A/C Stalling at SCE

DOE Workshop

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SOUTHERN CALIFORNIA EDISON

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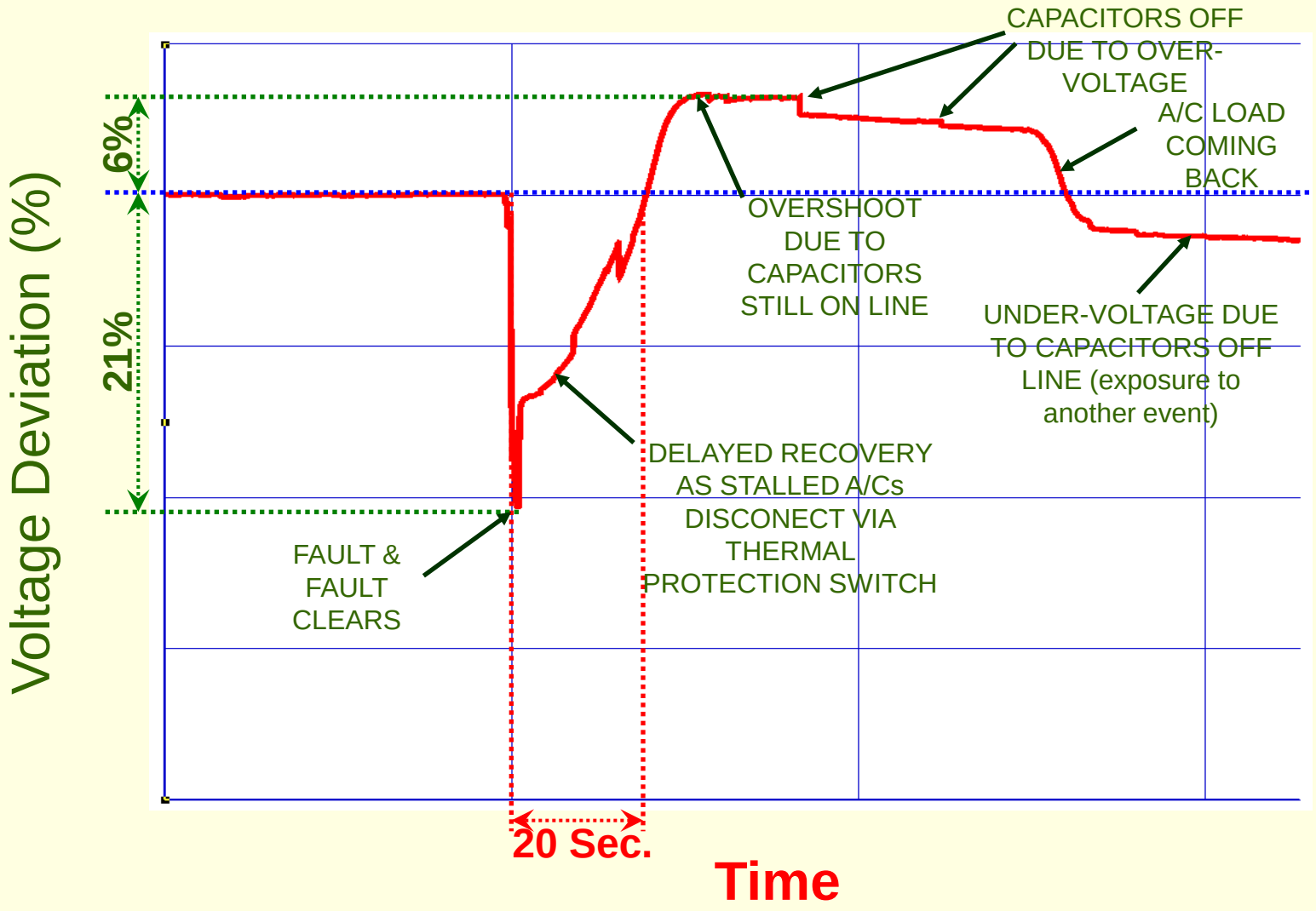
Problem Definition

