

Civilization, renewable energy, WAPA and the grid

University of California at Berkeley

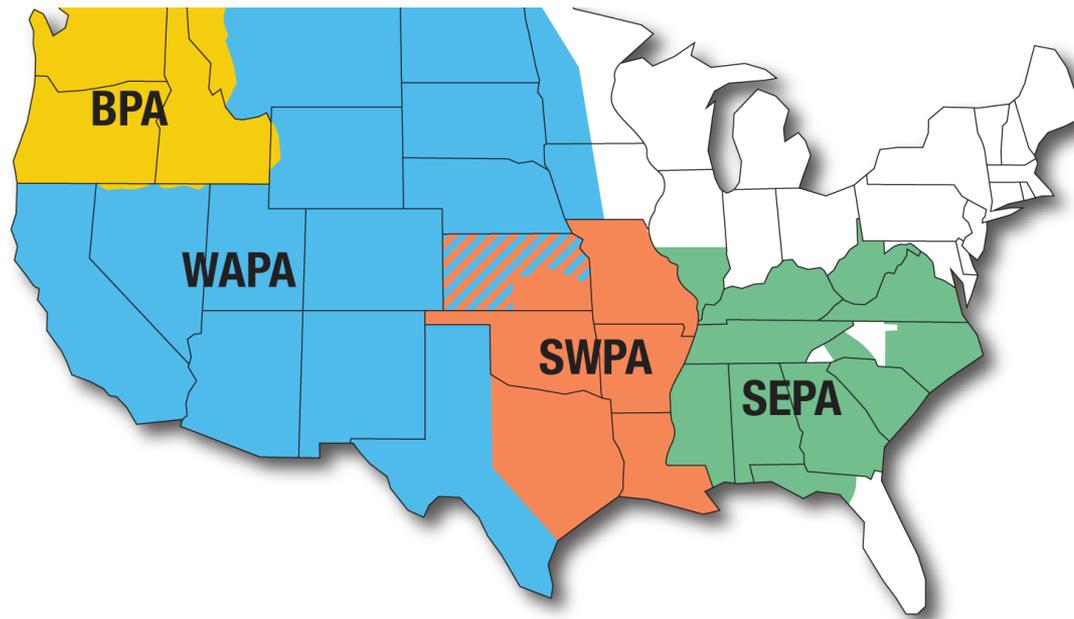
Oct. 26, 2017 | Berkeley, CA

Mark A. Gabriel
Administrator and CEO



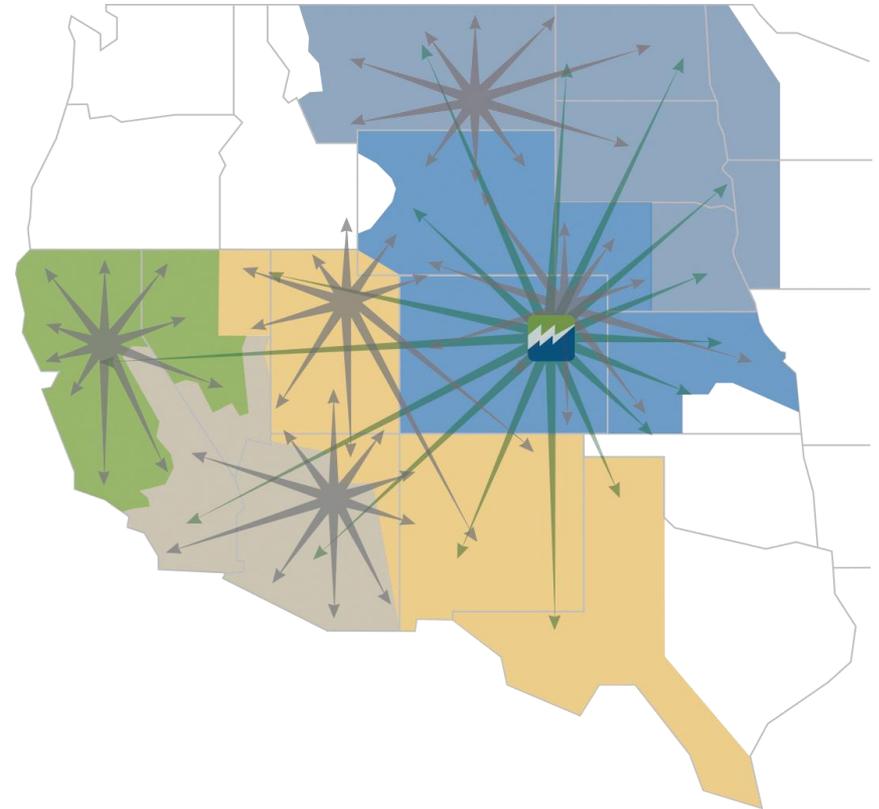
What is WAPA?

One of four power marketing administrations within the Department of Energy whose role is to market and transmit wholesale electricity from multi-use water projects.



Who we are

- Serve 40 million Americans
- 15-state footprint
- 1.4 million square miles
- 49 offices
- ~700 customers
- Top-10 largest transmission utility in country

