

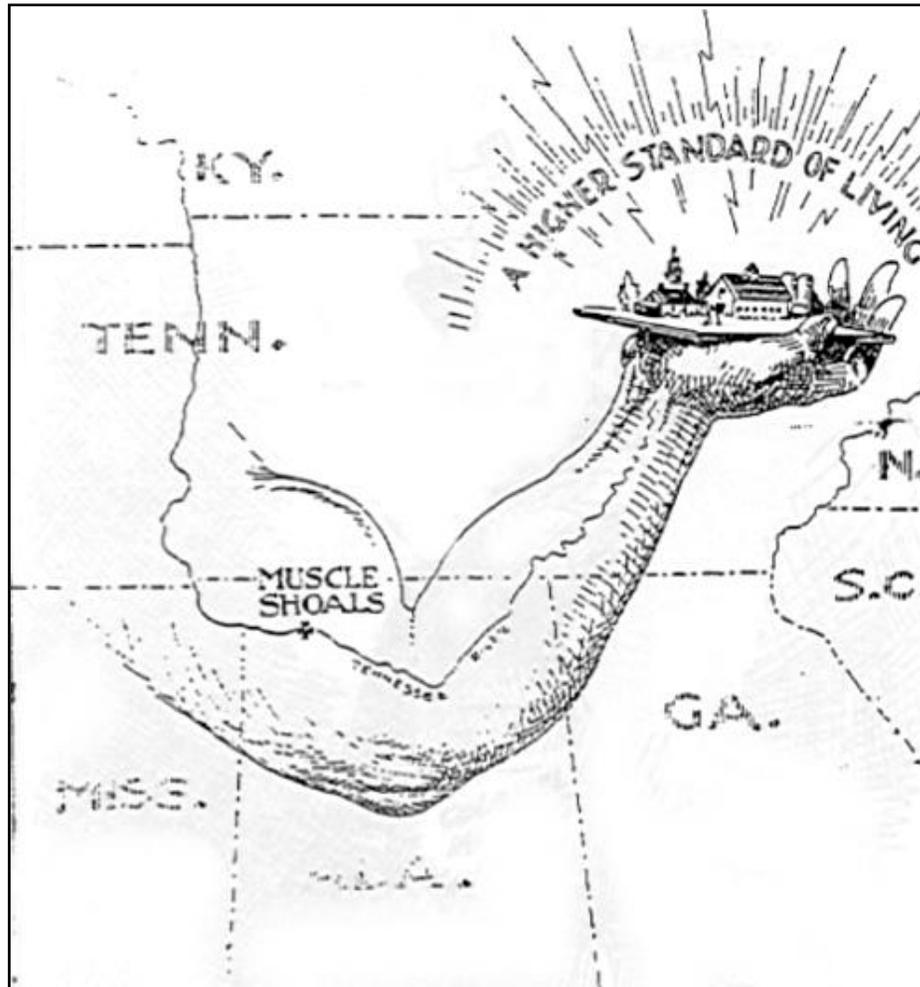


# Energy Storage for Reliable Electricity

*By Terry Boston, Executive Vice President  
Transmission/Power Supply Group  
To the Energy Storage Association  
April 26, 2001*



# The Vital Arm



Parrish. "The Vital Arm." Editorial Cartoon. Tennessean. 1934.



# Our First Energy Storage--1934





# Pioneering Pumped Storage--1957

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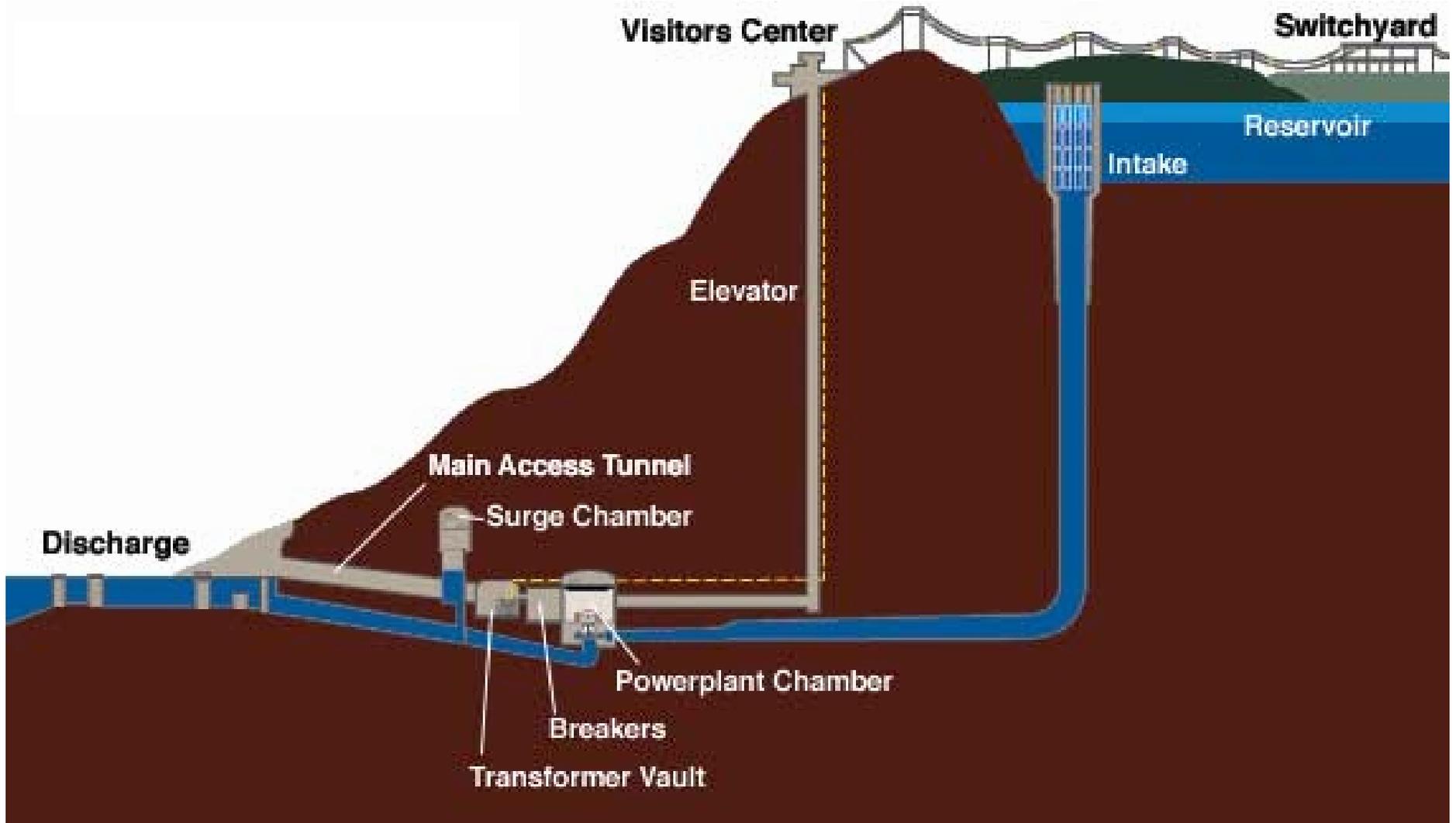