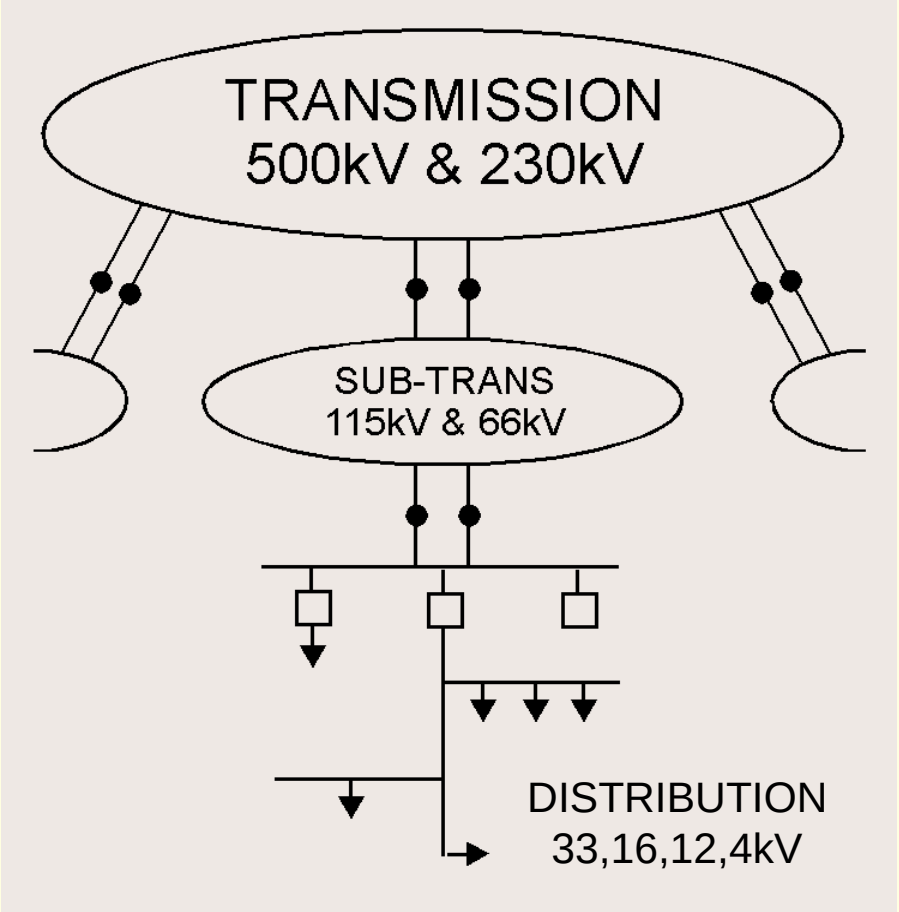
- Necessary system conditions:
  - High temperatures which cause high A/C usage
  - High electrical system loading
  - Electrical system fault (failed component, lightning strike, car hitting pole, etc)
- Fault (short circuit) causes low voltage in area until cleared (3 to 30 cycles)
- Low voltage stalls air conditioners and some loads disconnect themselves
- High reactive power draw from stalled A/C units keeps system voltage depressed for up to 35 seconds
- A/C compressors disconnect themselves with thermal protection switches
- Voltage recovers and air conditioners restart

Typical A/C Stall Event (230 kV)



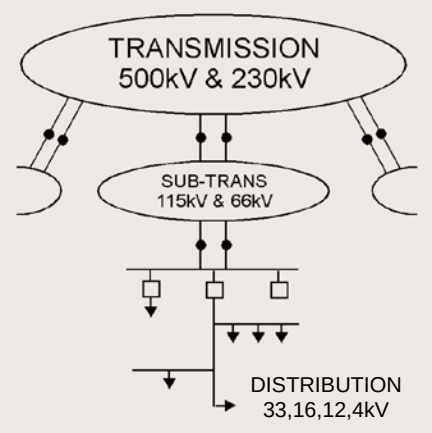
Typical Electrical System

- Transmission system feeds power into major regional load centers
- Sub-transmission feeds power to distribution substations
- Distribution feeds final customers



Why Are We Concerned?

