Beijing Electric Power and Pacific Gas and Electric

May 25, 2012

Agenda

* 9:00-9:15 Introductions
* 9:15-10:00 Smart Grid Overview
  * Kevin Dasso, Senior Director Technology and Information Strategy
* 10:00-11:00 San Francisco Transmission and Distribution
  * Manho Yeung, Senior Director System Planning and Reliability
  * Jon Eric Thalman, Director Regulatory Strategy
  * Raymond Thierry, Senior Manager Substation and Transmission Assets
* 11:00-11:15 Discussion of Logistics for Redacted Substation Tour
* 11:30-1:00 Lunch
* 1:30-3:00 Redacted Substation Tour

San Francisco Transmission and Distribution Grid

- San Francisco power grid development history
- 3-5 year load forecast and grid planning
- Load density in different districts including high tech, commercial/financial, industrial, and residential districts in San Francisco
- Coordination between local and remote power resources in serving load centers, especially for high density load pockets
- How to limit the short-circuit current in the high density load pockets
- Does PG&E divide a high density load pocket into several subdivisions to supply power?
- Principles PG&E used in planning and building the 12 kV/ 240 V/110V distribution networks in downtown San Francisco?
- How to preserve land and right-of-ways for future substation and distribution line development in downtown San Francisco?
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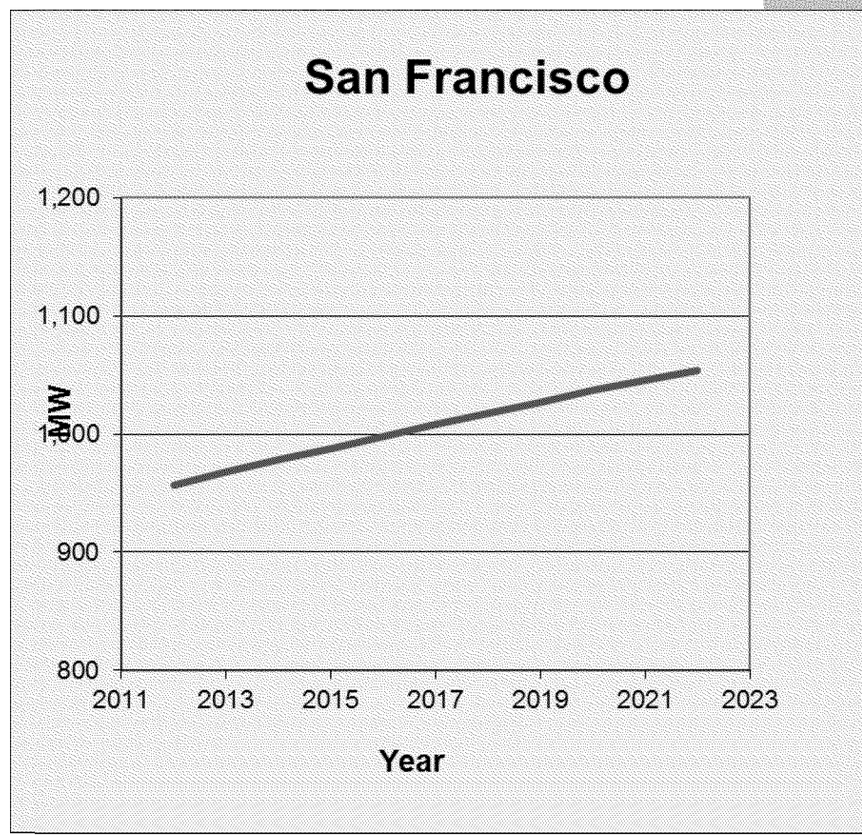
San Francisco Power Grid Development History (last 15-years)

- Generation
  - Hunters Point Plant shutdown in 2006
  - Potrero Plant in 2010
  - No generation within the city of San Francisco
- Electric Transmission
  - New 230 kV cable from Jefferson to Martin
  - New 230 kV DC cable from Pittsburg to Potrero (owned by the City of Pittsburg)
  - Two new 115 kV cables and two re-conductored cables in San Francisco
  - Re-conductored all six 115 kV overhead lines between San Mateo and Martin
  - Re-conductored the two Ravenswood-San Mateo 230 kV lines
  - Transmission transformer capacity and redundancy at Martin
  - Breaker-and-a-half bus upgrades at Martin
  - Voltage devices (static var compensator, capacitors & reactors) at Redacted
  - New Potrero-Embarcadero 230 kV Cable Project to establish a third power source to Embarcadero