# Pioneering Pumped Storage--1977





# Raccoon Mountain Plant





# Generation of Electricity





# Flood Damage Averted



*Same area during 1867  
flood*

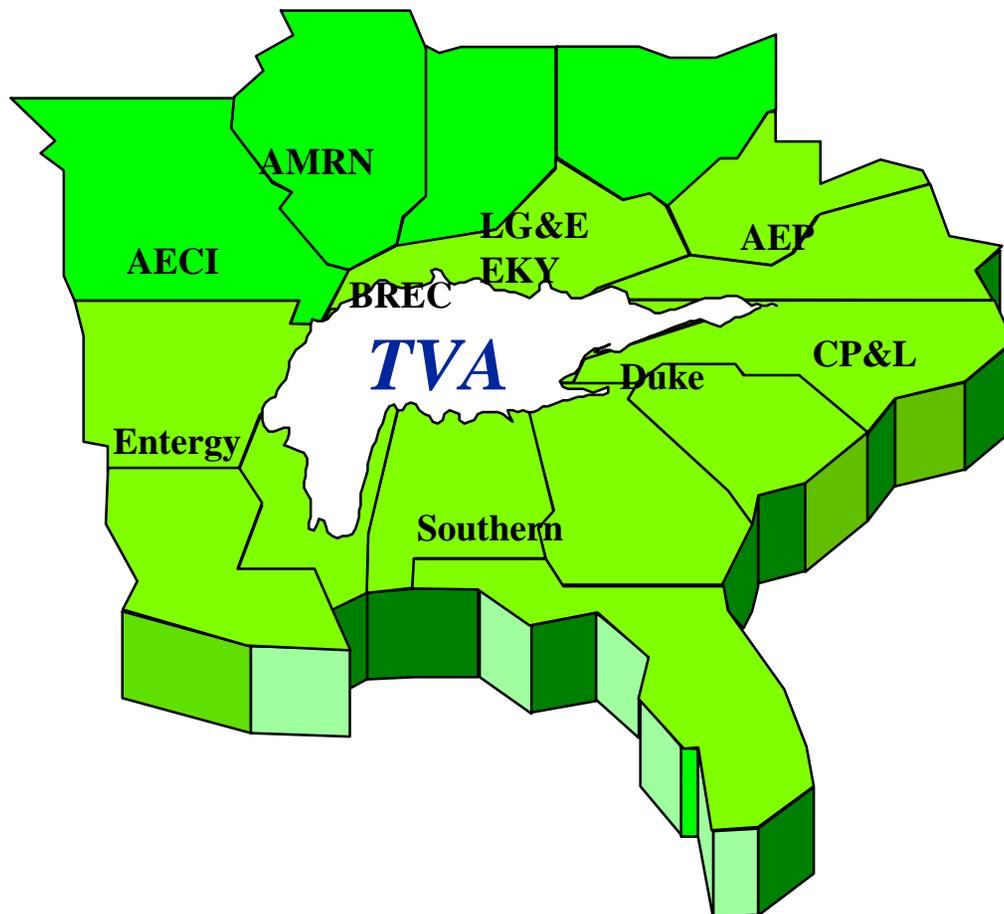
*(In 2000 Dollars\*).*

- 1973 - \$1,857,600,000
- 1977 - \$1,542,500,000
- 1984 - \$1,163,900,000
- 1994 - \$1,164,800,000
- 1998 - \$ 424,000,000

\* Adjusted using the CPI Index



# TVA Power System



- 80,000 Square Miles
- 158 Distributors
- 62 Directly Served Industries
- 8.3 Million Consumers
- \$6.8 Billion Revenue