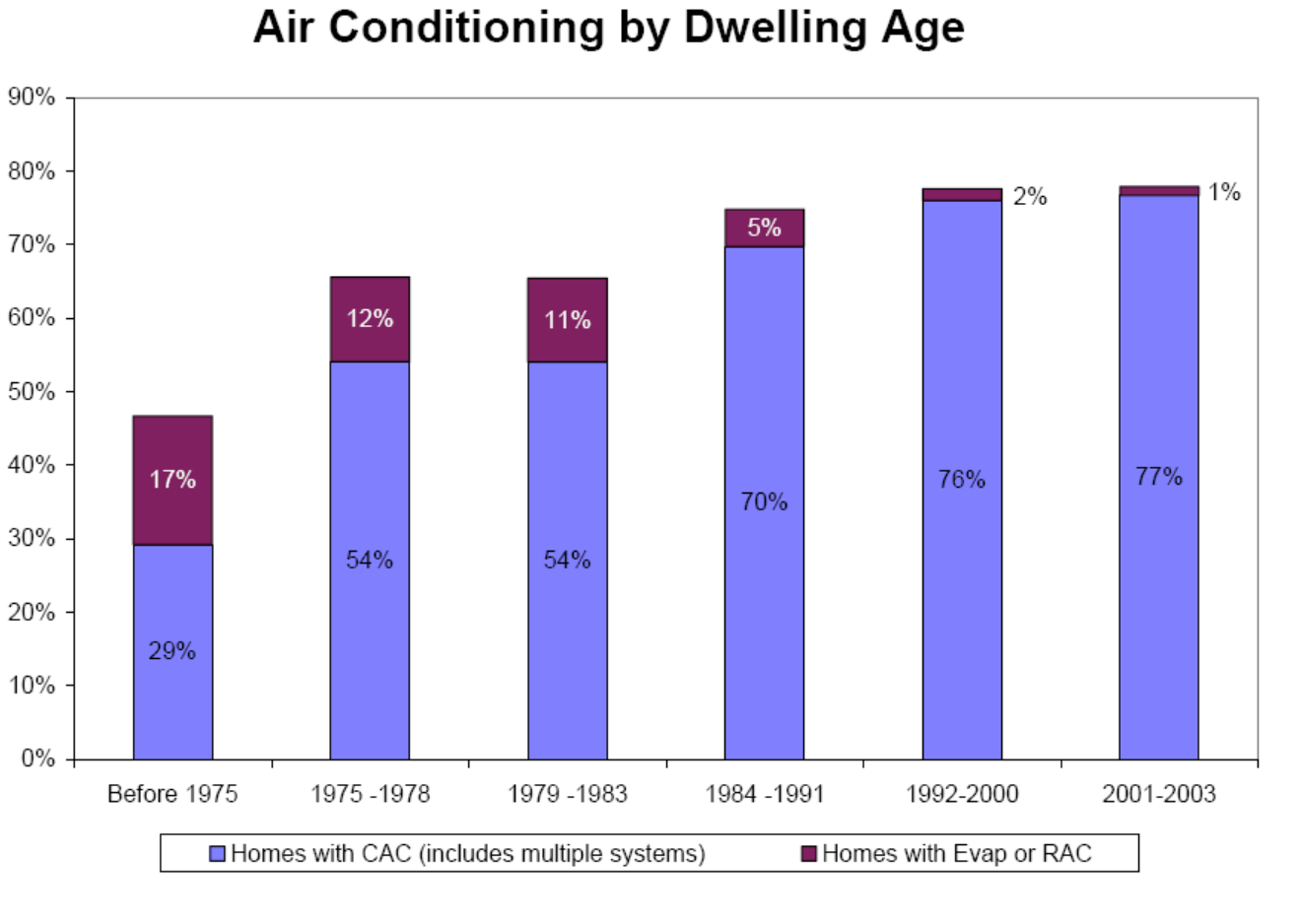
- Undervoltage event could lead to total system voltage collapse
  - Modeling work to better define
- Presents voltage sag to all customers in the area
  - Power quality issue for all customers
- Getting worse as more homes with air conditioners are built in warm inland areas



