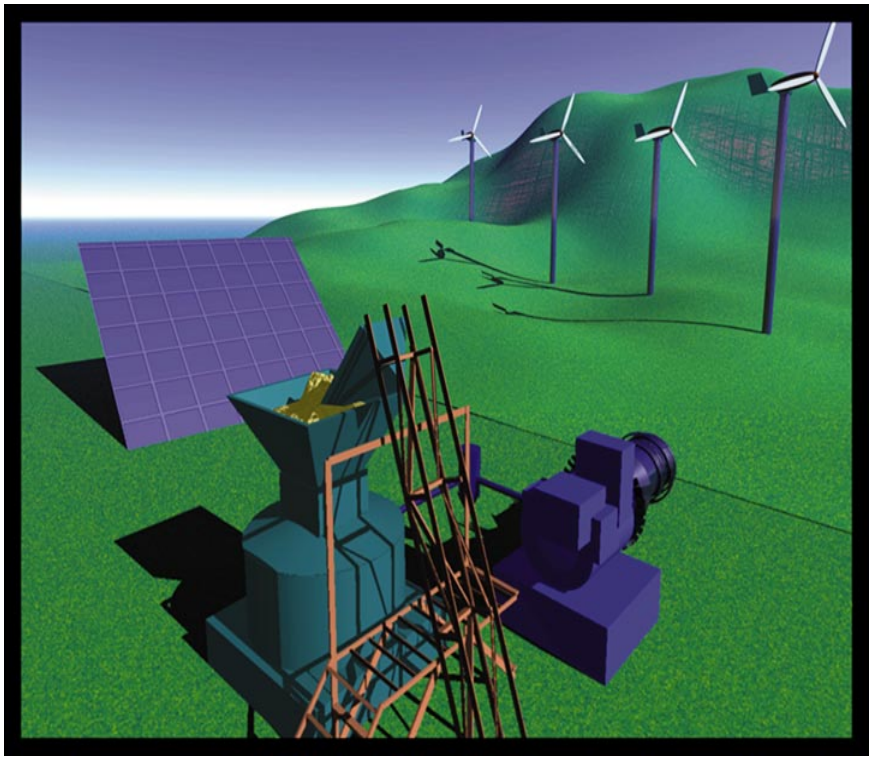
- With over twenty years' of experience in the development, demonstration, and implementation of renewable technologies, ETS staff has managed solar-PV installations from 1.5 kW to over 100 kW, at over a dozen sites throughout Southern California.

- ETS has developed a three-tiered approach to help utilities, international organizations, and commercial customers integrate a comprehensive solar program
  - This experience and knowledge will be highly applicable to designing and commercializing solar- PV technology for Village Power

ETS staff managed this PV installation off the California coast on Santa Cruz Island. This 130 kW site validates the cost-effectiveness of renewable technologies in isolated, remote applications.

Movement to Renewable/Fossil Hybridization

- Hybridization is essential to renewable energy technologies – lowering their levelized energy costs and increasing system reliability and capacity factor
- Many renewable energy technologies have distributed generation implications/similarities



Edison Technology Solutions and Micro-Turbine Generators (MTG's)

- ETS is managing a $2 million utility/industry/government effort to test, prove, and enhance micro-turbine generators.

- This effort grew out of ETS' early recognition, that a fundamental change in power generation was occurring - the replacement of economies of scale with economies of manufacturing. This insight allowed ETS to take a national leadership role in testing and improving this emerging technology.

- ETS' focus is on increasing efficiency, lower emission levels, and improving machine reliability.

Two micro-turbines under endurance testing at ETS' test facility

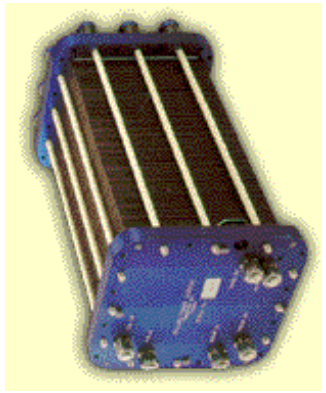
Edison Technology Solutions and Fuel Cells

- With over twenty years' experience in the evaluation, development, and demonstration of distributed generation technologies, ETS has extensive experience with two previous Siemens-Westinghouse 20 kW atmospheric SOFC designs.