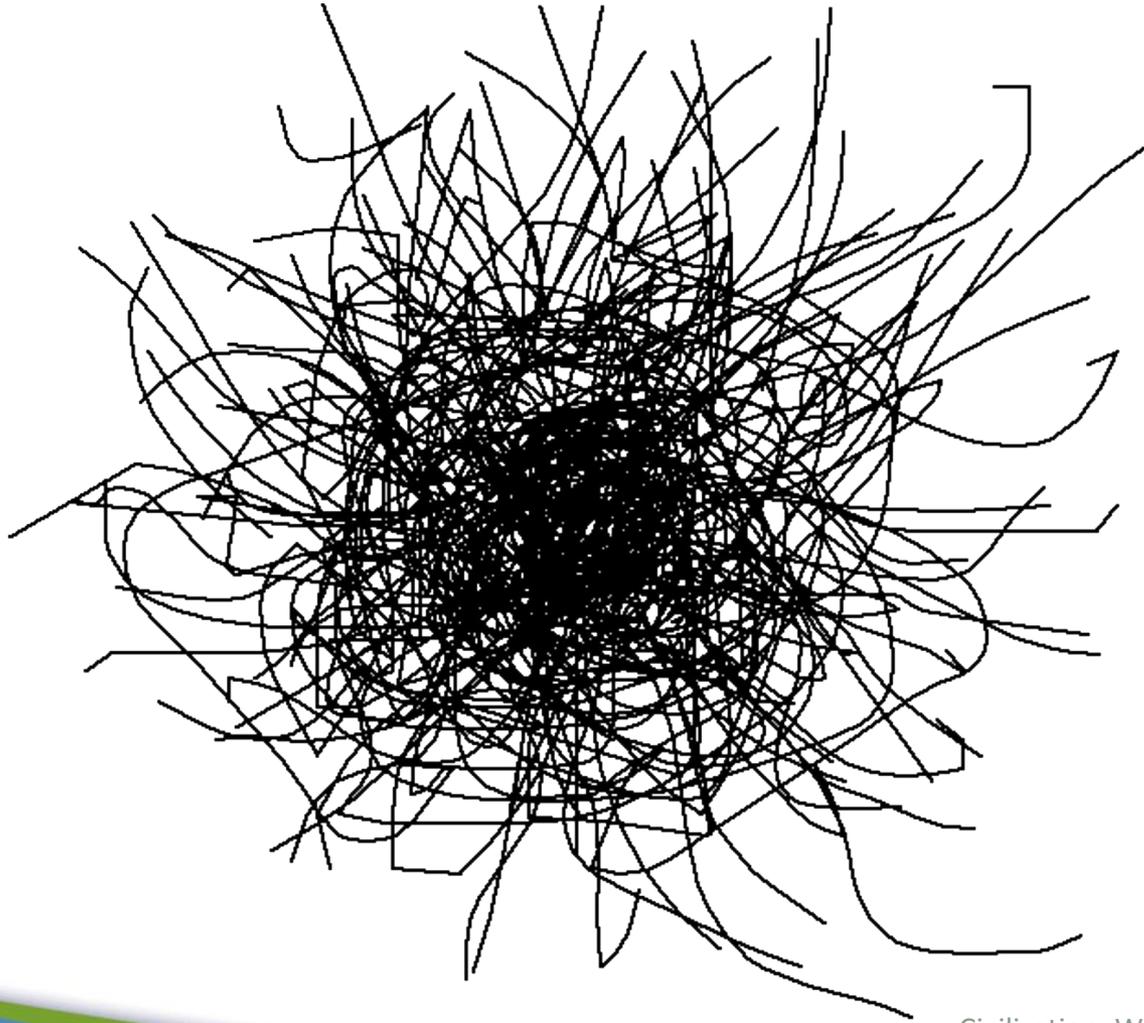


My perspective

- 30 years in electric industry (plus gas, oil and water)
- Eight years at Electric Power Research Institute
- Certified technology nerd
- Published author
- Utility, venture capital, private equity and consulting background
- A DOUG:
 - ✓ Dumb
 - ✓ Old
 - ✓ Utility
 - ✓ Guy

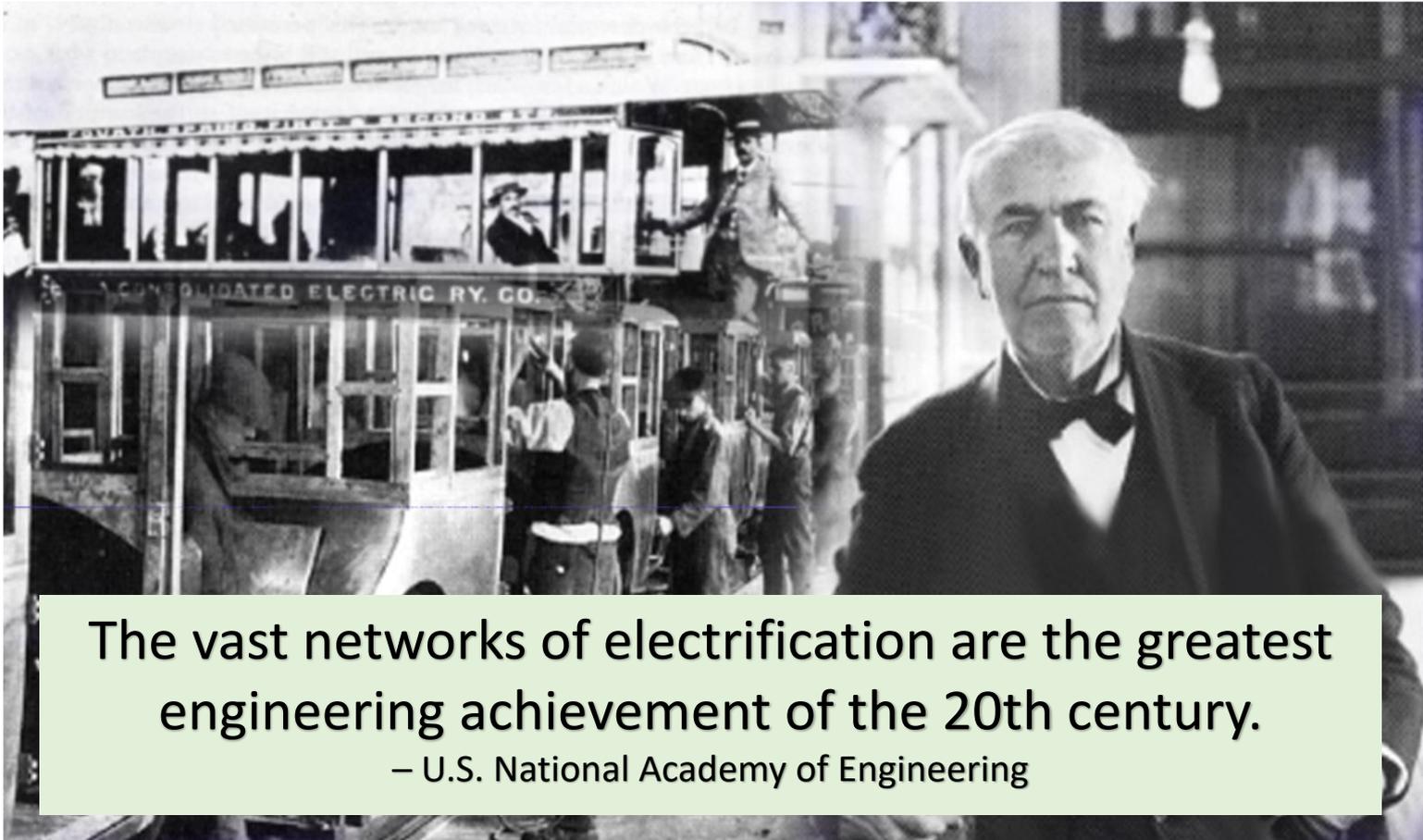


Untangling giant hairball of electricity



Civilization, WAPA and grid ops - 5

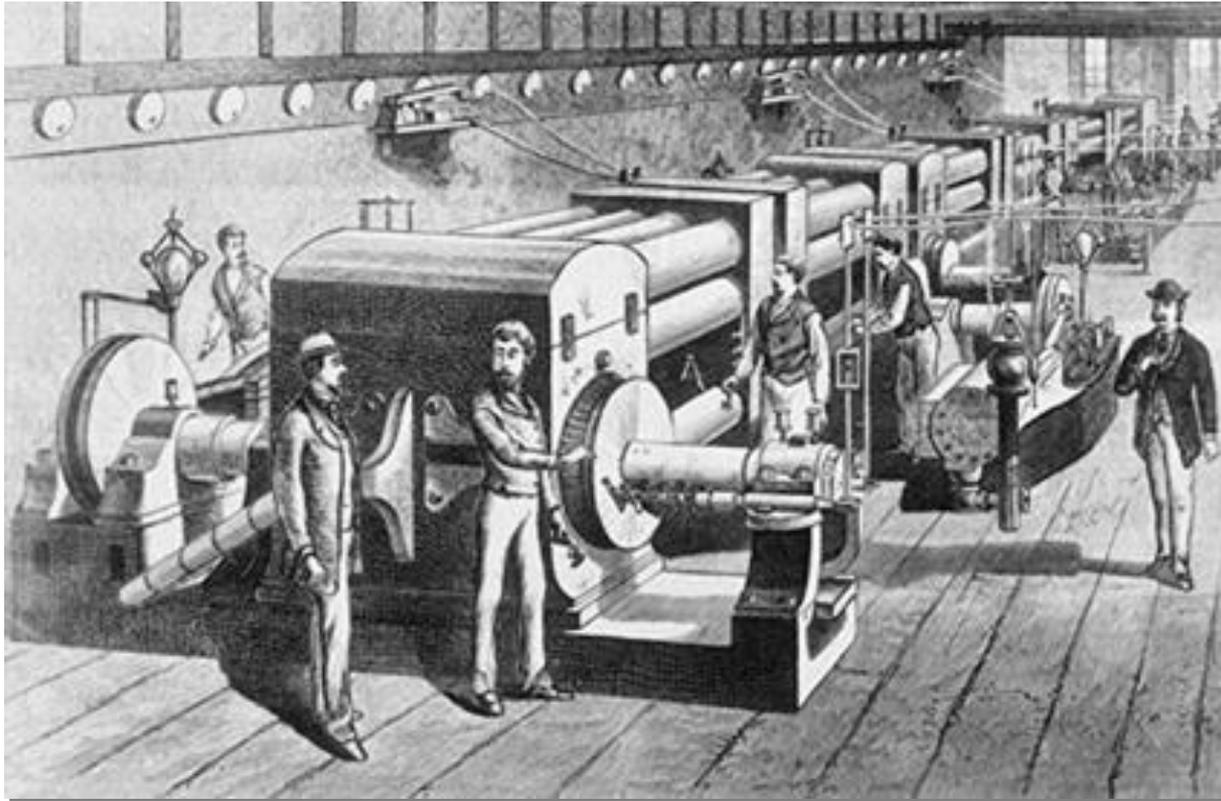
Do you recognize this man?