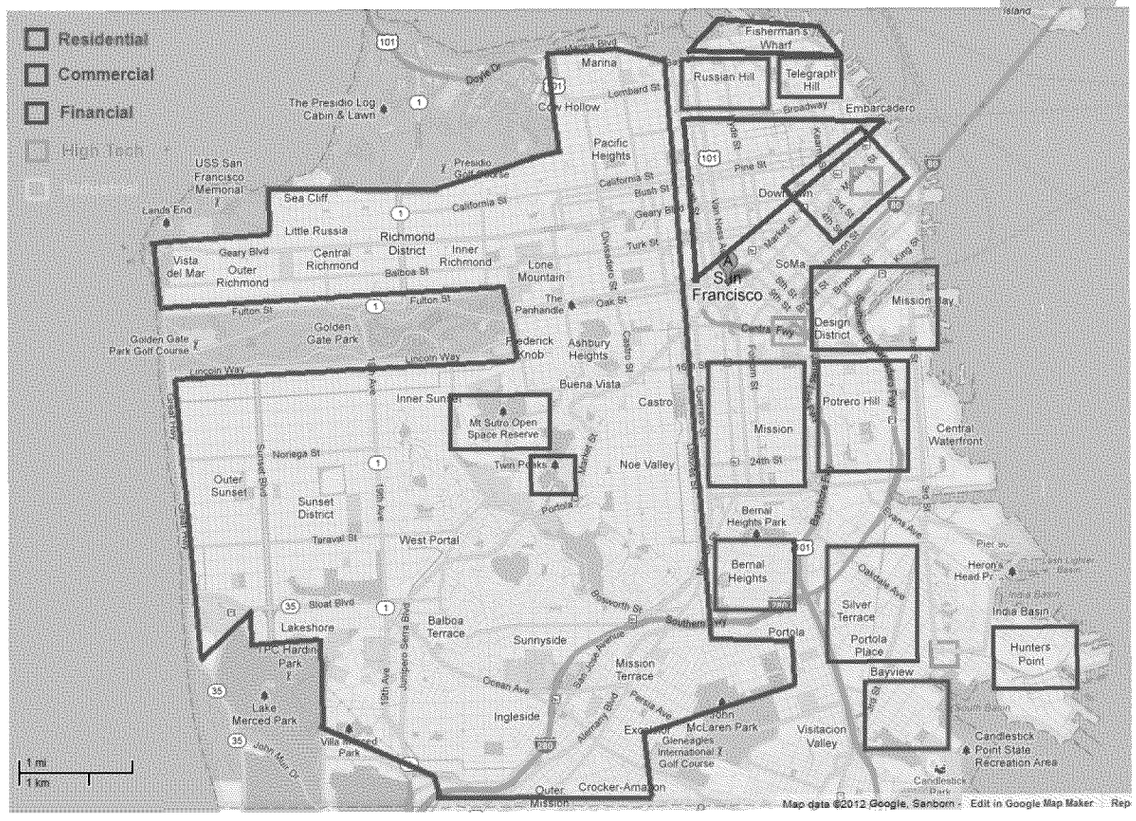
3-5 Year Load Forecast and Grid Planning

- San Francisco
  - City and County of San Francisco
  - Population: 805,000
  - 375,000 electric customers
- 2012 forecast of 950 MW
- 2022 forecast of 1050 MW
- Load growth of approximately 1% per year