- ETS' focus is to pursue initiative enabling technologies that will help foster rapid commercialization and significant deployment of fuel cells
  - Fuel reformation
  - Balance-of-plant (inverters)

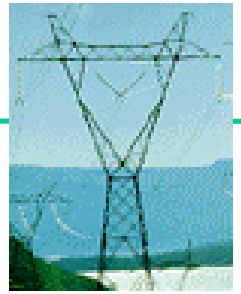
Prototype 25 kW SOFC in operation at the National Fuel Cell Research Center at Irvine, California. ETS is a founding member.

Fuel Cells Can Provide a Common Technology Platform for Many Market Sector Applications

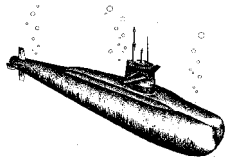


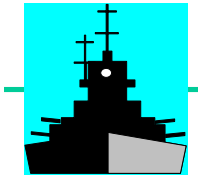
Transportation

On-Site Power



Distributed Power





Military & Portable Power

Source: AD Little

Next Wave of Technology Integration

- According to Power Engineering

  "The rapid evolution of gas turbines technology in recent years - achieving higher and higher efficiencies - leads one to wonder how close the thermodynamic ceiling is. The next barrier - 70% - is getting rather tight. To achieve that level, novel cycle designs will be necessary."

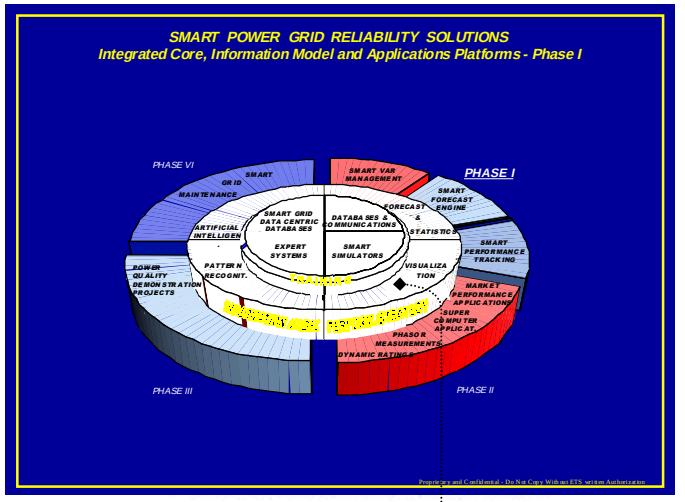
- ETS' Fuel Cell / MTG Hybrid Power Plant has an excellent chance of achieving 60% efficiency and beyond
  - *"Combined cycle"* integrating a fuel cell with a MTG
  - Chemical process - similar to a battery
  - Lower capital cost ($/kW) than a standalone fuel cell
  - Higher efficiency than either a standalone fuel cell or MTG
  - No detectable NO_x emissions
  - Modularity, sized for the less than 1.0 MW market segment

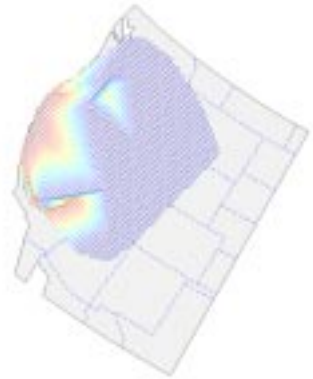
Edison Technology Solutions and “Grid-of-the-Future”

- With over twenty years’ of utility policy making, operating, planning and real time control experience, ETS has and is playing a leadership role in the electric industry restructuring, both on a national and regional basis from policy, operational and real-time control perspectives

- The vision of the “Grid-of-the-Future” program is to facilitate creation of new grid infrastructures that will integrate new technologies and tools to maintain and improve reliability and efficiency

- Integration of distributed generation, storage, and power electronics technologies at the transmission, distribution and consumer levels, in addition to development of smart integrated grid management tools make the ETS portfolio to improve grid reliability





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In Summary

- Entrepreneurial subsidiaries within a large, multi-national energy company *do possess* the synergistic characteristics of:
  - Providing the technology push for appropriate technology in the global marketplace
  - Having the market presence and financial strength to collaborate with multi- and bi-lateral organizations
  - Perceiving the de-centralization of energy supply and electrification of the “unplugged”