The vast networks of electrification are the greatest engineering achievement of the 20th century.

– U.S. National Academy of Engineering

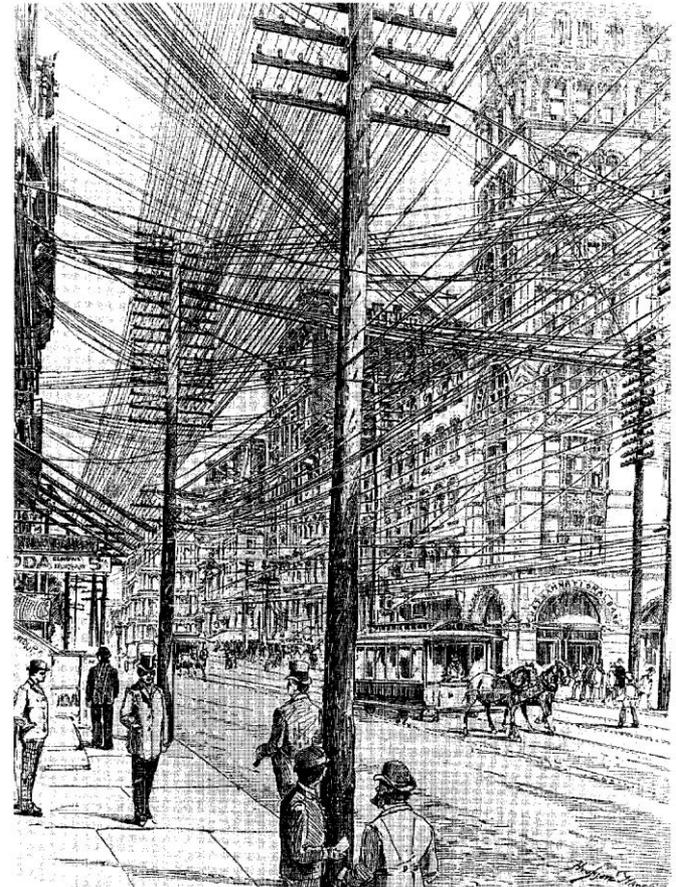
Dot-com era circa 1880: electricity



1882, First electric station built by
Edison on Pearl Street

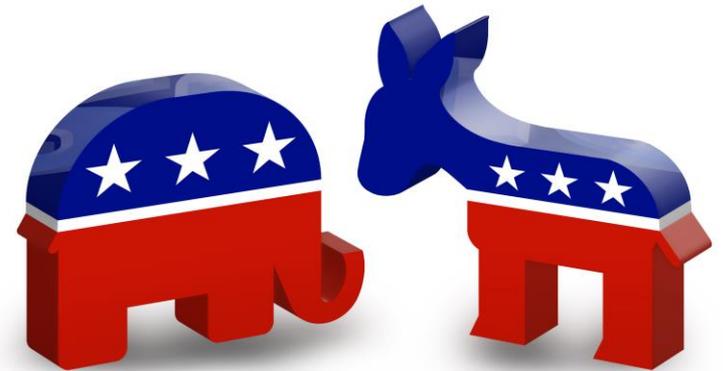
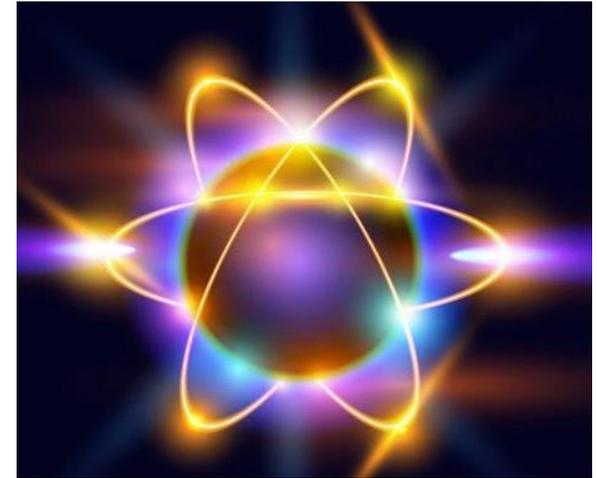
Dot-com era circa 1880: electricity

- Industry began in support of other enterprises
 - Industrial
 - Telegraph, telephone
 - Street cars
- Wild West of the east coast
 - 20 companies providing service in NYC
 - 18 deaths in 1889



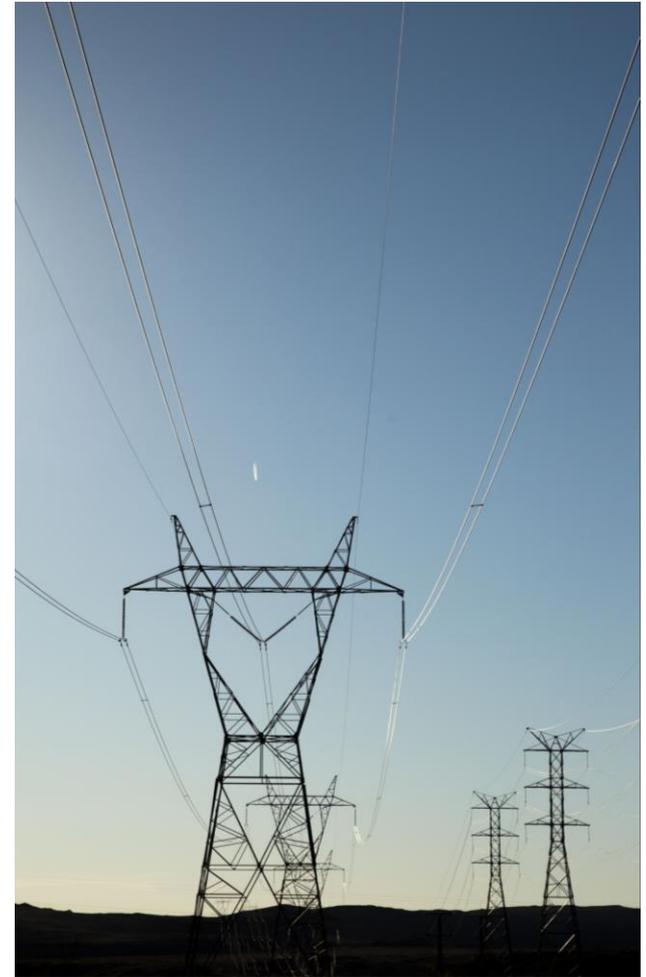
Basic rules of electricity

- Electrons are governed by the laws of physics
 - Flows to the point of least resistance
 - Always must be in supply and demand balance
 - No storage outside of fossil fuel, water and some chemical reactions
- Electricity is governed by the laws of politics



