Transmission Reliability Research Review

Ancillary Services From Aggregations of Small Responsive Loads

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Objective

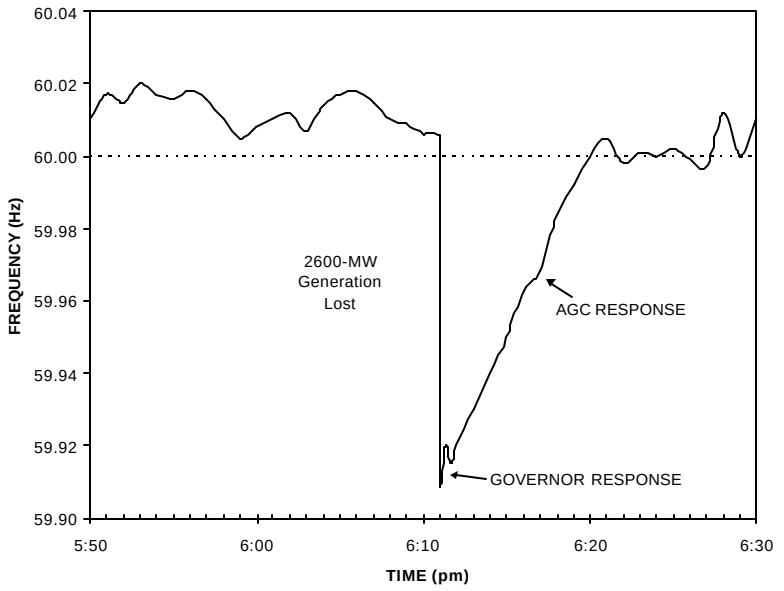
- Develop the capabilities of aggregations of small loads to provide reliability services (ancillary services) to the bulk power system
- Demonstrate the technical capability of residential and small commercial air conditioning loads to provide spinning reserve

All customers benefit if the power system is more reliable, costs are reduced, and capacity is increased

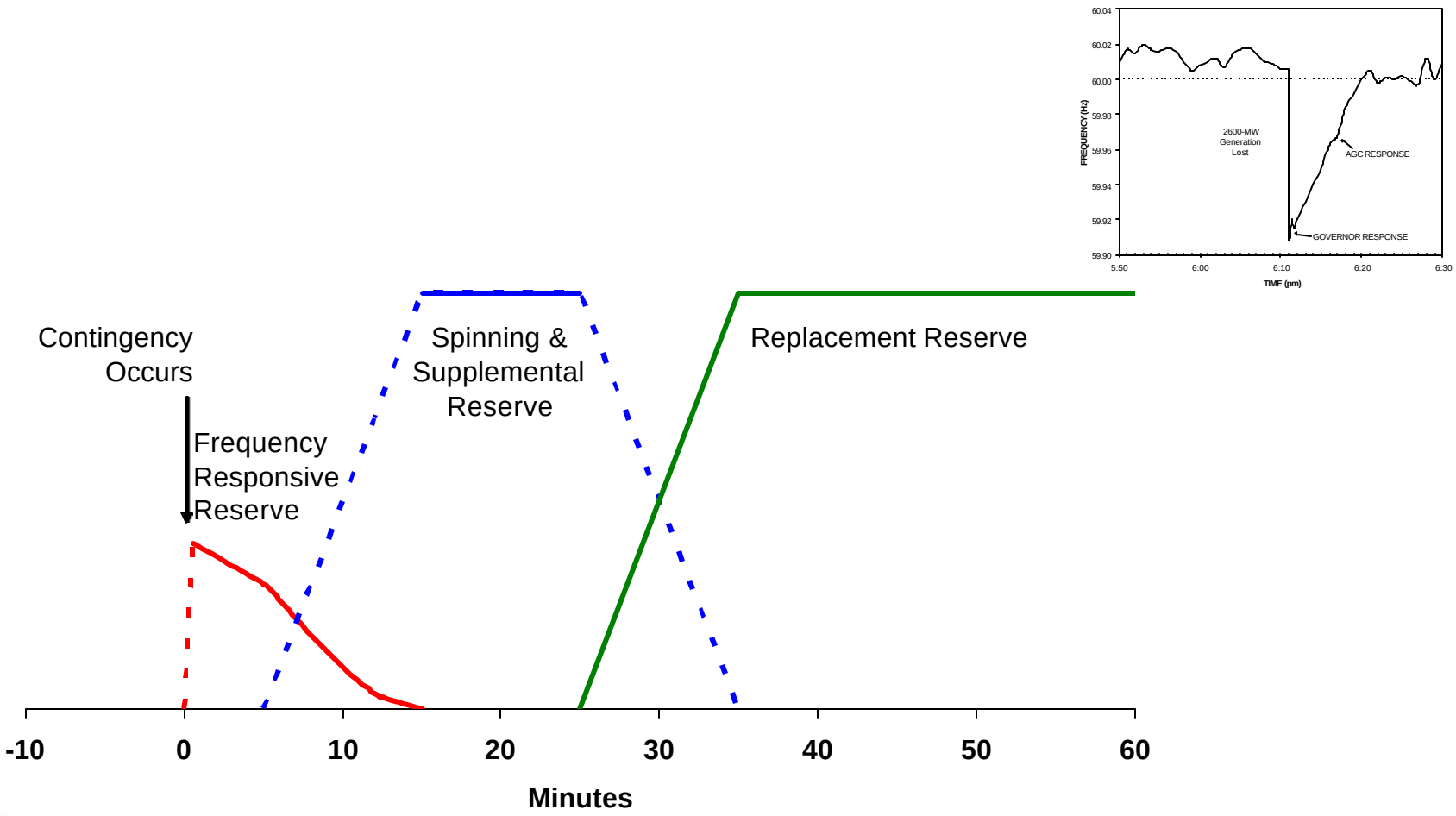
Responsive Loads: Better Matched To Spinning Reserves Than Peak Reduction