Delayed Voltage Recovery Events at SCE

- 1988 & 1989 – First delayed voltage events observed at SCE (Devers and Antelope)
- 1990 – Valley (June)
- 1997 – Lugo plane crash – lost 3500 MW (8/5)
- 2004 – 4 events at Valley/Devers
- 2005 – 3 events at Valley/Devers
- 2006 – 37 events at Valley, Devers, Antelope, Rector, Villa Park
- 2007 – 6 event at Rector, Antelope, Valley

Increasing Air Conditioning Usage

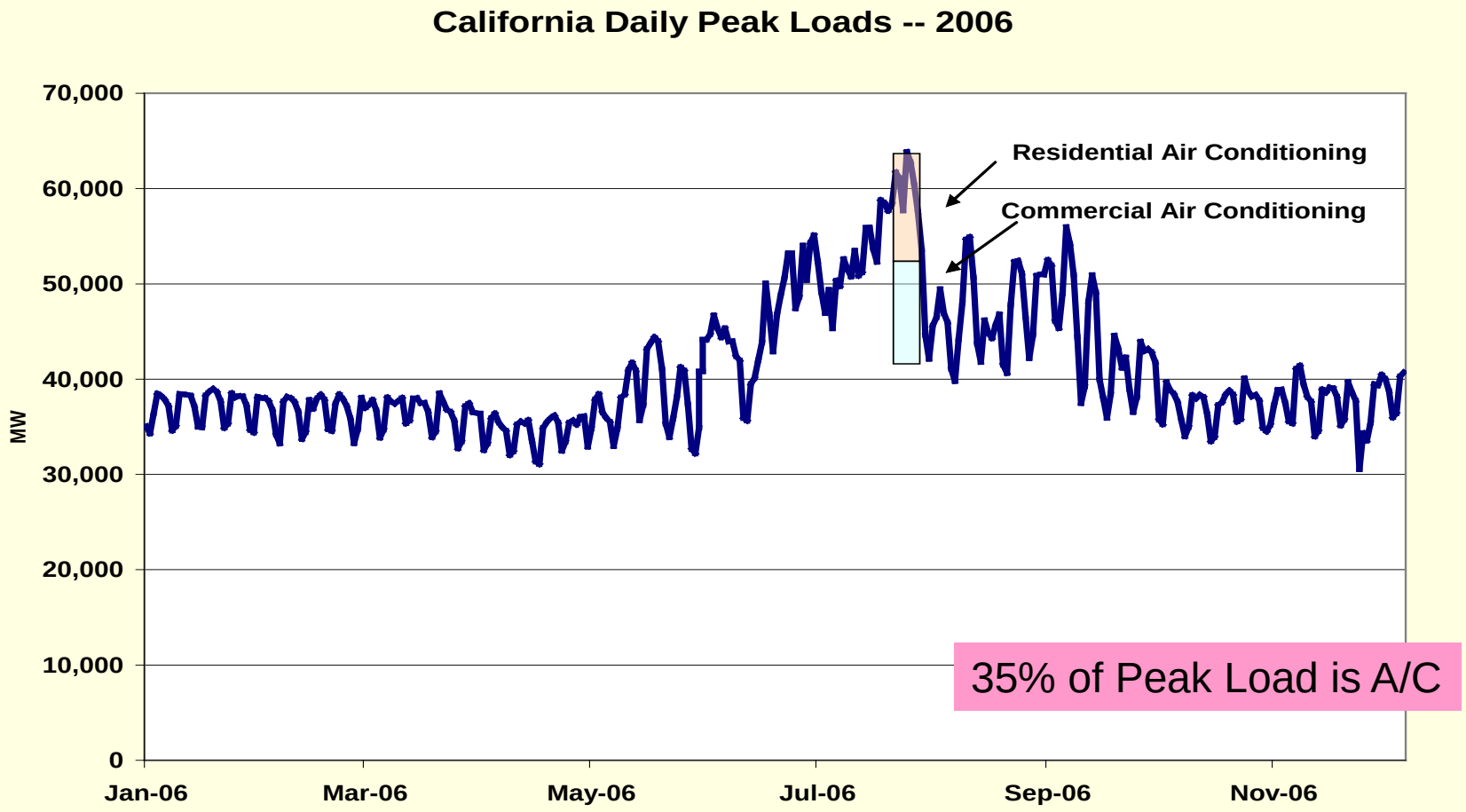


Source: California Energy Commission, California Statewide Residential Appliance Saturation Survey

