

Electric Perspectives

Hillhouse Club

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Mark A. Gabriel
Administrator and CEO

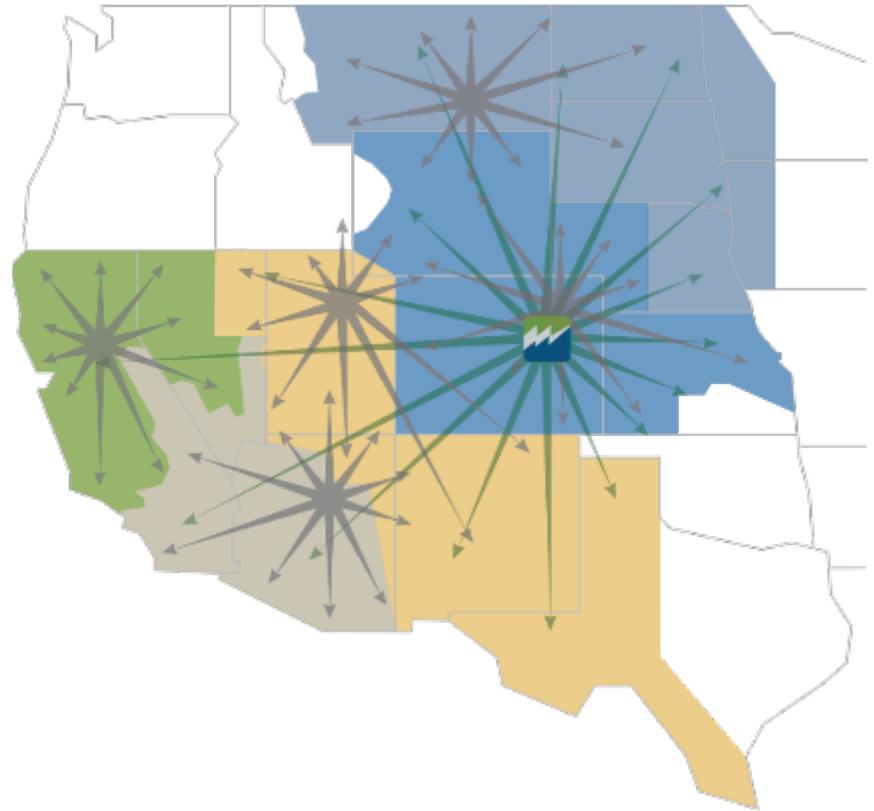
My perspective

- 30 years in electric industry (plus gas, oil and water)
- 8 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