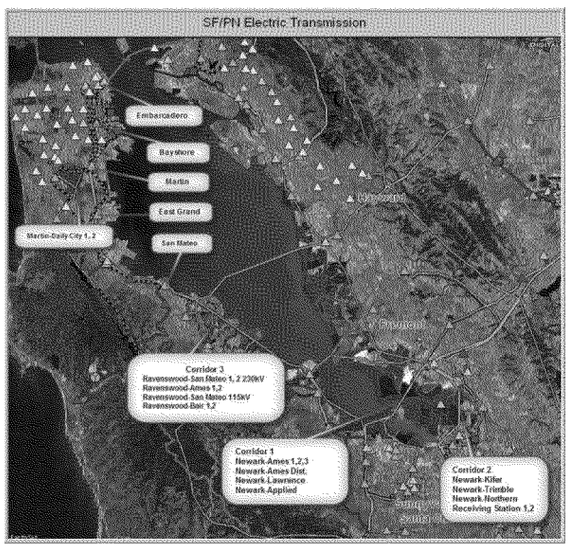


Load Density in Different Districts

* High tech: 44 MW in 1 sq. mi.
* Commercial: 200 MW in 11 sq. mi.
* Financial: 372 MW in 2 sq. mi.
* Industrial: 20 MW in 4.5 sq. mi.
* Residential: 343 MW in 28 sq. mi.



Coordination Between Local and Remote Power Resources in Serving Load Centers



- The San Francisco Peninsula has no internal generation
- Supplied with electric power by nine transmission lines through two paths
- Eight transmission lines from Redact Substation to four major distribution substations
- One third-party-owned TransBay DC Cable connecting Pittsburg to Potrero Substation.

- Redact Substation serves 73,000 customers directly and an additional 284,000 customers via eight electric transmission lines to four substations in San Francisco.

- Redacted Substation serves the downtown financial district and is supplied by two 230kV cables from Redac Substation.

- Redact Substation is the primary site for production of reactive power in San Francisco and is supplied by three 115kV transmission lines from Martin and Hunters Point. Redact is also the San Francisco terminal for the TBC.

- The TBC is a direct current, 400 MW submarine cable connecting Pittsburg area generation in the East Bay to San Francisco. The TBC is the only transmission facility serving San Francisco that is independent of Martin Substation.

How to Limit the Short-Circuit Current in the High Density Load Pockets

- **Mission Substation Example**
- **Re-design substation for reliability**
  - **Increase capacity**
  - **Improve reliability (N-1)**
  - **Improve safety (fault duty)**
- **Previous design had 5 banks in parallel**
  - **Optimized capacity**
  - **High fault duty inside substation**
- **Future design**
  - **3 sections with two 75 MVA high impedance bank**
  - **Line reactors on all radial, network and tie cable groups**
  - **Reducing fault duty to within equipment specificatins**

Does PG&E Divide a High Density Load Pocket into Several Subdivisions to Supply Power?

* Our secondary network distribution system serving downtown San Francisco is divided into 10 "subdivision" or groups.
* Eight of ten groups has both a 120/208V dispersed network or grid as well as 277/480V spot networks.
* Two of the ten groups serves only spot networks. Each group has its own set of dedicated primary circuits and serves a specific geographic area.
* The 120/208 Volt grid or dispersed secondary network of one group is electrically isolated from the 120/208V grid of the other groups.

Principles Used in Planning and Building the 12kV/ 240V/110V Distribution Networks in Downtown San Francisco?

* The key principle in the planning and building design is based on idea that the loss of one element in the power system will not result in an outage to customers supplied from the network. This requirement is why we use multiple primary circuits in multiple pathways to serve our network customers. It is also the main reason our substations have redundant transformer banks feeding multiple substation busses. In addition the transmission feeds to our substations with network distribution circuits have multiple transmission sources.

Reference: ABB Electrical Transmission and Distribution Reference Book, Chapter 21; Primary and Secondary Network Distribution Systems

How to Preserve Land and Right-of-Ways for Future Substation and Distribution Lines Development in Downtown San Francisco?

Circuits within Franchise Areas

- Grants rights to utilities to install infrastructure within public areas
- Fees are assessed base on value of assets installed
- Relocations at utility expense should conflicts arise

Redacted Indoor Substation Rebuild

- Rebuild station within the existing building and parking lot
- Install new enclosed 12 kV switchgear at the parking lot
- Layout switchgear to leave access for a crane to bring in and out equipment from existing substation building
- Remove existing 12 kV switchgear
- Install new 12 kV feeder reactors where old 12 kV switchgear sat
- Remove existing 12 kV feeder reactors
- Install new 115 kV GIS BAAH where the old feeder reactors used to sit
- Remove existing string bus

Redacted Outdoor Substation Expansion

- Space available from decommissioned power plant
- Expand substation fence boundary to accommodate new bus and transformer