Number of A/C Units at SCE

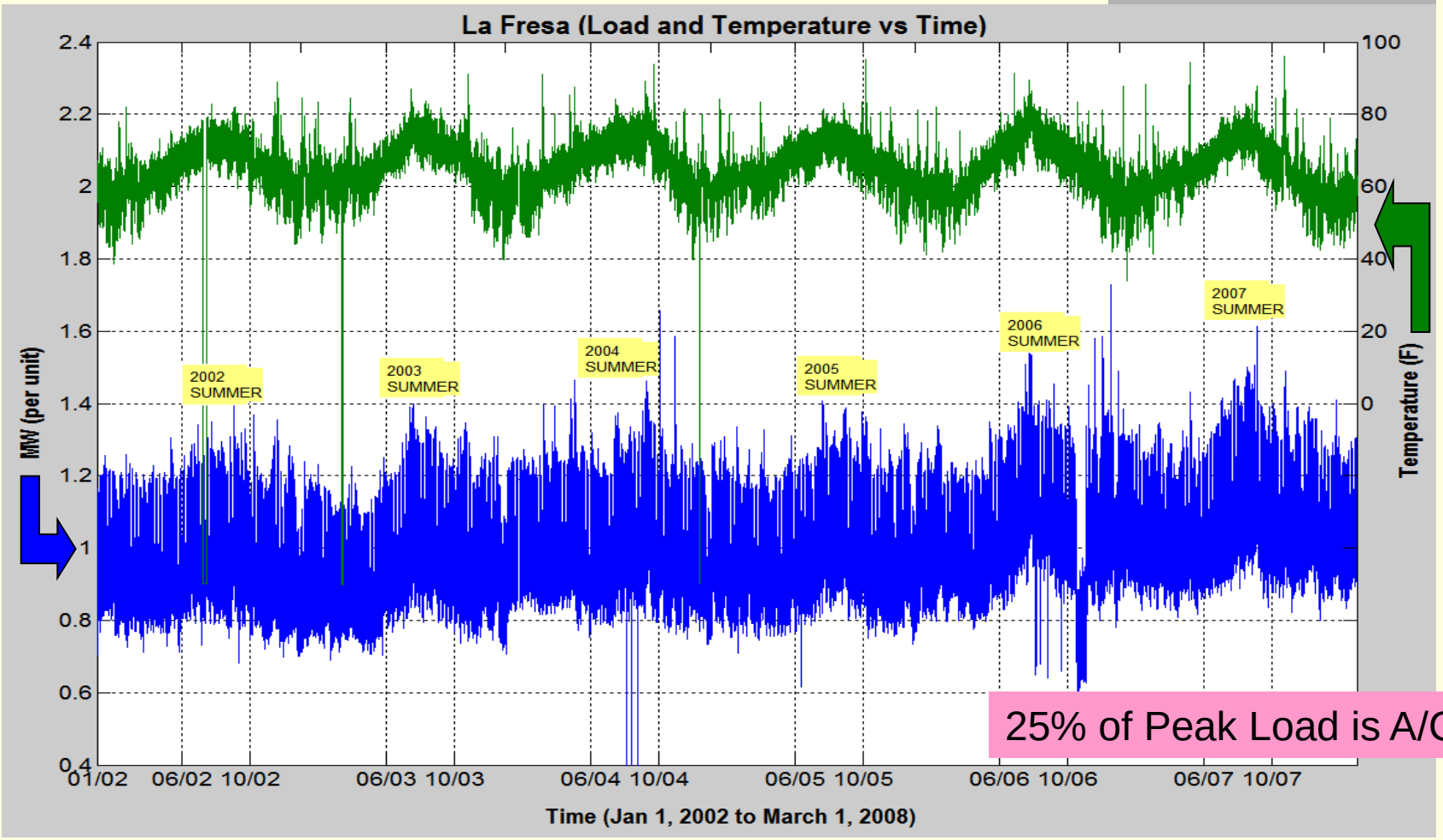
- 2003 Study
  - 2.2 M Central A/C (4.5 M customers)
    - ~ 7000 MW at peak
  - 1.0 M Window A/C
    - ~ 1000 MW at peak
  - 2003 System Peak Load ~ 20,000 MW
  - A/C ~ 40% of load on peak