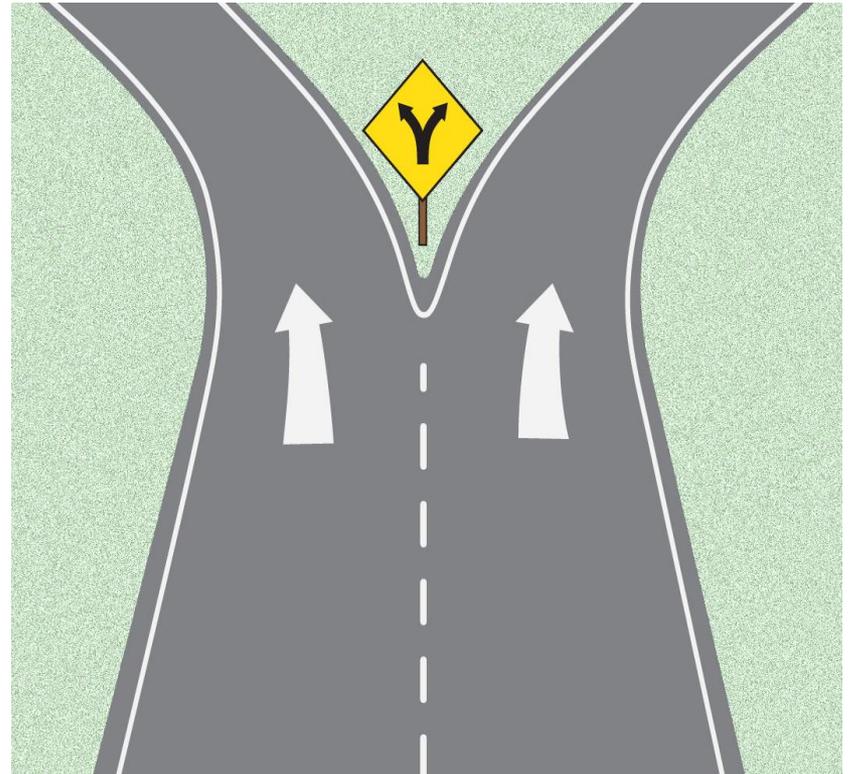
Build it bigger

- The U.S. power supply network is the largest most complex machine ever created
- Engages enterprise involving:
 - 5,000 corporate entities
 - Several forms of ownership and levels of regulatory oversight
 - Some 100 million customers
- Attempts to satisfy conflicting economic, social political and environmental objectives
- Complexity is increasing driving need for more system intelligence



Challenges in the energy frontier

- Aging Infrastructure
- Increased regulation
- Intermittent resources
- Decreased hydropower production
- More customer-side resources
- Changing markets
- Security



Industry changes



Who won the movie format battle?



Neither!

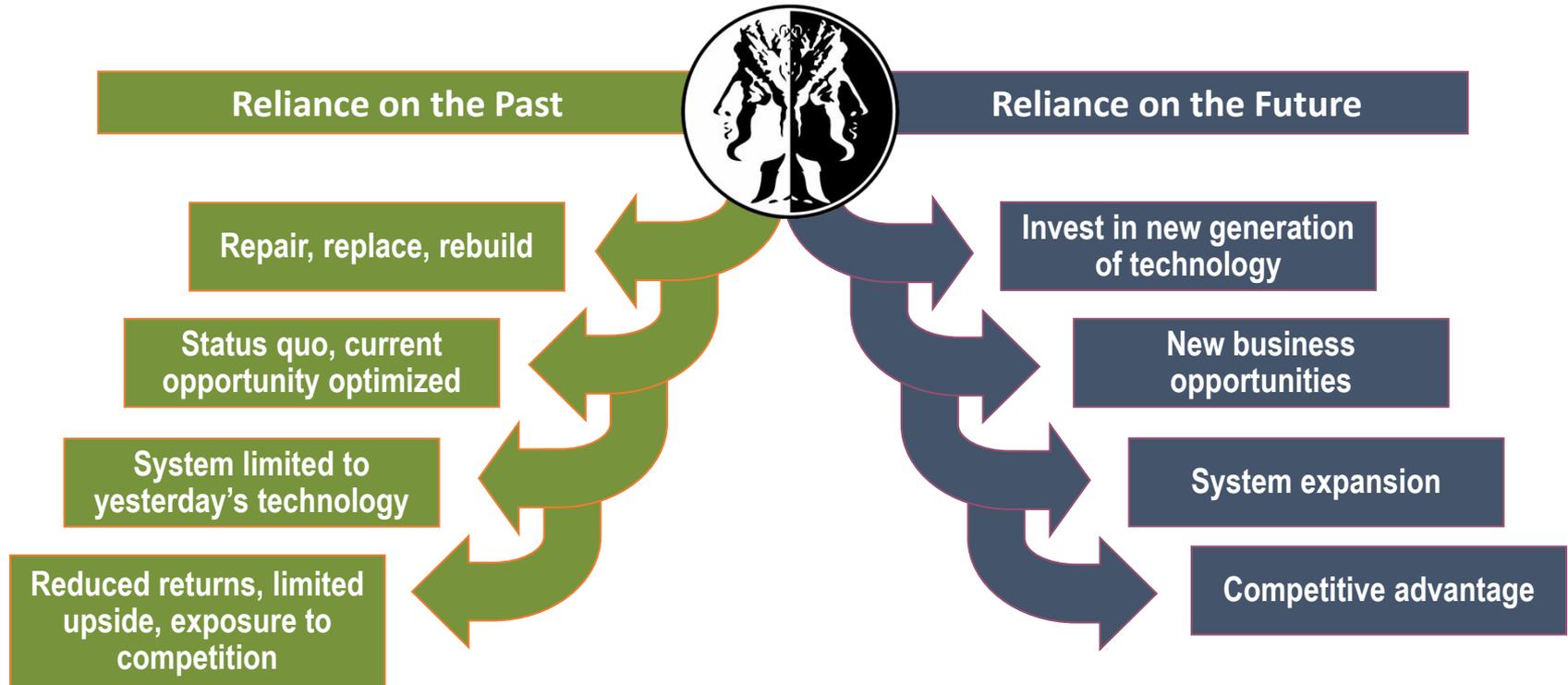
- Apple redefined the market
- Identified a megatrend