- **Better for the load:** **shorter, less frequent disruption**
- **Better for the power system:** **faster response, more reliable, better use of generation**
- **Better for other loads:** **reduced energy and ancillary service prices**
- **Better for society:** **reduced need for generation and transmission**

Power System Reliability Events Are Fast, Infrequent and Relatively Short

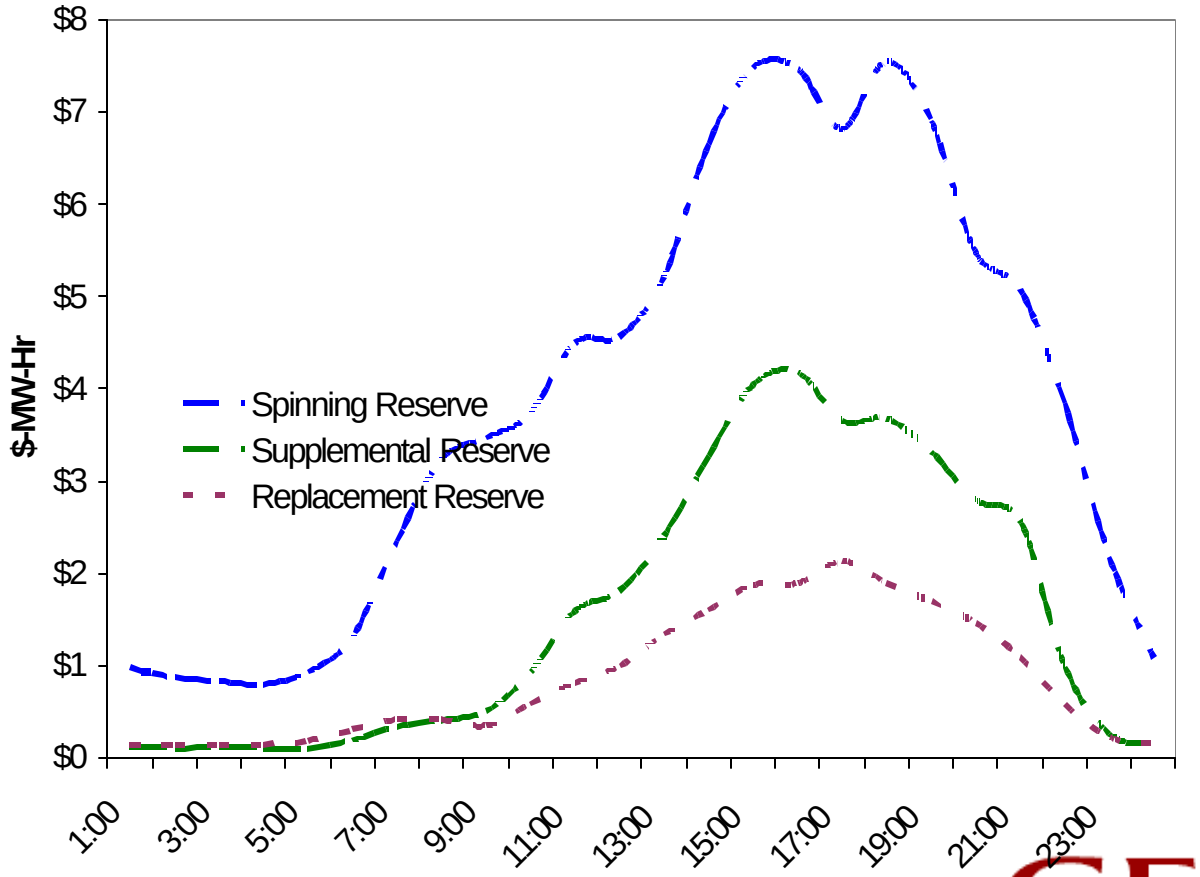


A Series of Reserves Respond To Contingency Events

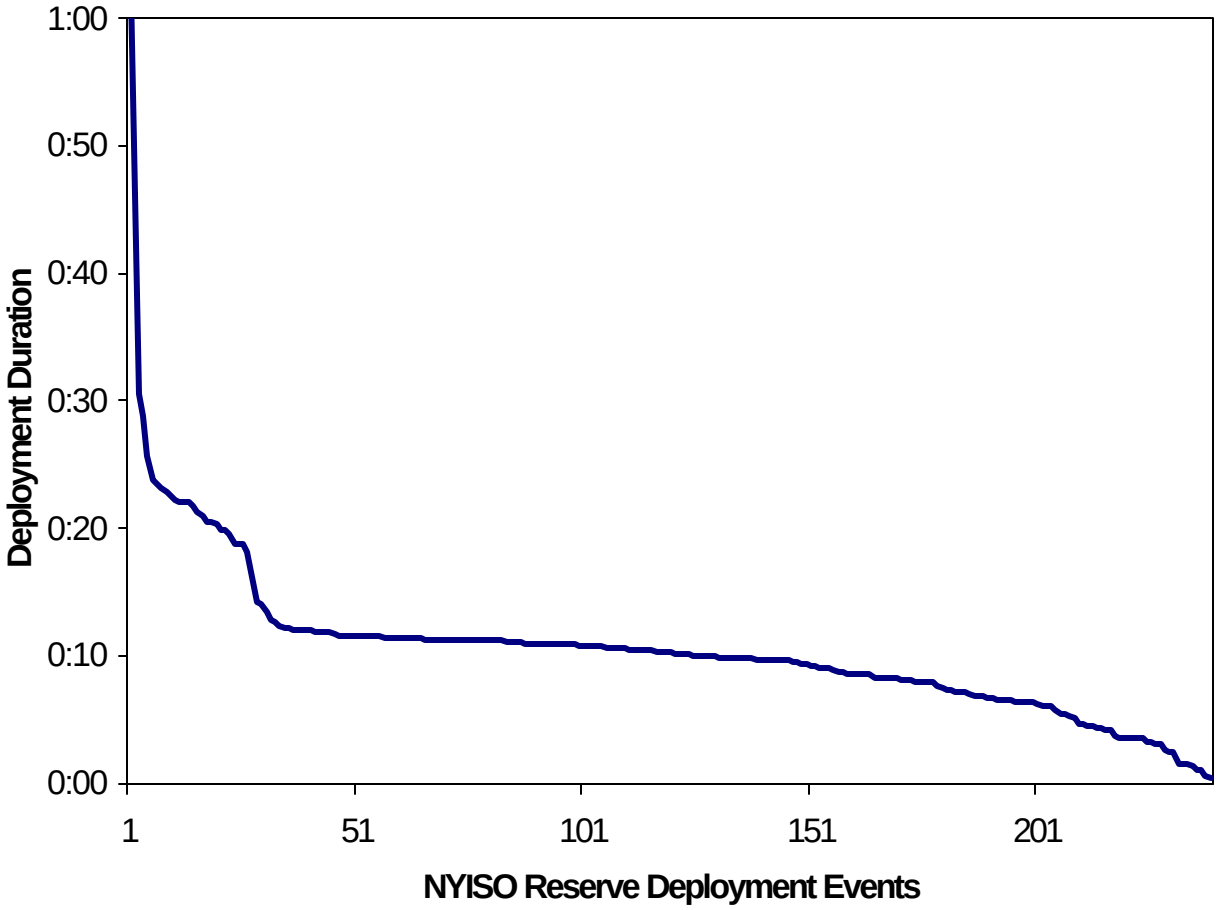


Spinning Reserve:

- Twice as Expensive as Supplemental
- Highest Priced When Load is Available



Spinning Reserve Is Typically Deployed for 10 Minutes or Less



It Is Now Possible and Desirable for Loads to Provide Spinning Reserves

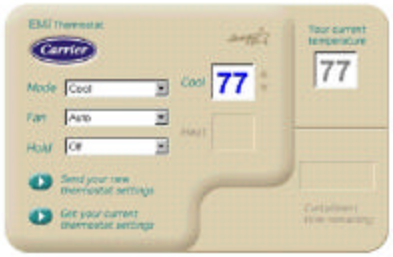
- Historically, loads have not been allowed to provide spinning reserves, the fastest, highest price contingency reserves
- Advances in communications and control now make it technically possible
- Power system reliability needs now make it desirable
- Many loads are better matched to providing spinning reserve than demand reduction
- Spinning reserve is *capacity*