## Peak Demand

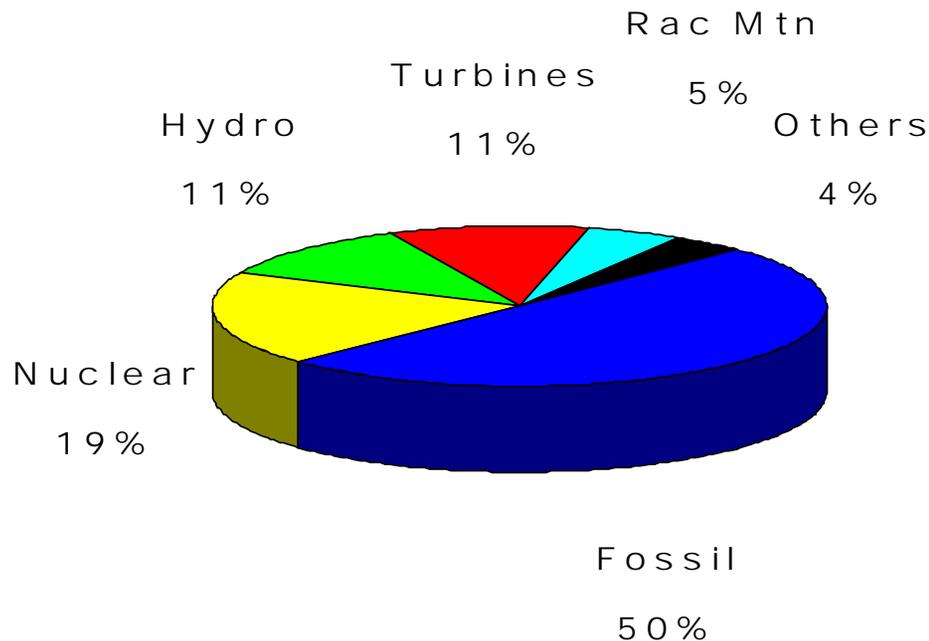
Summer 29,344 MW

Winter 27,015 MW

(3% Annual Demand Growth)<sup>9</sup>



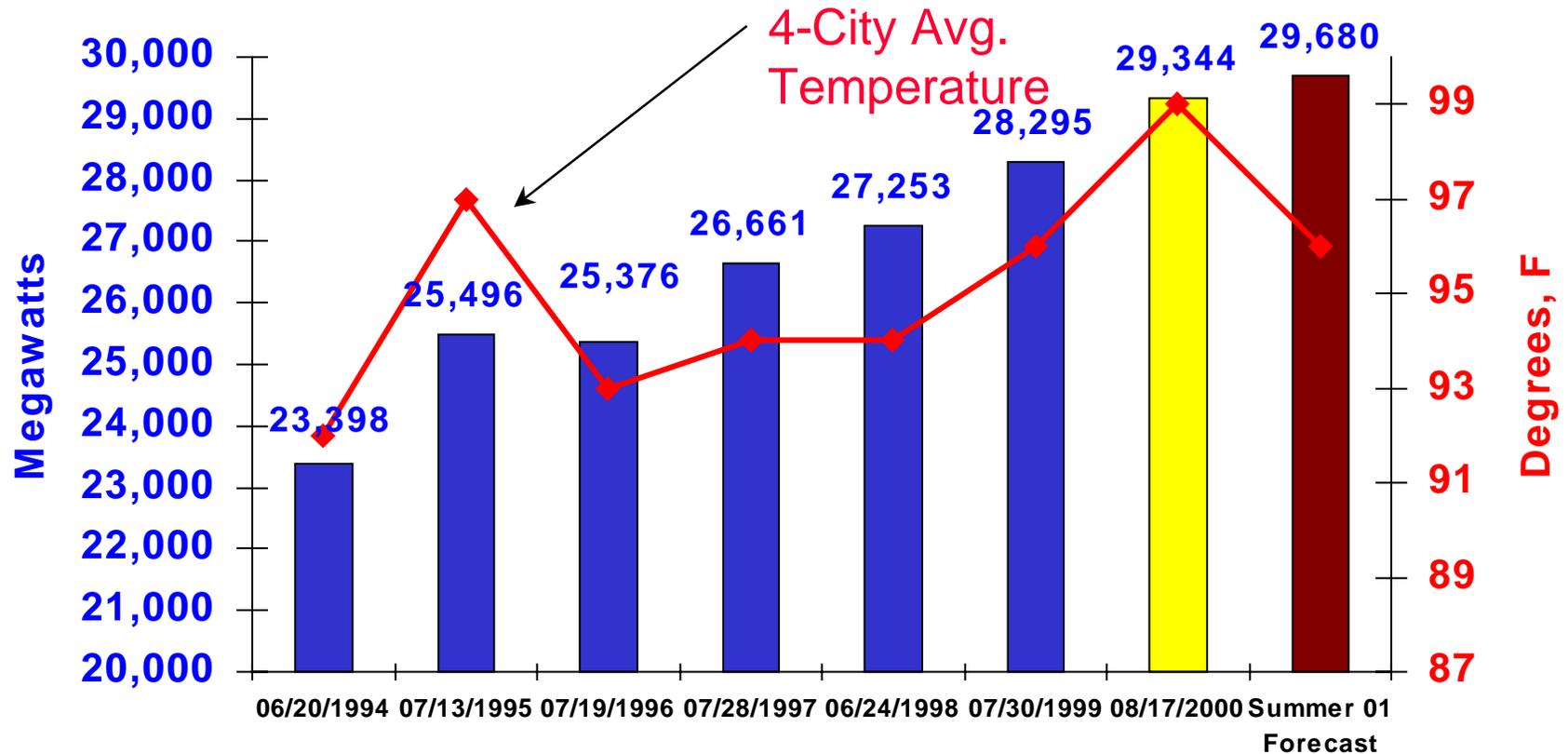
# Generation Mix



- 11 Coal Plants (15,042 MW)
- 29 Hydro Plants (3,289 MW)
- 5 Nuclear Units (5,729 MW)
- Combustion Turbines (3,154 MW) \*
- Pumped Storage (1,576 MW)
- Red Hills (440 MW)
- Corp of Engineers (405 MW)
- TAPOCO (318 MW)



# TVA Summer Peaks



**Net System Load vs. Temperature**



# Excellence in Performance

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- TVA ranks as nation's largest public power producer
- TVA had record power sales totaling \$6.8 billion last year and has had only one general rate increase in 13 years
- TVA set all-time reliability record of 29,344 MW in power delivery on August 17, 2000
- TVA's five nuclear units have achieved record generation for the 5th consecutive year and increased output for the 8th year straight
- For FY 2000, TVA operated with 99.999% reliability



# Among Largest Transmission Owners



- Delivered 165 Billion kWh in Fiscal 2000
- 17,000 Miles of Lines
- 130,000 Wood/Steel Structures
- 240,000 R-O-W Acres
- 850 Substations, Metering & Switching Locations
- 57 Interconnections
- 2,500 Miles Fiberoptic Cable
- \$2.3 Billion System Investment



# TVA Transmission Firsts

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- **1st** 500-kV network in the free world
- **1st** to build major interconnections
  - seasonal diversity exchange
  - reliability
- **1st** large-scale Flexible AC Transmission System (FACTS) device--Statcom
- **1st** to combine power electronics & energy storage to improve transmission reliability & voltage
- **1st** to move from silicon science to diamonds for power electronics for FACTS and DC devices



# Reliability: Why Worry?

*Customer  
Reliability  
Priorities*

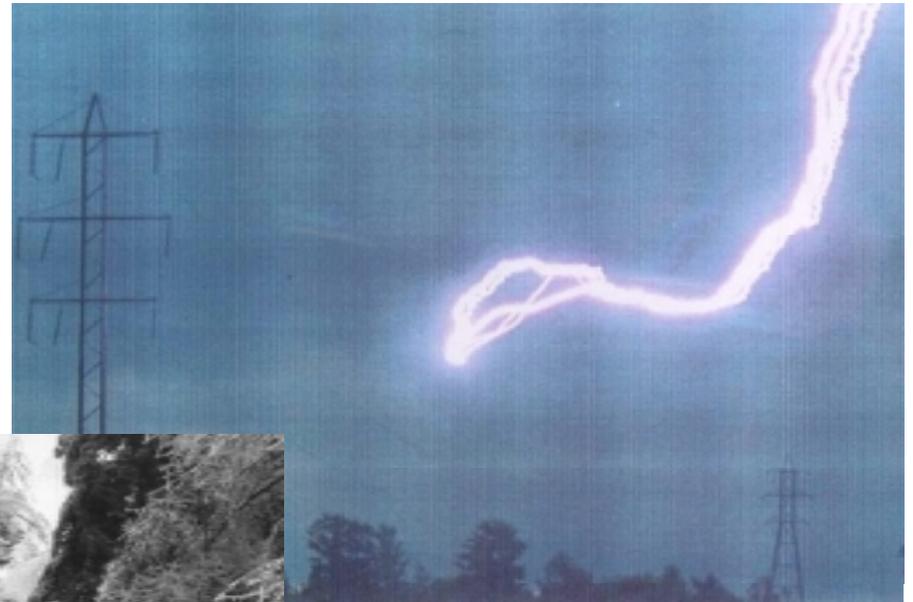
*1. Sustained  
2. Momentary*

*Interruptions  
of Any Type*

- Increasing customer expectations : with computer automation and robotics, momentary interruptions of less than 1/3 second cause customer pain.
- Today, 1/3 of the U.S. electric load flows through electronic equipment; by 2005, one half will.
- EPRI estimates that power failures have doubled and cost customers over \$50 billion / yr.