Personalized
entertainment



The Janus Conundrum

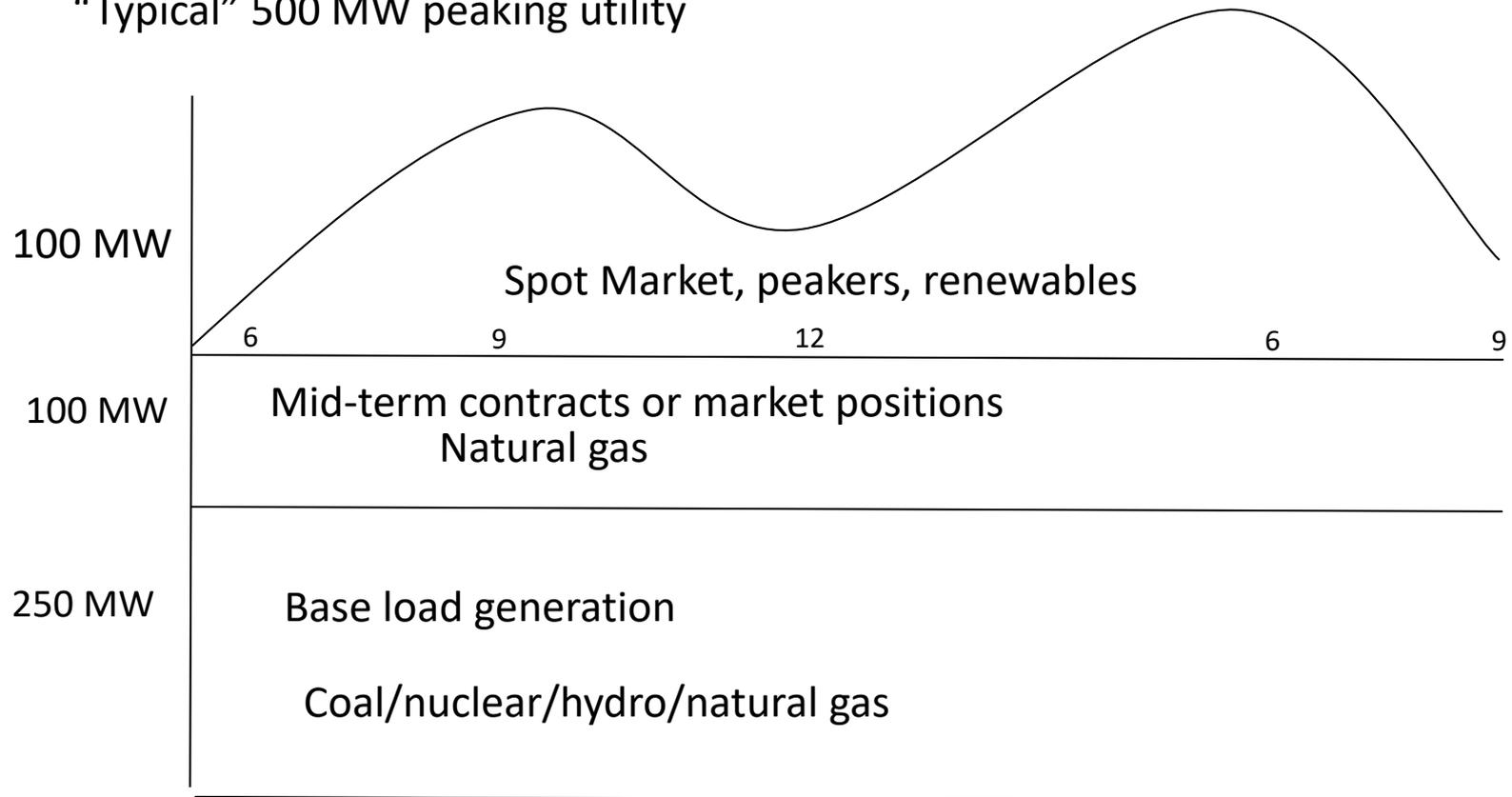
Choice of Capital Investment



® Mark A. Gabriel, *Visions for a Sustainable Energy Future*

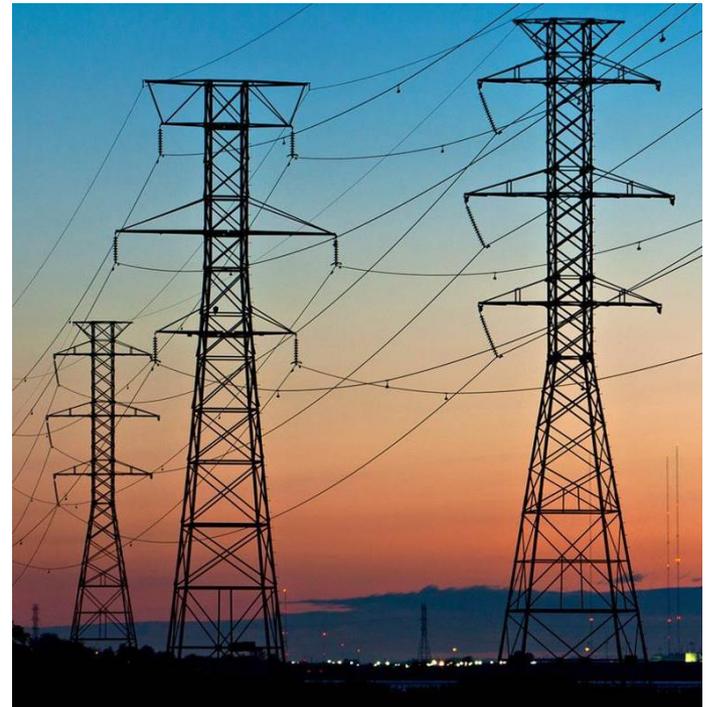
The challenge of system ops

“Typical” 500 MW peaking utility

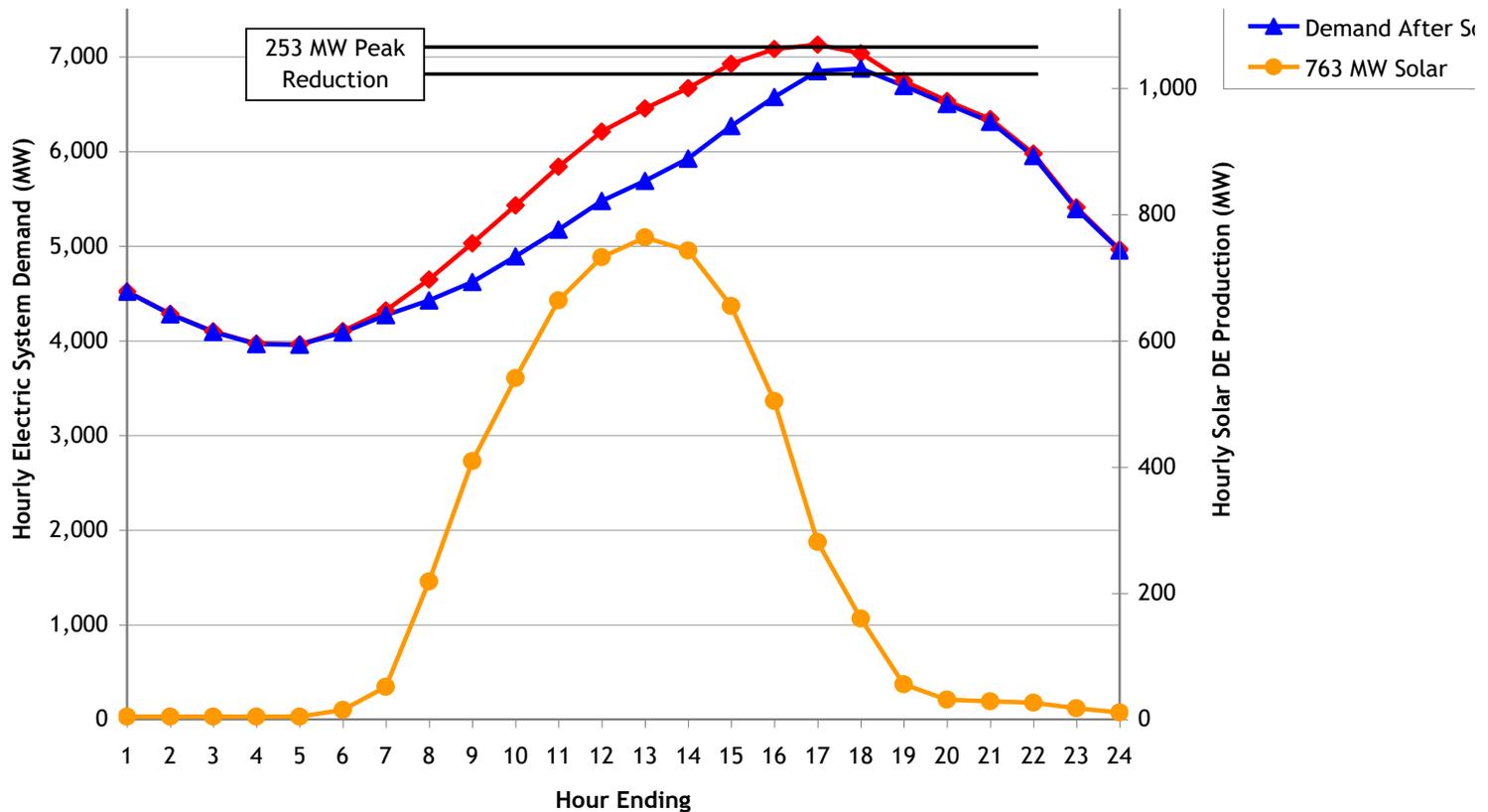


Key concepts

- Utilities *make* money on assets
- Utilities *collect* money based on kWhs used
- Utilities may also act as tax collectors for states, municipalities and counties
- In many states (California) there is no benefit to utilities selling more electricity