Loads Can Be Ideal Suppliers of Ancillary Services – Especially Spinning Reserve

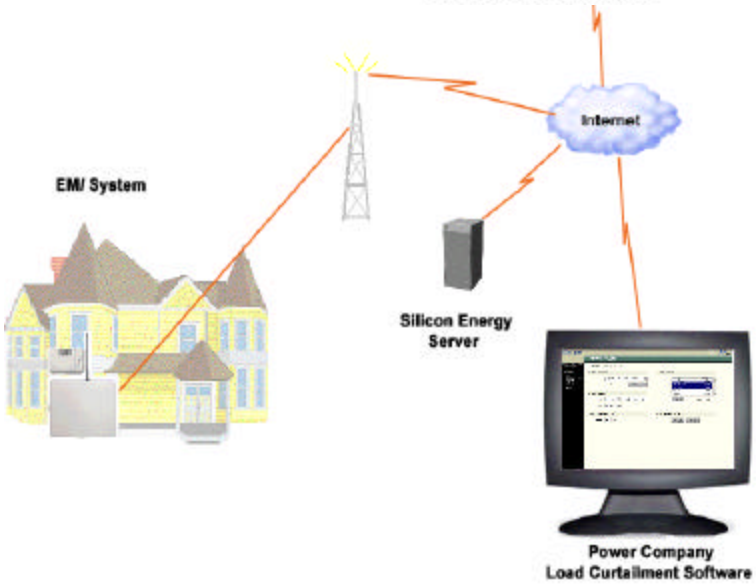
- Fast response
- Fast deployment
- Redundancy
- Distributed throughout the power system
- Fewer and shorter interruptions than demand reduction or energy market response
  - less storage required
  - less disruption to normal load operations
- Complements energy management and price response
- Only looking for a small percentage of load to respond

Spinning Reserve From Residential and Small Commercial Thermostats

- Existing Carrier ComfortChoice technology for peak reduction
- Faster than generation for spinning reserve
- Spinning reserve capability ~3x peak reduction
- Significant monitoring in place



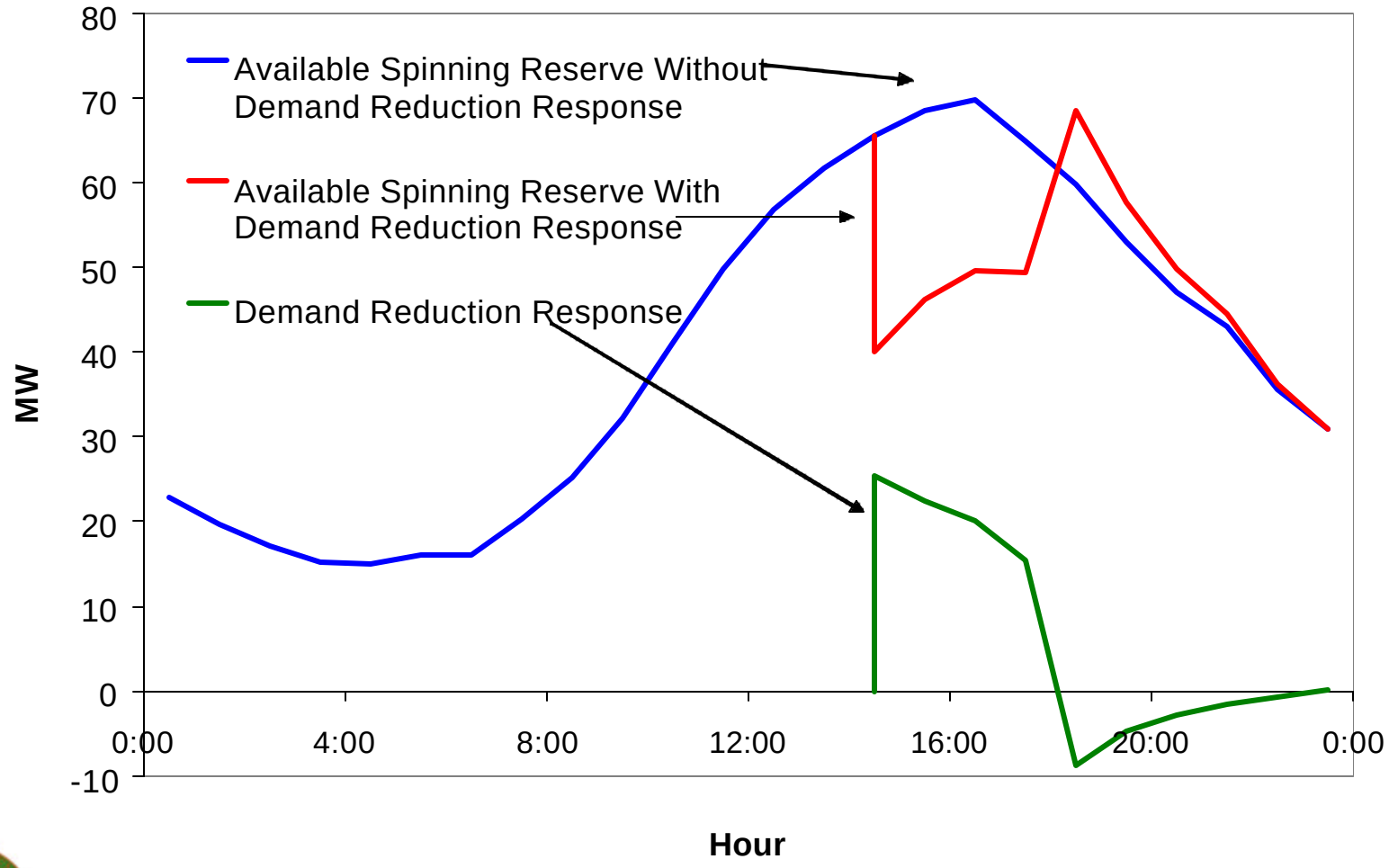
Homeowner Web Interface



Communications and Control

- Designed for multi-hour peak reduction
- Deployment signal <90 seconds
- Verification delayed to protect paging system
- Grouping by location, type, or any other criteria
- Customer override allowed for peak shaving, not for spinning reserve
- Control can be duty cycle, set point, or turn off
- Monitors temperature, run time, communications
- Customer remote monitoring and control web interface