# Traditional Reliability Challenges





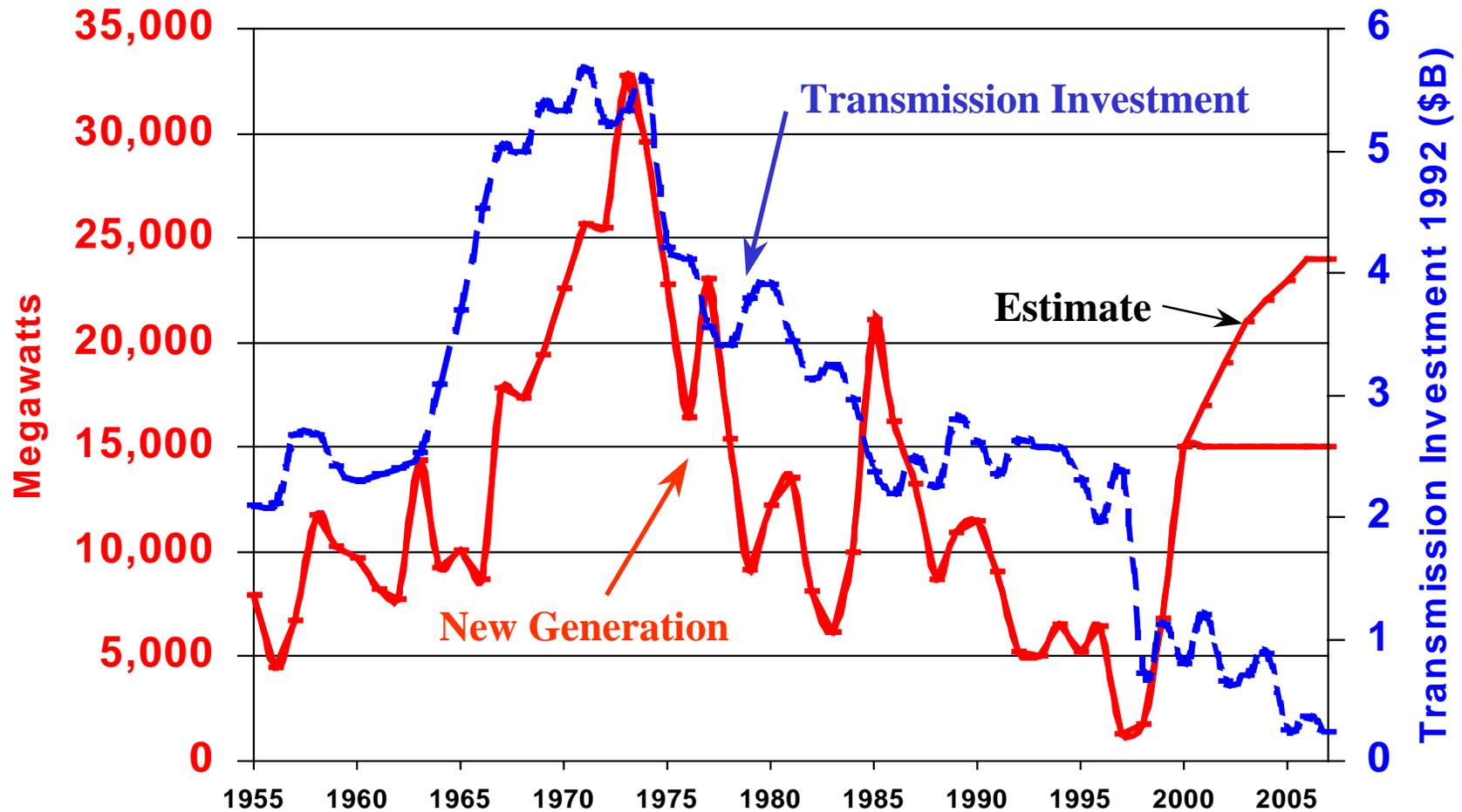
# New Reliability Challenges

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- Transmission not being built fast enough to keep up with huge growth in generation
- De-coupling of generation and transmission planning
- Exponential growth in transactions
- Transactions are based on contract path, not how power actually flows over the grid
- Some market participants put their financial goals ahead of reliability



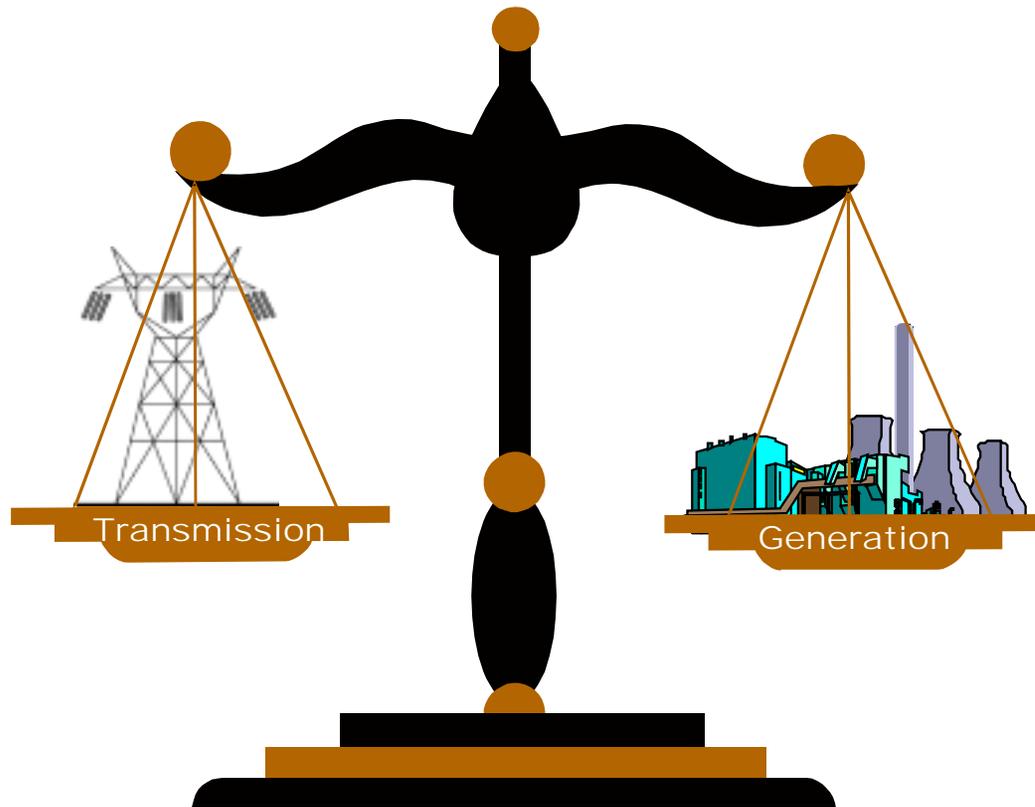
# De-coupling of Investment in Generation & Transmission



Source: Cambridge Energy Research Associates, Electric Transmission Advisory Service, 2000