California A/C Load at Peak



Source: California Energy Commission

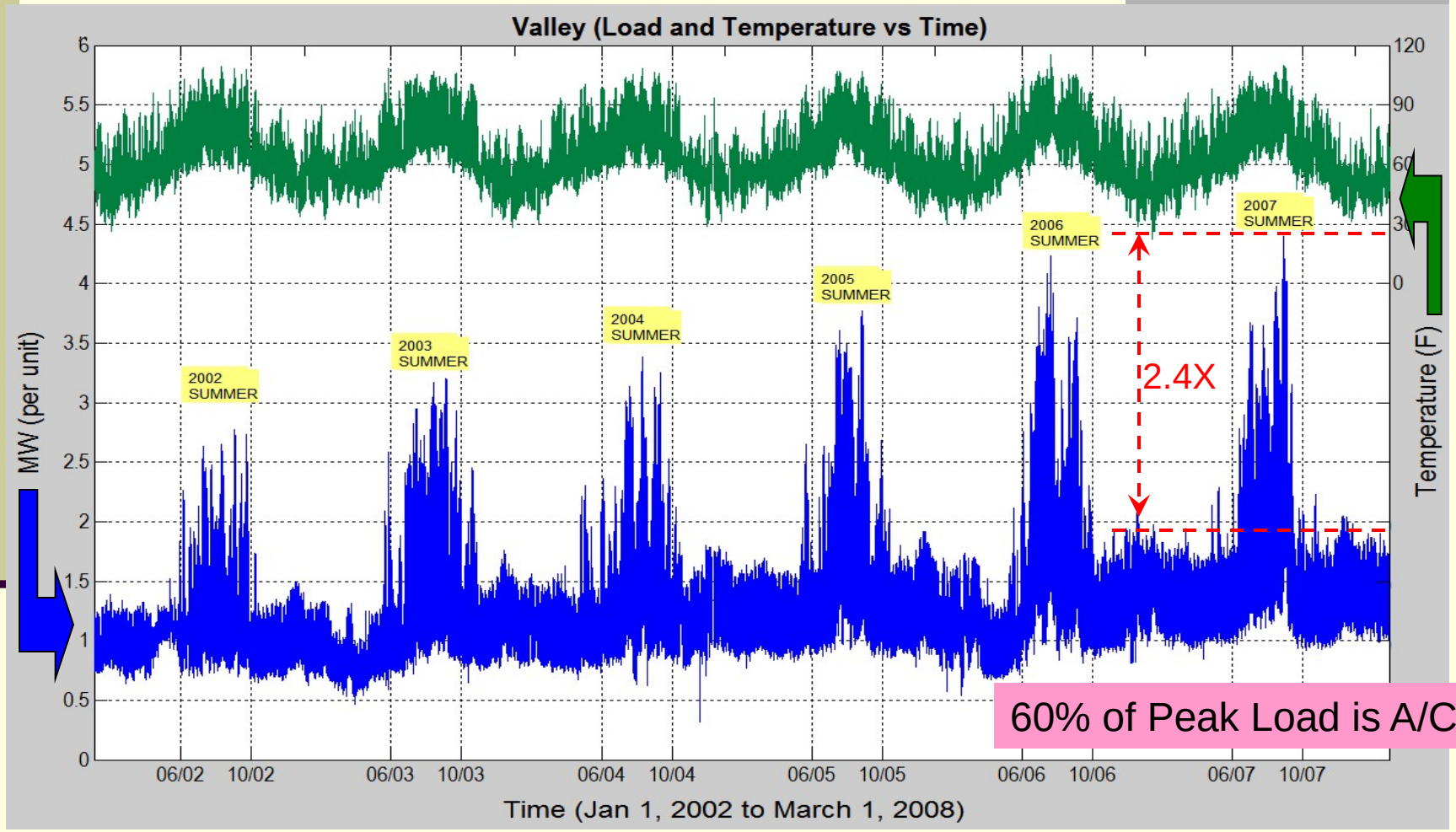
Coastal Load



25% of Peak Load is A/C

Peak Load ~ 600 MW

Inland Load



Peak Load ~ 1,500 MW

What's Being Done

- A/C tests done to obtain better A/C system performance data
  - SCE, BPA, and APS/EPRI
- WECC working on A/C load modeling project to more accurately model A/C stalling effects (CEC $'s)
- Evaluating mitigation measures
  - Electric System level
  - A/C Unit level
- Engaging A/C Industry, Utilities, DOE, and regulatory bodies to develop comprehensive national solutions

Actions Underway

- Manufacturers
  - Help identifying best solutions
  - Work with Air-Conditioning, Heating and Refrigeration Institute (AHRI)
  - Prefer national measures, not state-by-state
- Utilities
  - Gather group of interested utilities to support actions

Actions Underway

- DOE
  - This workshop…
- California Energy Commission
  - Fund research on models
- Legislative/Regulatory
  - Investigating how to develop new standards
    - Federal level best to address national problem
    - Appliance efficiency standards
    - Rebate programs
    - Other ideas

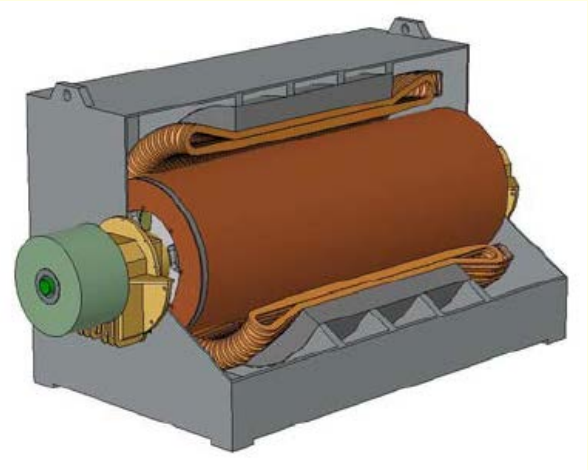
Long-Term Solution

- New air conditioner standard is needed; e.g.:

  "Any air conditioner shall include features which prevent the compressor from remaining connected to the electrical supply system in a stalled condition for more than {one-tenth?} of a second."
- An A/C standard would keep the future situation from getting worse
- Large number of existing A/C units means retrofit might be necessary
- Need a combination of approaches (standards, retrofits, system)

Electric System Level Measures

- Use new models to study:
  - Speed of voltage collapse
  - If system level devices (SVC, Statcom, Sync Condensers) can help prevent voltage collapse
- SCE has recently installed SVCs and HV capacitors for system needs and is evaluating their performance in addressing the problem



Assessment of Electric System Level Measures

- Cannot prevent faults from occurring nor A/C units from stalling
- System level solutions (e.g. SVC, Statcom) should:
  - Reduce the size of the area affected
  - Reduce the length of stall events
- Could be very costly
  - Would need a number of devices throughout the SCE system
  - A large SVC costs $20M to $50M each

Summary & Next Steps

- A/C Stalling problem is complicated and will take time to solve
- Many possible solutions, all have challenges
- Actions are being taken on all fronts:
  - Use system solutions wherever practical to prevent voltage collapse
  - Determine how to deal with existing population of A/C units (are retrofits necessary?)
  - Pursue standards or other methods to prevent the problem with new A/C units (limit growth of problem)

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