Can Provide Spinning Reserve While Providing Peak Reduction



Substantial Installed Capacity That Could Be Tested Today

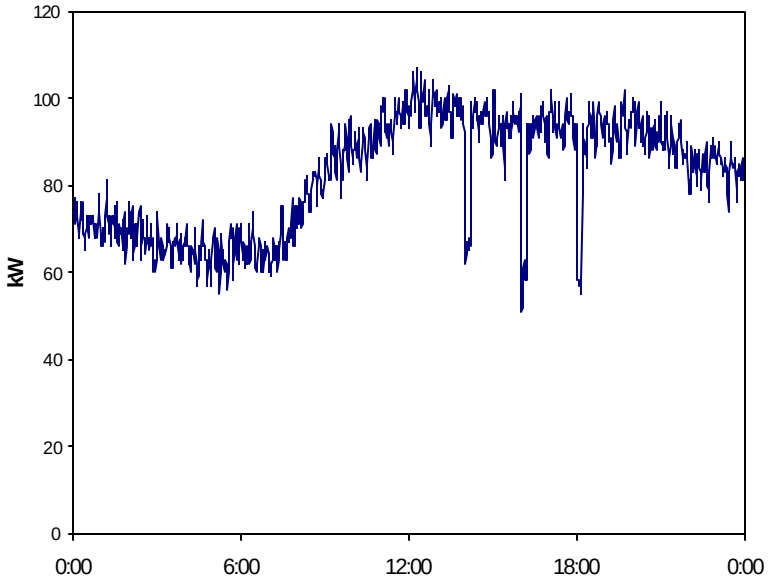
	Units	Demand Reduction	Spinning Reserve
LIPA	23,400	25 MW	75 MW
Con Ed	25,000	25 MW	75 MW
SCE	50,000	50 MW	150 MW
SDG&E	5,000	5 MW	15 MW

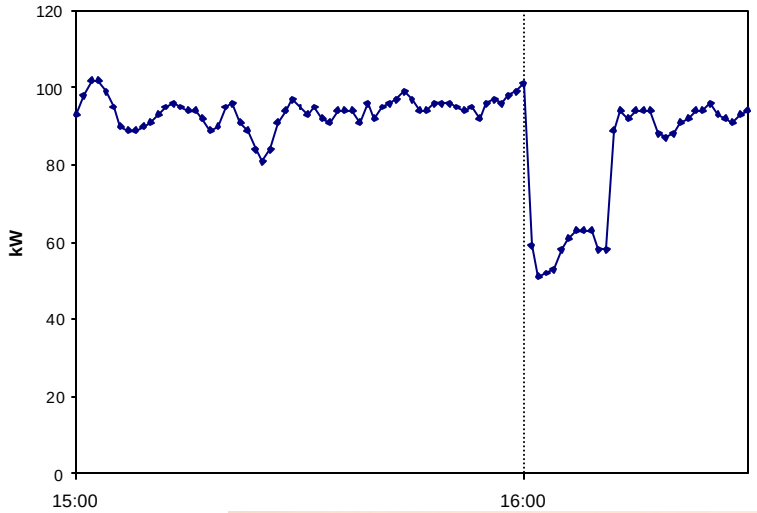
Spinning Reserves From Commercial Loads

- **Supervisory controllers in hospitality industry can:**
  - Save energy and can reduce electric demand
  - Reduce space heating/cooling in rooms that are unoccupied
  - Shift electric loads during peak periods for short time intervals
  - Provide the capability for utilities to satisfy spinning reserve(?)