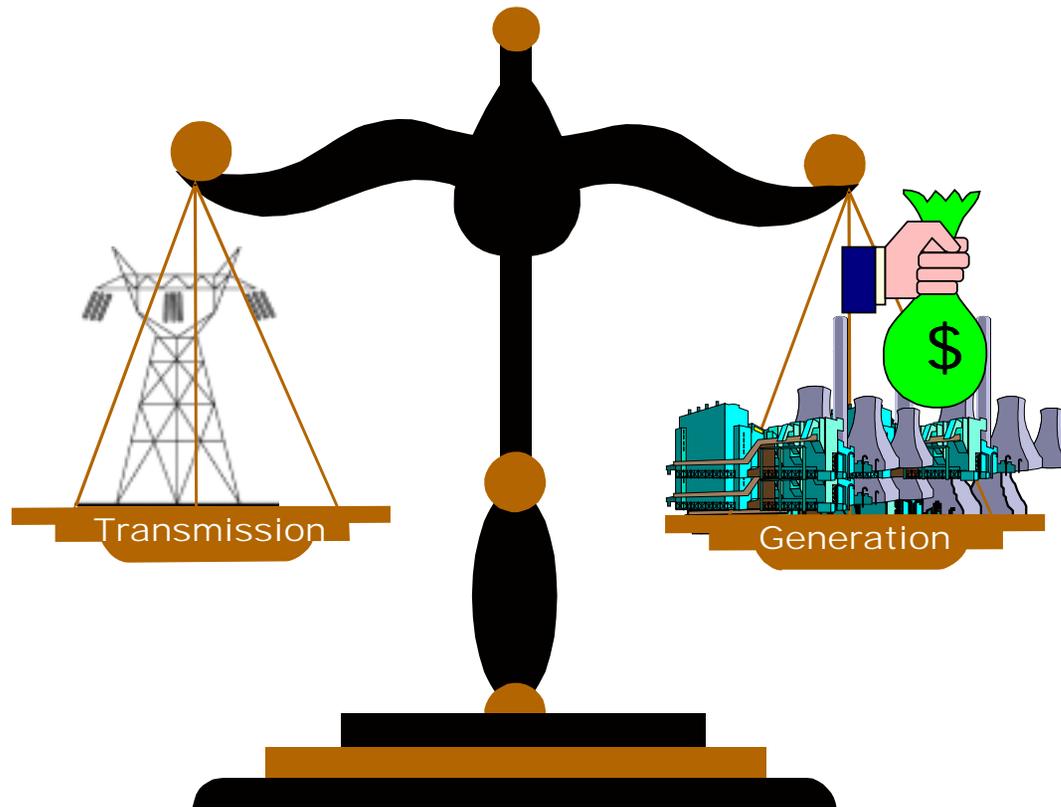


# The Essential Balance



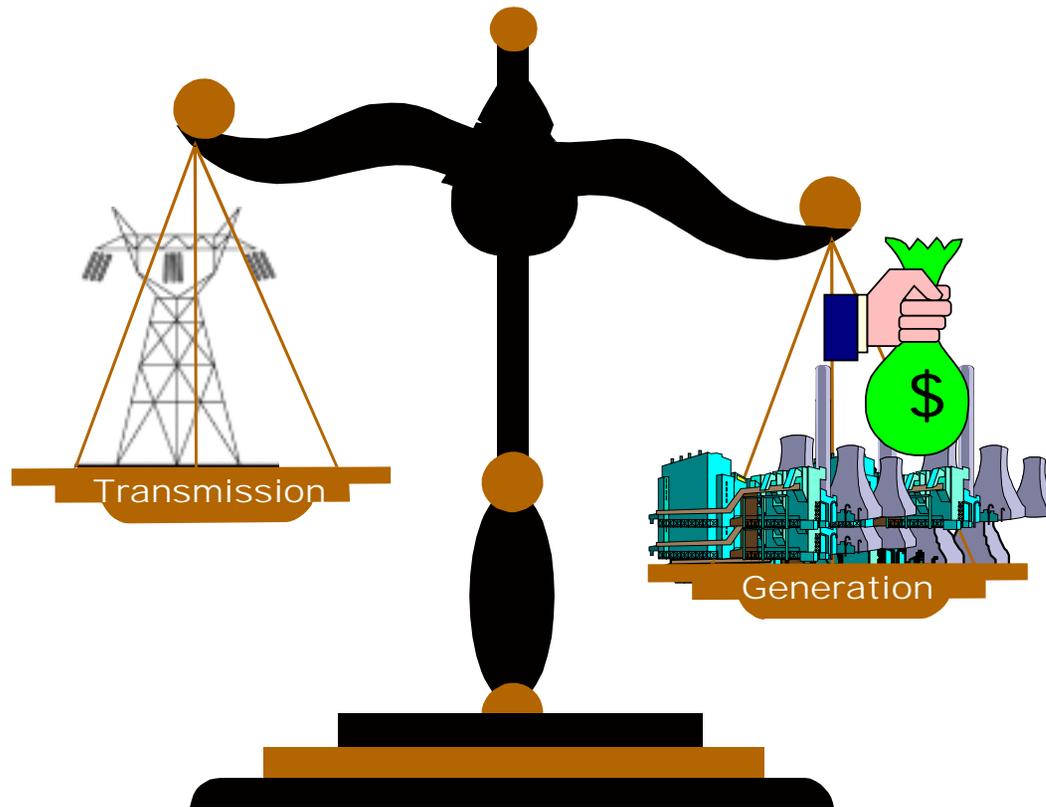


# The Essential Balance



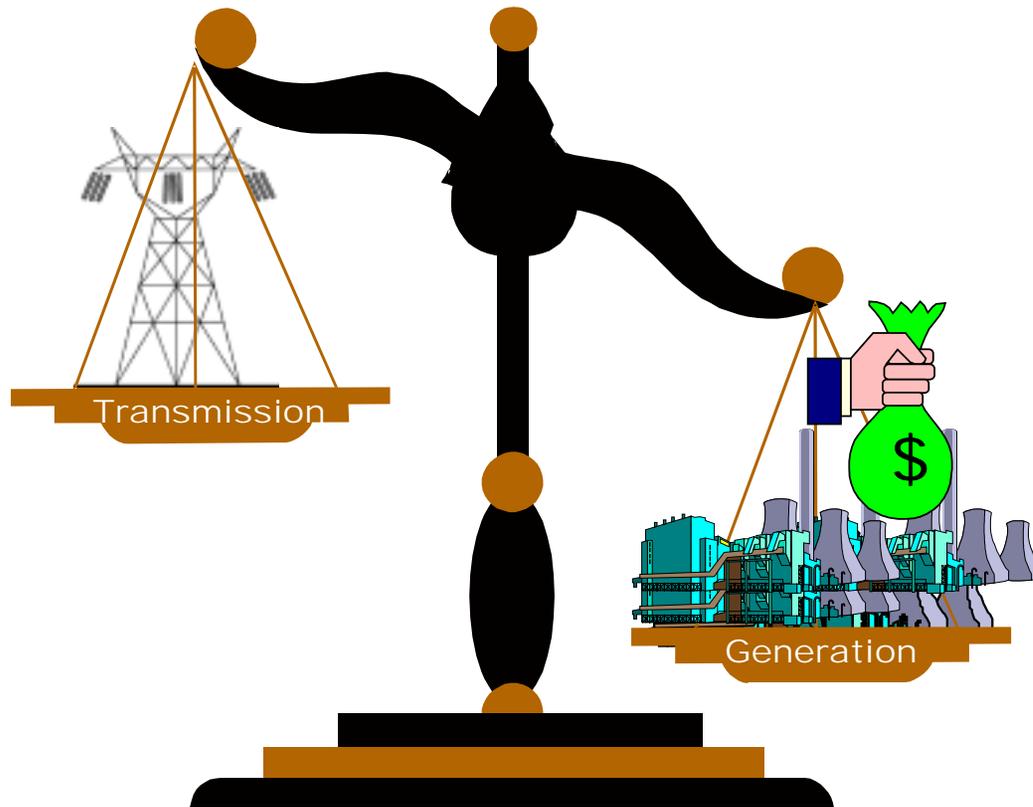


# The Essential Balance



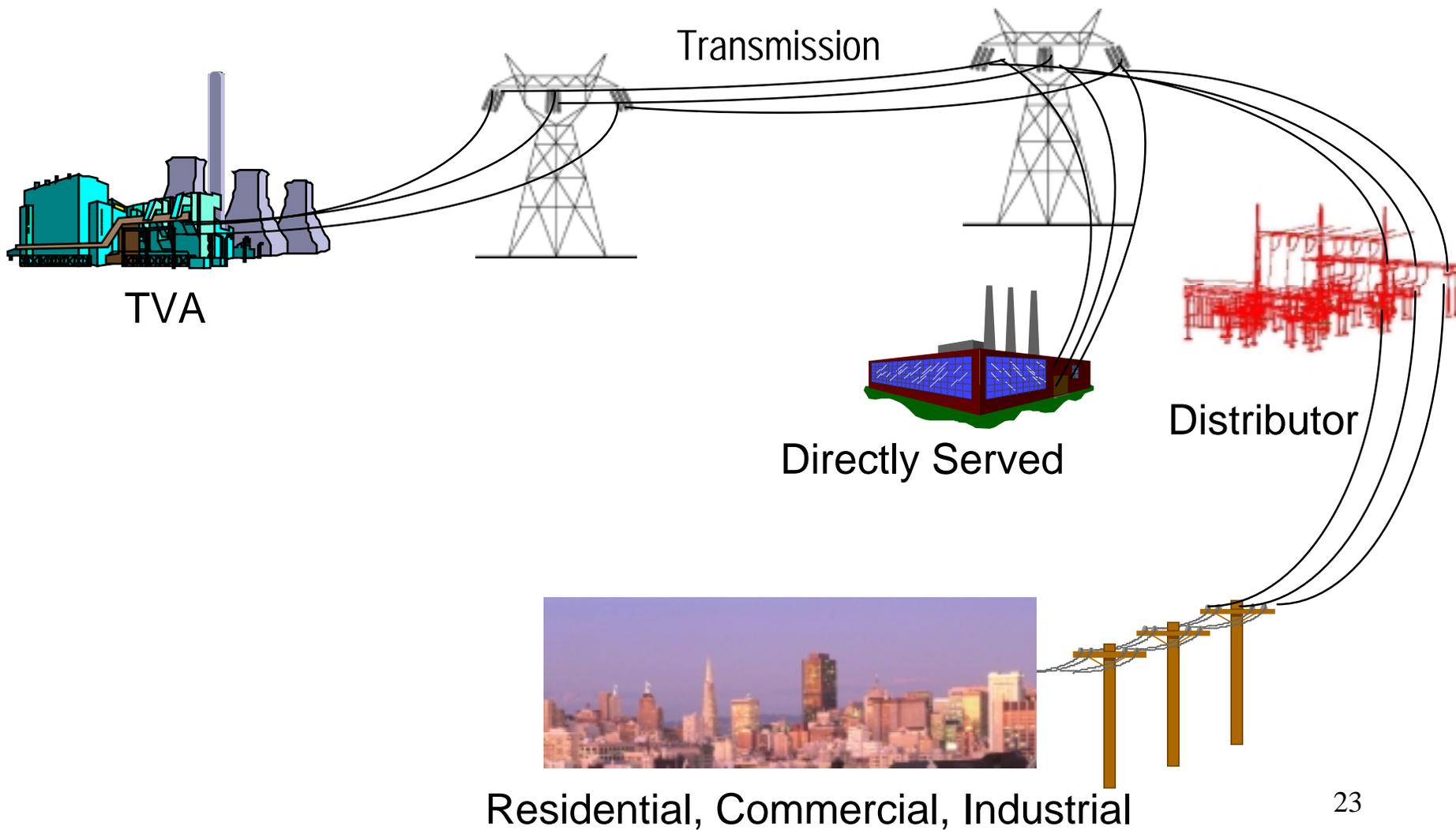


# The Essential Balance





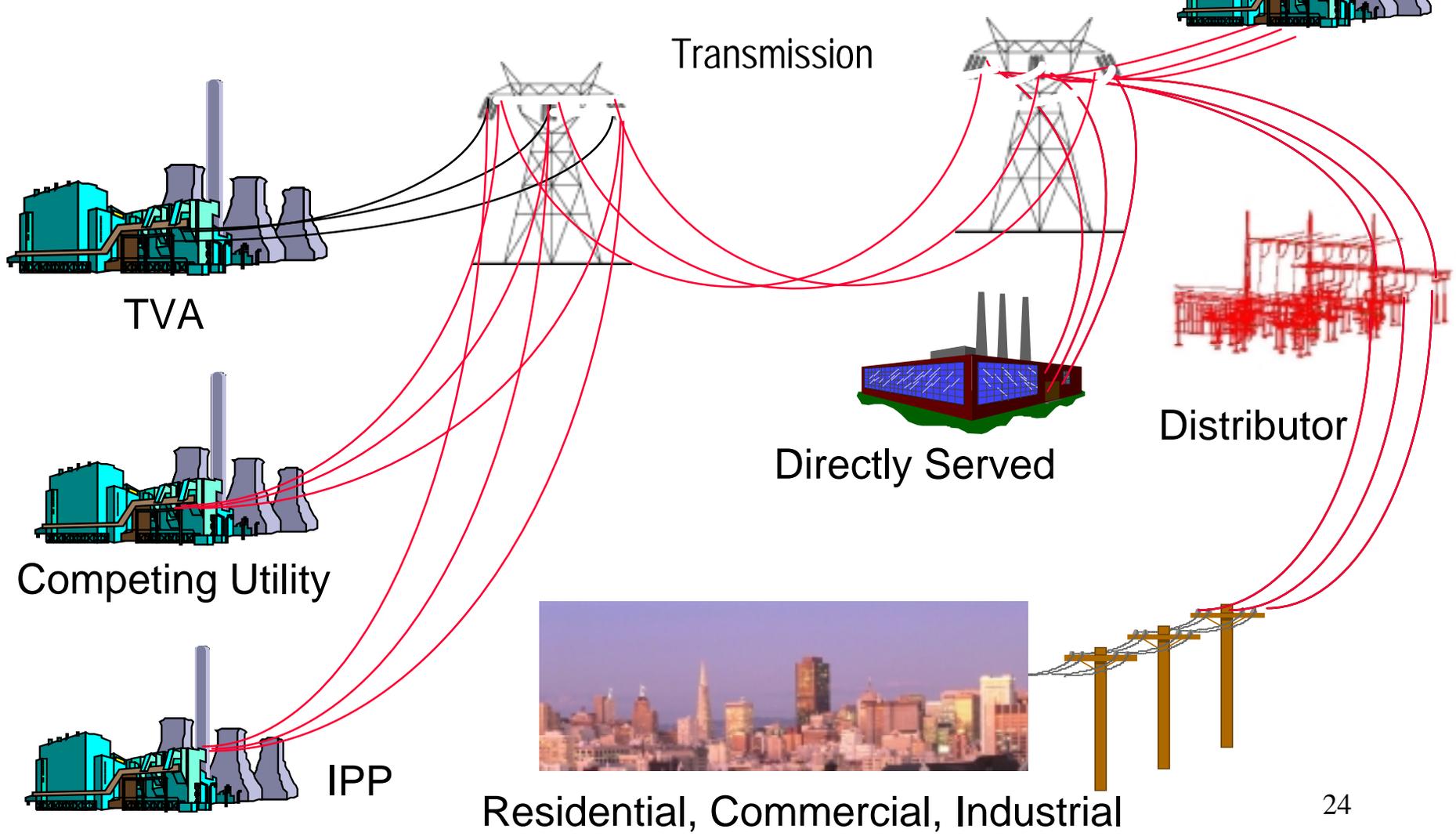