The Solar/Peak Conundrum (even in Arizona)

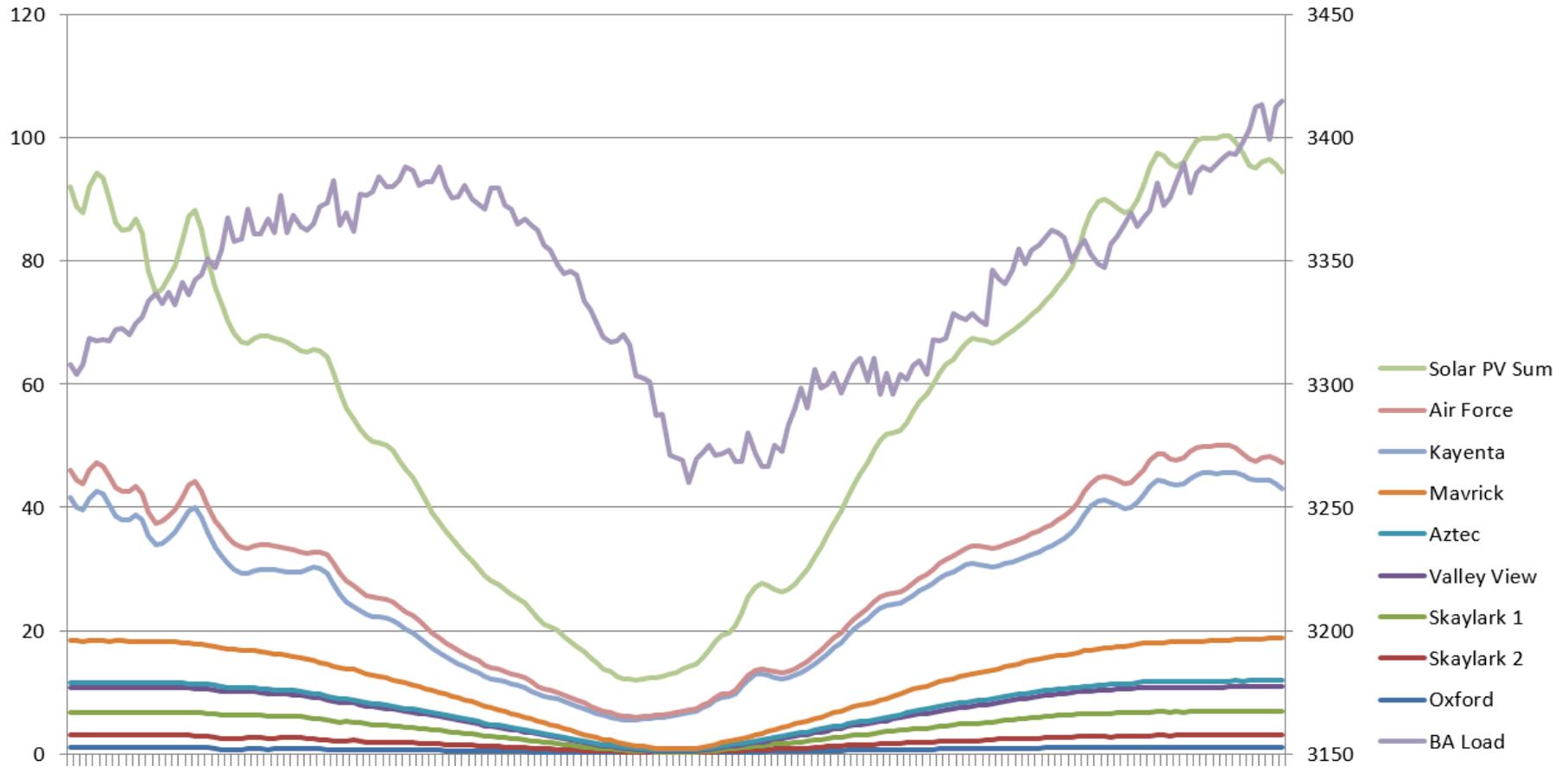


Eclipse operations

- Replacement energy came from the following:
 - Interties (~3,200 MW)
 - Hydro (~800 MW)
 - Thermal (~1,600 MW)
 - EIM transfers (~350 MW)
- No manual intervention during the eclipse



Eclipse operations



Megatrend: Carbon/Capacity Conflict

We are on track for the “t***n w***k”
of regulations vs. carbon et al.



Carbon constraints/capacity conflict

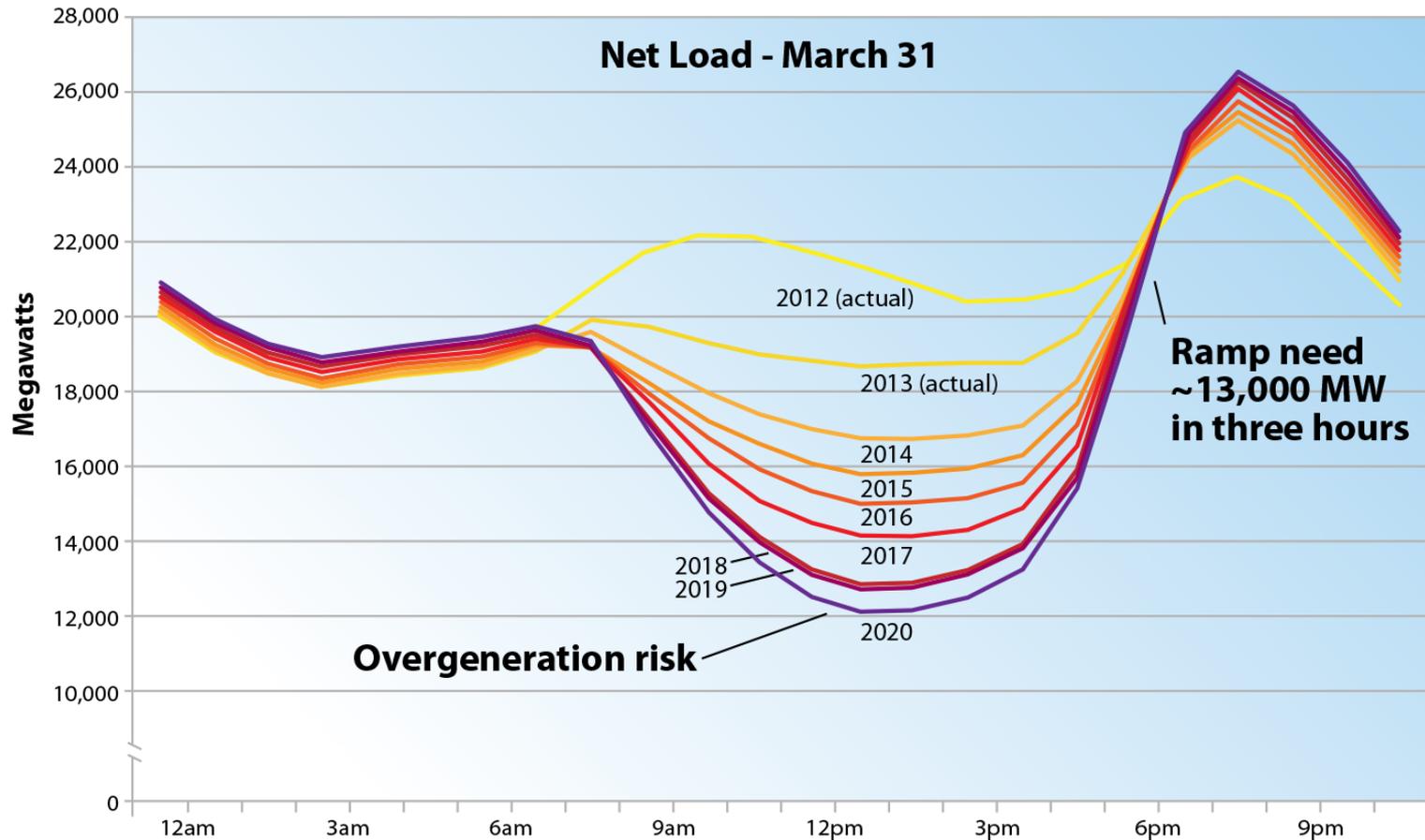
- Demand for new power sources will outstrip capacity
- Demand for clean energy will outstrip the capacity
- Public perception contrasts with the reality of the system
- Renewables are being promoted the only answer
- Cost of renewables creates financial challenges