- **Easy retrofit – Fast deployment**
  - Developed by Digi-Log Technologies; tested for energy savings by ORNL
- **Spinning reserve is an easy add-on**
  - Modified to operate by pager signal from utility
  - Demo with LIPA and possibly others
- **Will work with many technologies**

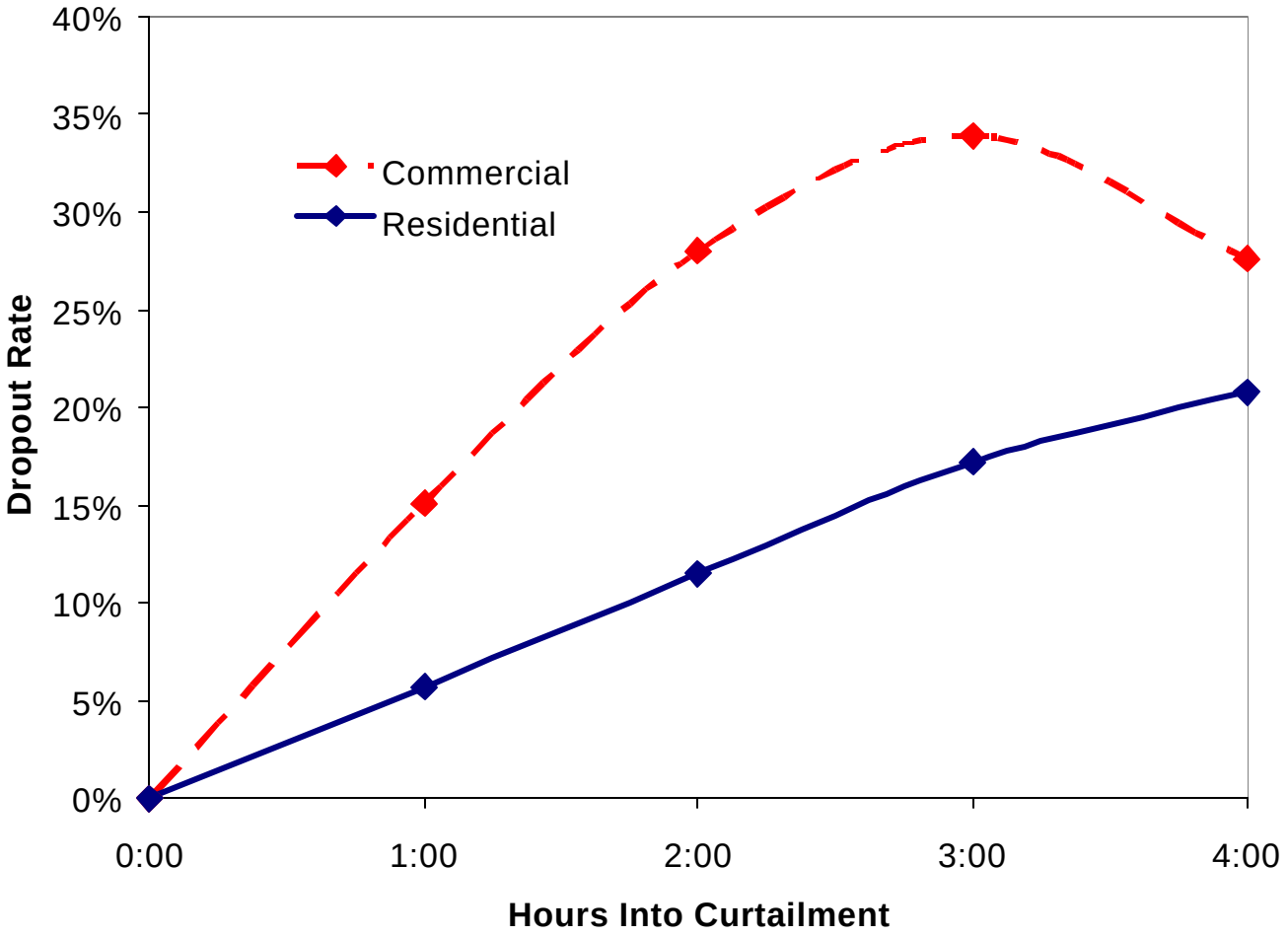
DigiLog Motel Energy Management System Provides Spinning Reserve