# Before Competition



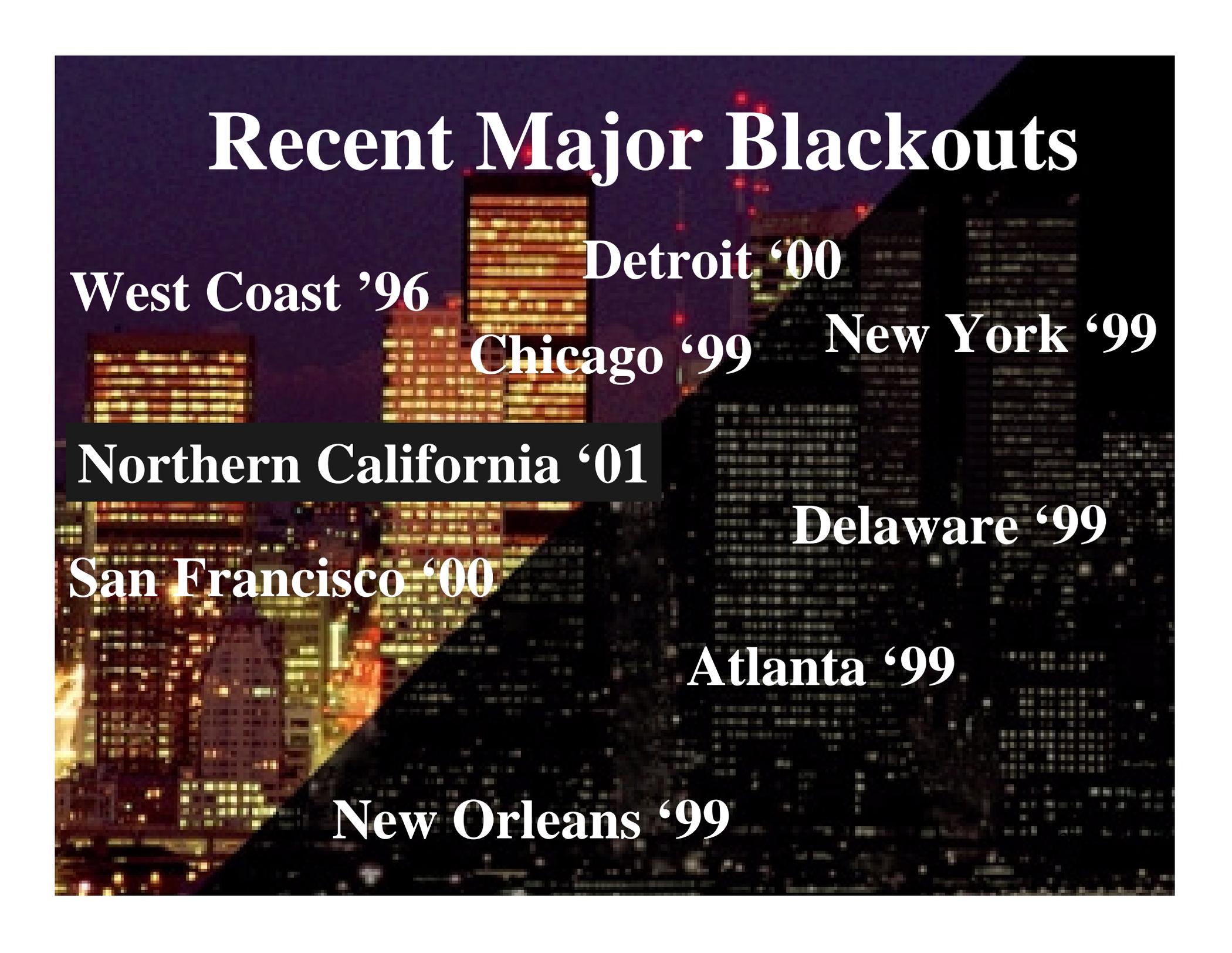


# After Retail Competition

Competing Utility



# Recent Major Blackouts

The background of the slide is a nighttime photograph of a city skyline, likely New York City, with numerous skyscrapers illuminated. A dark, semi-transparent diagonal shape cuts across the image