Developed world
demand dead?
Developing world
demand galloping!

California duck curve

California Independent System Operator Duck Curve



Fundamental change

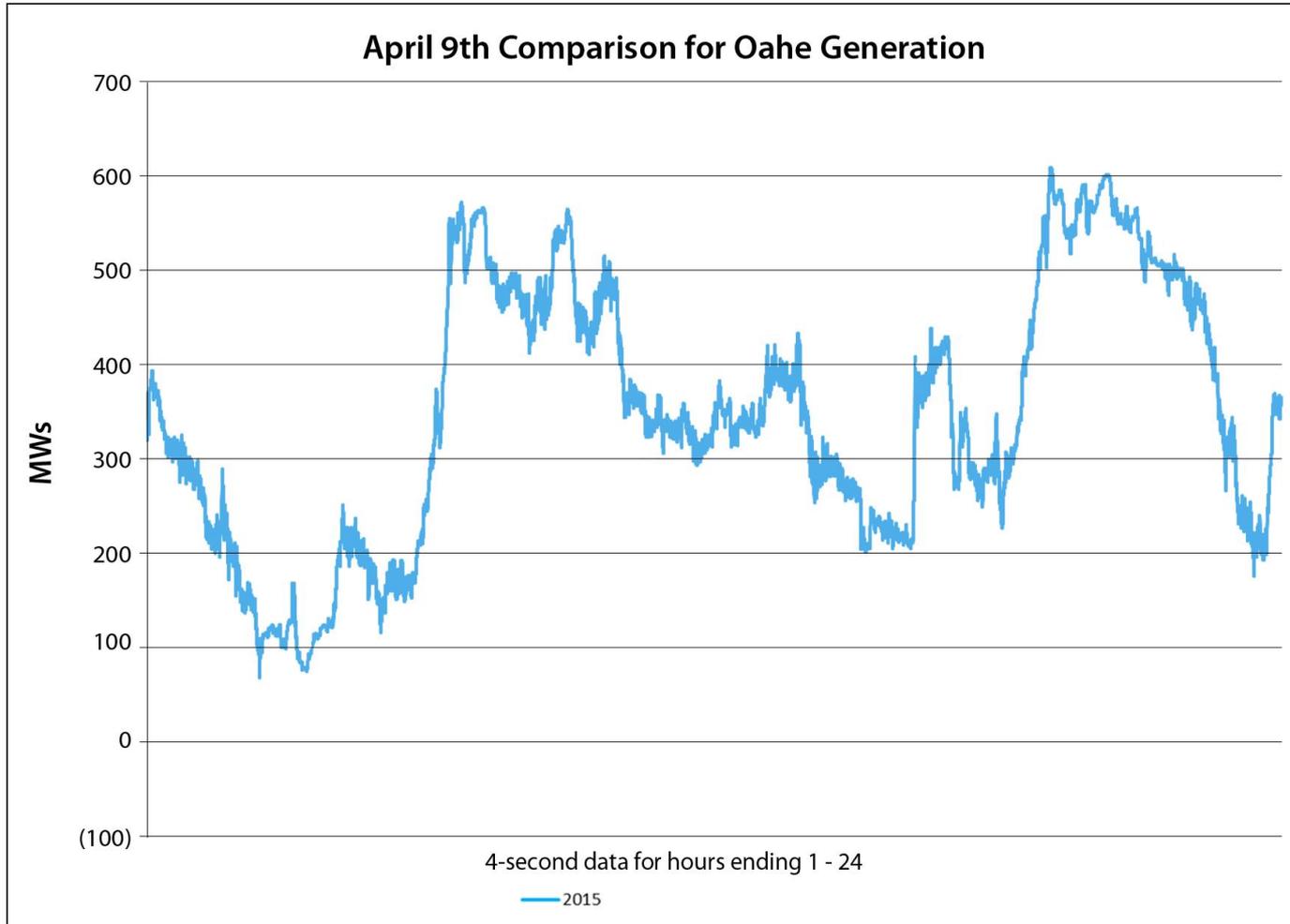
The challenge for the utility of today is not only what is real but what is perceived as real.