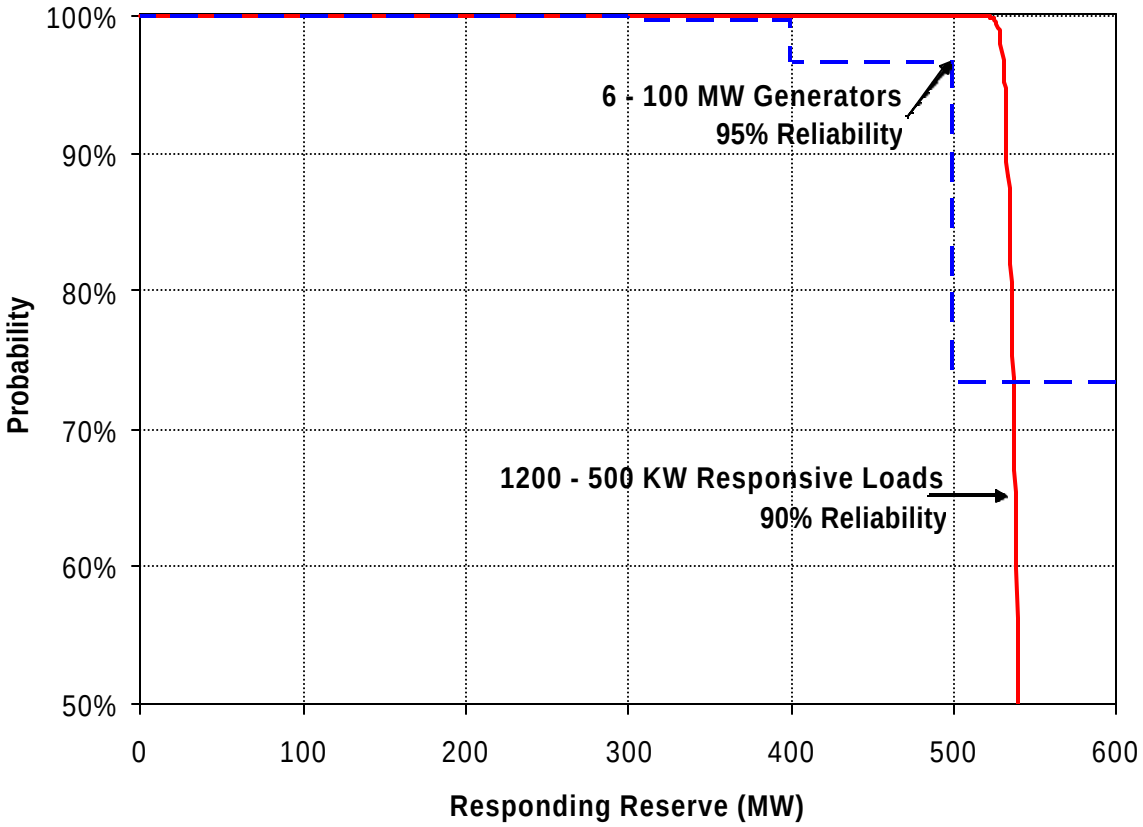


- 80 room Howard Johnson motel
- 1 minute revenue metering
- Pager deployed spinning reserve
- 34kW, 36% load drop in 1 minute

Common Concerns: Overrides – *A Benefit and a Problem, But Less of a Problem for Spinning Reserve*



Statistical Response is Better Than Monitored Response



Aggregation of many (smaller) individually lower reliability resources still provides higher *guaranteed* response than fewer (larger) individually higher reliability resources

Metering and Communications Requirements

- Givens:
  - Payment must be tied to actual response
  - Deployment signals have to be fast
- One SCADA monitoring system currently performs three functions
  - Continuous readiness monitoring
  - Real-time event monitoring
  - Performance monitoring
- How much monitoring is required?
  - Statistical resources may not need the individual real-time monitoring that deterministic resources need
    - Redundancy may be better than observability.
    - A 5% error in total load forecast can be a problem. A 5% error in reserve response may not be.
  - Performance monitoring can be slower
  - What information does the system operator really require in real-time?

Communications Requirements Are Asymmetric

(This is a Big Benefit)

- System-to-load communications are typically broadcast
  - Resource need – MW of response desired
  - Price
  - **Deployment – respond *Now!***
- Load-to-system communications are typically individual
  - Capabilities and price offer
  - Performance monitoring – conceptually can be slower
  - Aggregator may help

Service Definitions Are Critical

- Most generators do not care if they run for 30 minutes or 8 hours
  - May have minimum run times
  - May have emissions limits
- A load may be able to respond for 10-30 minutes but not 2 hours
  - Can re-arm immediately if not used frequently
- Response capability matches spinning contingency reserve much better than demand relief

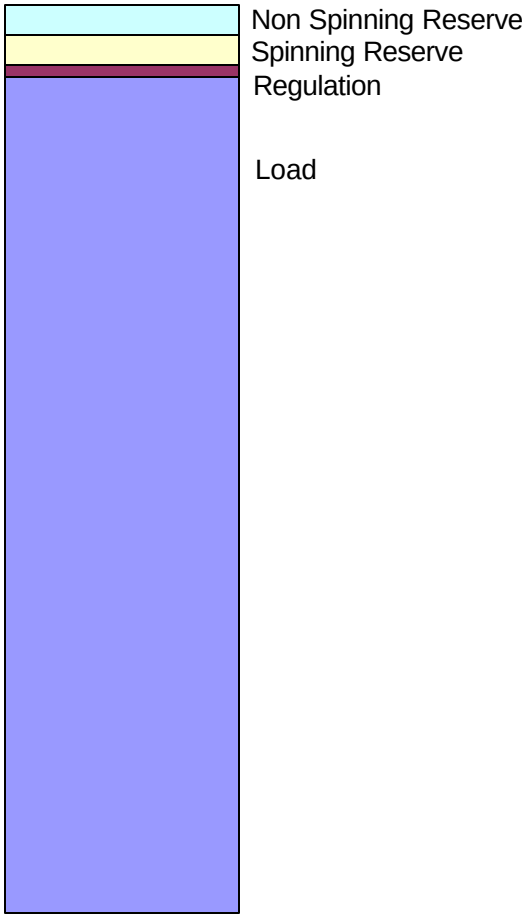
Technical Conclusions

- Communications and control technology now makes spinning reserve from load possible
- There are advantages to the responding loads, the power system, other customers, and society
- Spinning reserve is a better match for some loads than peak reduction