from the bottom-left towards the top-right, creating a sense of depth and shadow.

West Coast '96

Detroit '00

Chicago '99

New York '99

Northern California '01

Delaware '99

San Francisco '00

Atlanta '99

New Orleans '99



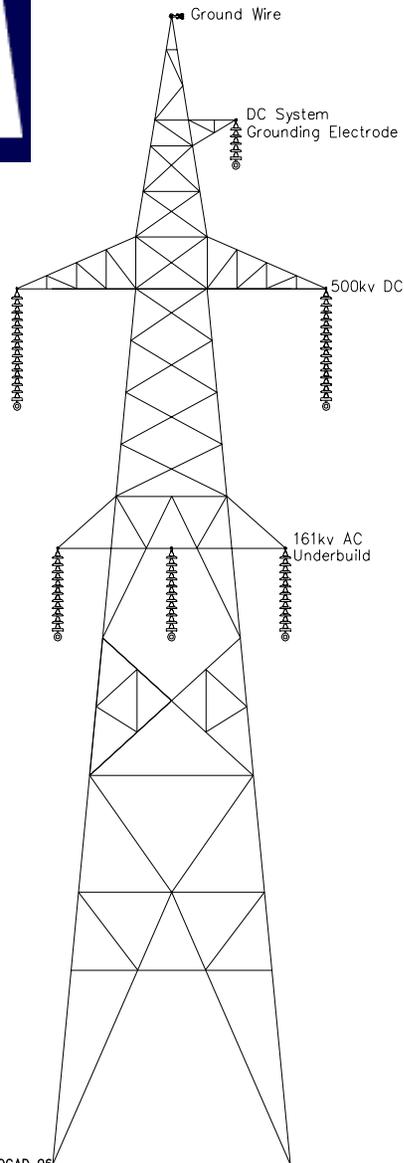
# A Prescription for Gridlock

A State Highway System . . .