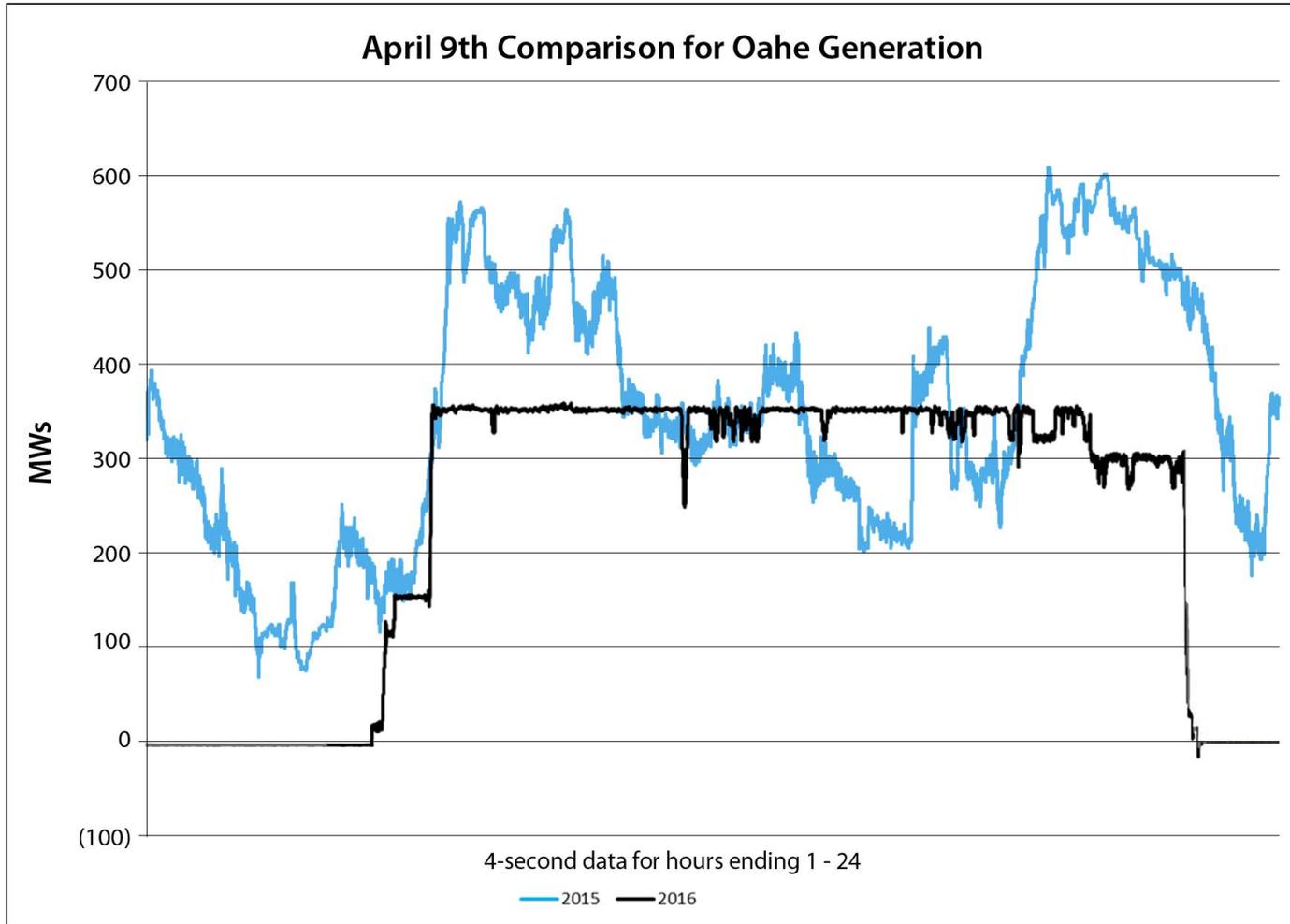
Change is upon us



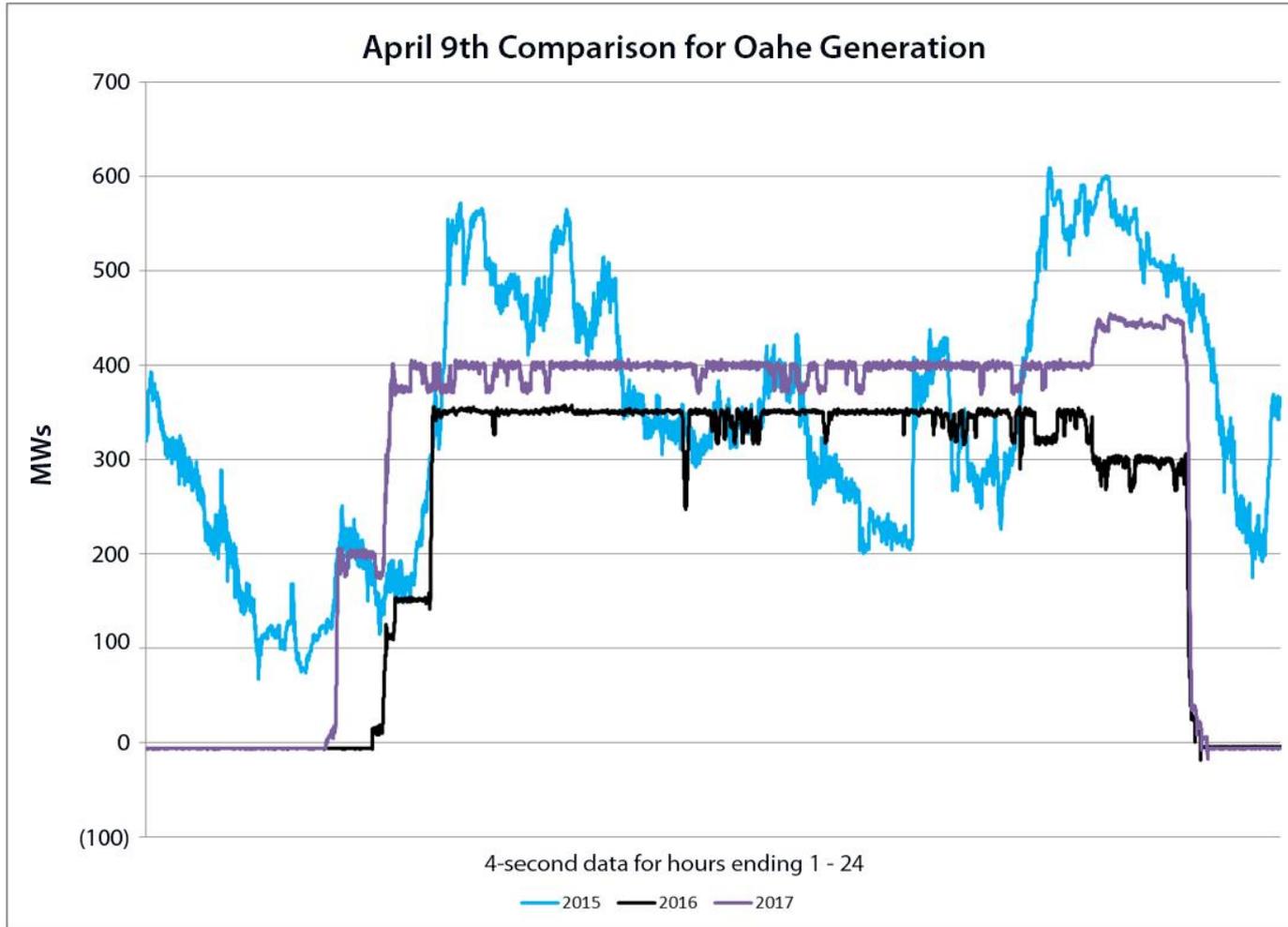
Oahe generation 2015



Oahe generation 2016



Oahe generation 2017



Contrasting world views

- Reality of system ops generally ignored
- Sky is falling?
- Sky is not falling?
- Reliability hangs in balance
- Surge in demand may lead to significant shortages
- Timing of regulations affect regions differently
- Belief, not engineering, leads the way



And over in Germany...

- Energiewende to eliminate coal and nuclear as a social policy
- Wholesale prices down steadily while consumers bear the impact: 40 cents/kWh
- Blown up the utility business
- 800-900 DSOs
- 4 TSOs (owned by foreign entities)
- 1.8 million generators
- Reliant on assets of other countries



Destiny of intelligent infrastructure

- \$50 billion will be spent in next 5 years in T&D
- How smart grid will change load profile is critical
- The enabler for energy efficiency and demand response
- How customers interact with the system is key



My unpopular Smart Grid theory

- 80% of the benefits of intelligent infrastructure will initially accrue to the utility
- Consumer participation will be initially low
- Hype will hurt the efforts
- Utilities will move to smart grid because it makes sense
- Utilities will not get significant benefits unless they make major process changes



Choice vs. risk



Home tech drives smart grid benefits

4.92 billion wireless devices globally / 66% penetration

Source: Hootsuite, January 2017



Water-energy nexus

Project	Annual H ₂ O need (gallons)
Genesis Solar	536 million
Mojave Solar	705 million



Economic challenge

How can we manage in a
Twitter-centric world?



Radical thoughts...

- kWh is dead
- All-you-can-eat electricity
- Time-of-purchase rates
NOT time-of-use rates
- Utility is the network
provider
- Markets replace IRPs



Key takeaways

The industry is changing at a rapid pace.
There are no indications of it slowing.
We need the best and the brightest to stay ahead
and remain competitive.



Contact/follow me

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