Rules are absolutely critical

Basic Economics Work
Market & Regulatory Rules Do Not

- Capital cost less than CT
- Spinning reserve *is* capacity (total needed generation)
- Responsive load spinning reserve naturally rises and falls with system need
  - Forecast error
  - Daily load shape



Problem: New Reliability Enhancing Technologies Are Not Deployed

Some new technologies appear to be well matched to providing ancillary services, but:

- Reliability services (ancillary services) are procured through markets
- System operators do not aggressively seek new reliability enhancing technologies
  - System operators must remain market neutral
- **Existing ancillary service markets are designed around the large generating resources that have historically provided the services**
- **Changing market rules to accommodate new technologies is *very* risky and slow**
  - **Rule changes apply to *all* new and old market participants**
  - **Rule changes can have unintended consequences**
  - **Reliability can be threatened**
  - **Cost/market impacts can be large**

Penalties Are Rigid - Rewards Are Not

- New technology must meet all existing requirements
  - Monitoring
  - 2 hour response duration
  - 24/7 response…
- New benefits are not valued
  - Regulation response accuracy
  - Spinning reserve response speed
  - Increased statistical reliability from smaller resources
  - Response matched to system load…

Current rules are often tied to existing generation technology, not system physical requirements

New Technology Hurdles
(Just to Be Allowed to Try to Compete)

- Technology must actually work
- Technology must be perceived as working
- Aggregate resource must be perceived as large enough to be of value
  - Physically (there has to be enough physical response capability)
  - Economically (technology must be perceived as economically viable enough to capture a large market)
- Must meet all existing requirements
  - Even if they are irrelevant to the new technology
  - Any required rule changes can not adversely impact existing technology reliability

The economic push available to new central generation technologies is not available to small distributed technologies

System Operator Fears Are Well Founded In A Restructured Industry

- System operator controls the market, not the resource
- Limited ability to “try” something new
- Relationships are competitive and contentious by design
- The problem is universal
  - CAISO, WECC, ISO NE, PJM, AEP, NY, …

There May Be An Alternative: Regulated Resources to Manage Risk

- The regulator could evaluate a technology and determine if it offers advantages for rate payers
  - It might reduce the need for an ancillary service and save rate payers money while increasing reliability
- The regulator could approve a limited deployment (at rate payer expense) to test the technology
- The ancillary service could be offered at no cost to the system operator, reducing the amount of ancillary service that must be procured in the unchanged ancillary service market
- Rules for service delivery can be legitimately different because the system operator is in control of how and when the resource is used
  - Physical rules remain important but market rules can differ
  - Physical rules can be technology specific
- If the test goes well the regulator can decide to expand the program
  - There is no danger of unexpected market resource shifts or reliability degradation
- The new technology may move into the competitive arena with market rules adjusted based upon knowledge rather than perception, OR the new technology may remain as a regulated T&D asset

Reactive Power Analogy

- Markets for dynamic reactive support from generators are starting to develop
- Should Static Var Compensators become competitive resources instead of regulated transmission resources?
- Should capacitors?

No. The regulated T&D resources reduce the system requirements for dynamic reactive power support from competitive generation markets. Regulated resources can coexist with competitive resources for the supply of ancillary services.

Treating Appropriate Ancillary Service Technologies as Regulated Resources Will:

- Minimize power system reliability risk
- Minimize developer and system operator financial risk
- Maximize customer reliability and economic benefit
- Separate technical from market design challenges
- Develop confidence in new technologies by controlling deployment

Publications: *all report on work developed in this program*

- Water Heaters to the Rescue: Demand Bidding in Electric Reserve Markets, *Public Utilities Fortnightly*
- Allocating Costs of Ancillary Services: Contingency Reserves and Regulation, *ORNL/TM 2003/152*
- The Distribution System of the Future, *The Electricity Journal*
- Technical Issues Related To Retail-Load Provision of Ancillary Services, *New England Demand Response Initiative*
- Opportunities for Demand Participation in New England Contingency-Reserve Markets, *New England Demand Response Initiative*
- Microgrids and Demand Response: How Software Controls Can Bridge The Gap Between Wholesale Market Prices and Consumer Behavior, *Public Utility Fortnightly*
- Spinning Reserve From Responsive Loads, *ORNL/TM 2002/19*
- Microgrid Energy Management System, *ORNL/TM 2002/242*
- Spinning Reserves from Controllable Packaged Through the Wall Air Conditioner (PTAC) Units, *ORNL/TM 2002/286*
- Technical Potential For Peak Load Management Programs in New Jersey

Presentations

all report on and extend work developed in this program

- 2 Ancillary service conferences including AS 101 workshops
- 2 New England Demand Response (NEDRI) meetings
- Energy Storage Conference
- NPCC
- Canadian Energy Research Institute (CERI) 2003 Electricity Conference
- WECC MORC (Minimum Operating Reserve Council)