. . . Being Used as an Interstate





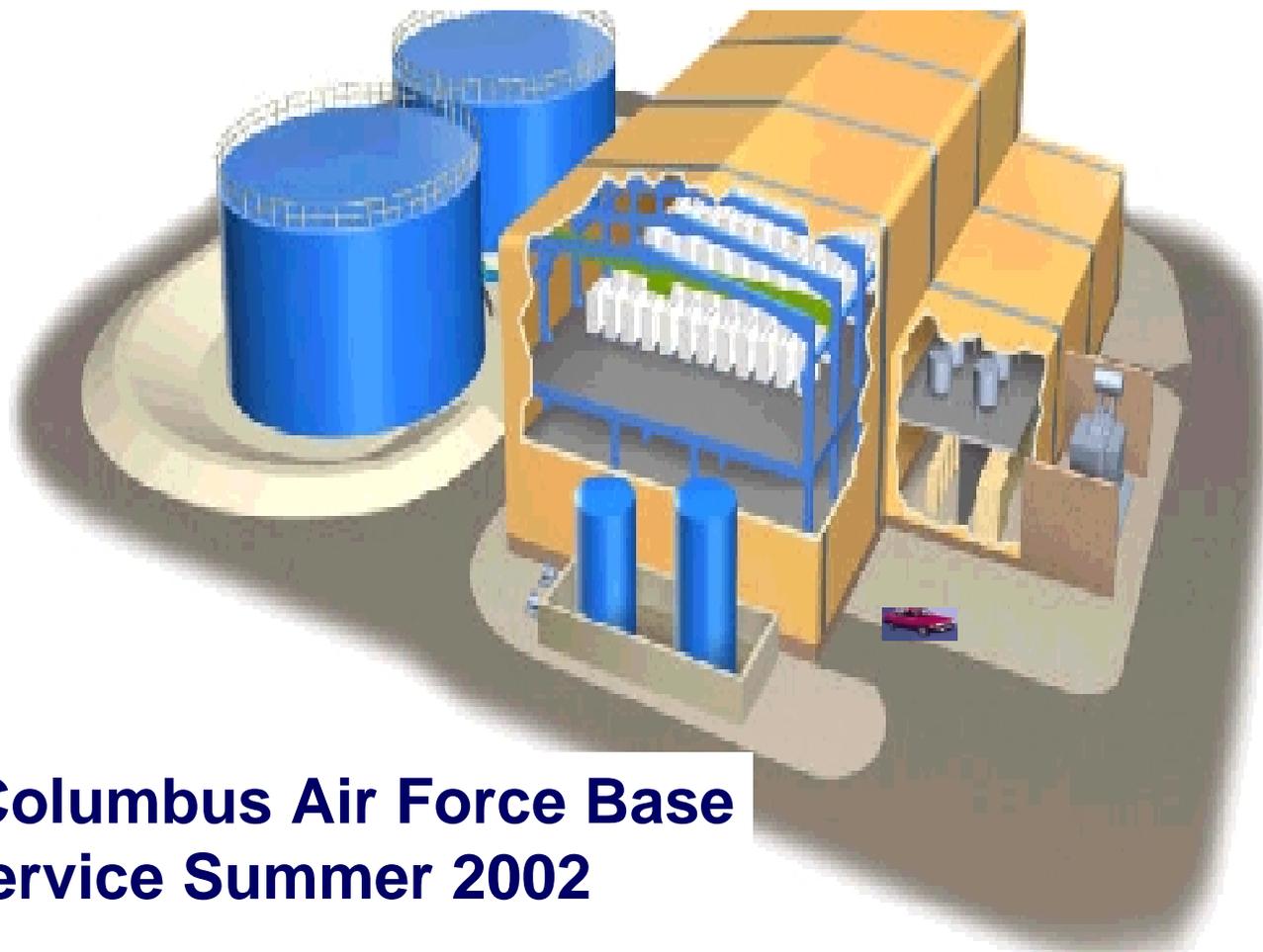
of 500KVdirect\_current1 AUTOCAD 96  
s 02/23/01 15:25:40

# U.S. Needs a National Electricity “Interstate Highway System”

- Hybrid AC/DC solves many grid problems
- Built over existing AC lines using common towers--very little new right-of-way needed
- DC allows much higher power transfers over longer distances with fewer losses
- Power flows more controllable than AC, thus allowing new markets to work



# Regenesys Energy Storage Project



**TVA Columbus Air Force Base  
--In-Service Summer 2002**



# Regenesys Highlights

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- Power is generated when electro-chemicals flow from storage tanks through fuel cell modules.
- Will eliminate interruptions for future e-commerce customers needing premium power (less than 1 interruption in 10 years, no fluctuation in voltage, flicker, etc.)
- Selected by Financial Times as the most innovative R&D project worldwide (*Fall 2000*).



# Potential Benefits

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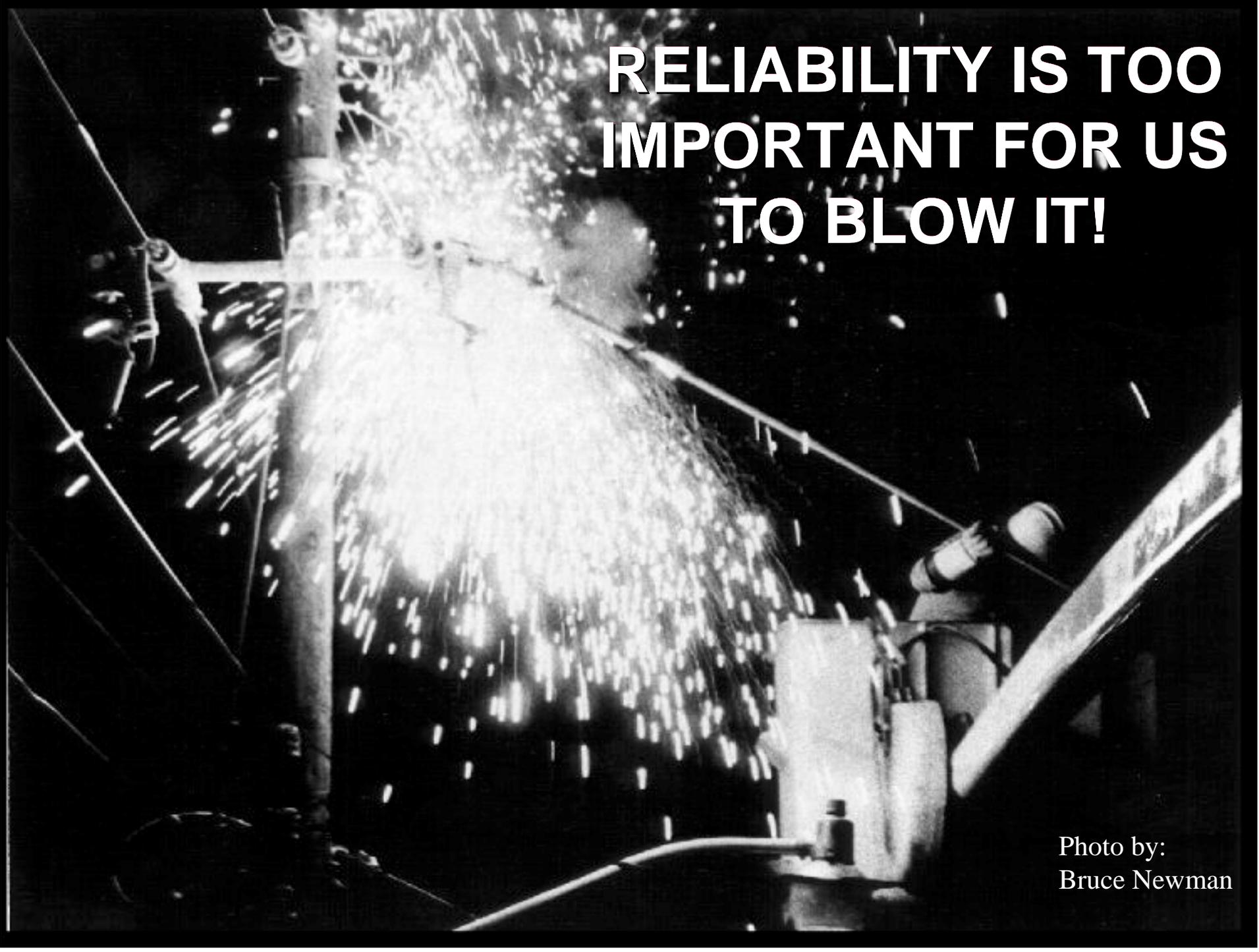
- Instant start-up & availability (MW & MVARs)
- Premium uninterruptible power source
- Increased power flows & improved transmission stability
- Reduced congestion on transmission pathways & less volatile markets
- Fast, low-cost power system frequency regulation (LFC)
- Improves value of non-dispatchable renewable resources (wind, solar etc.) by storing renewable energy & shifting it to peak periods



# Our Guiding Principle

*Electricity is a Lifeline . . .  
. . . Not Just a Bottom Line*





**RELIABILITY IS TOO  
IMPORTANT FOR US  
TO BLOW IT!**

Photo by:  
Bruce Newman