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

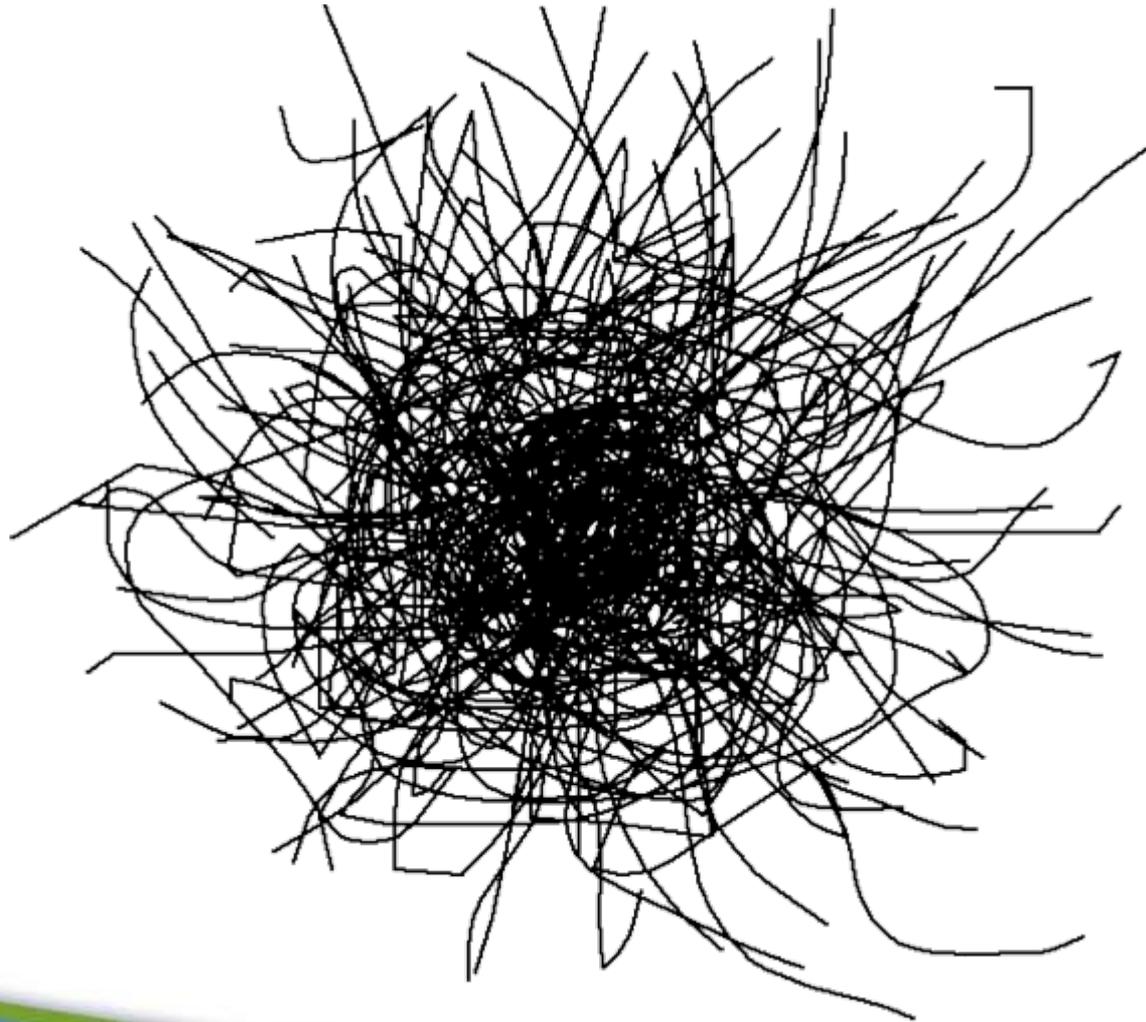


What we manage

- \$4.3 billion in assets
- 114,863 structures
- 17,231 miles of transmission line
- 322 substations
- 291 transformers
- 661 buildings
- 487 communication sites

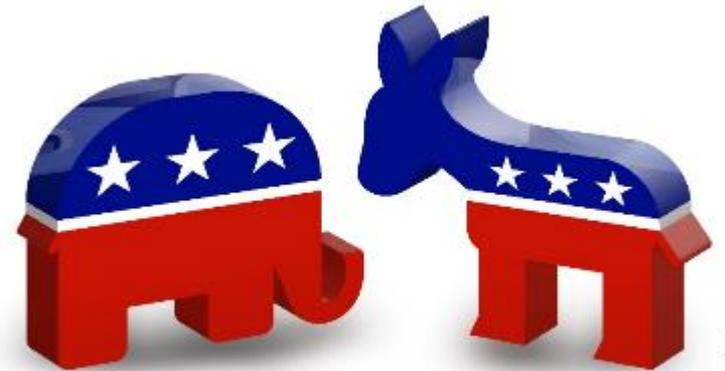
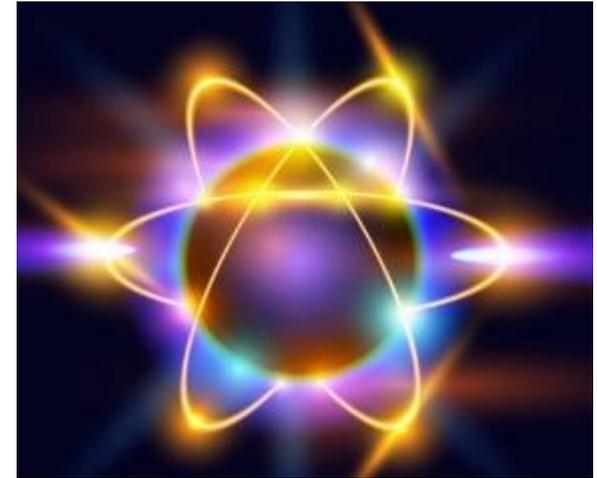


Untangling giant hairball of electricity



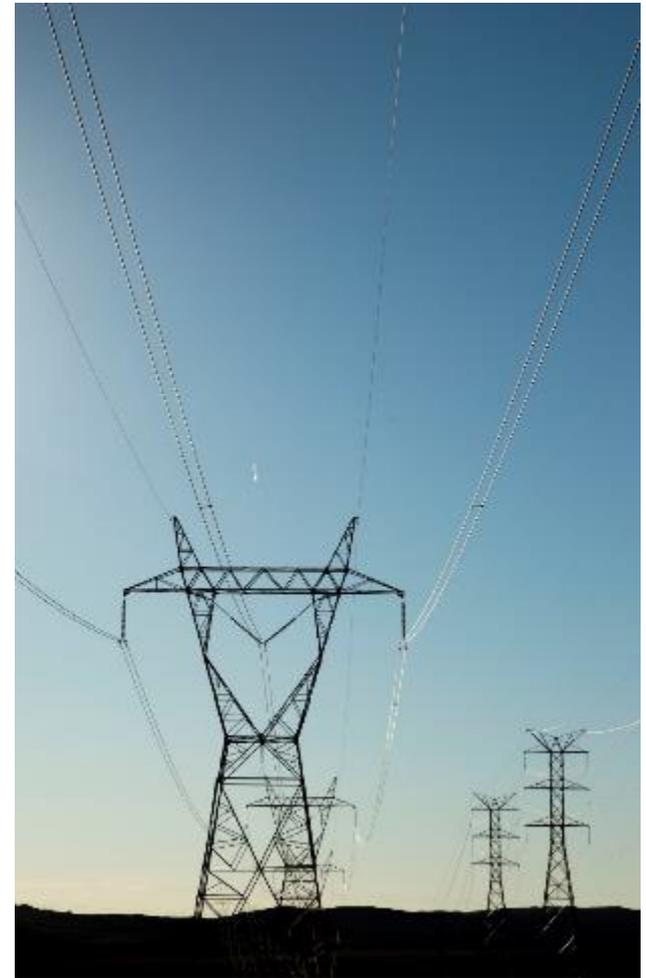
Basic rules of electricity

- 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



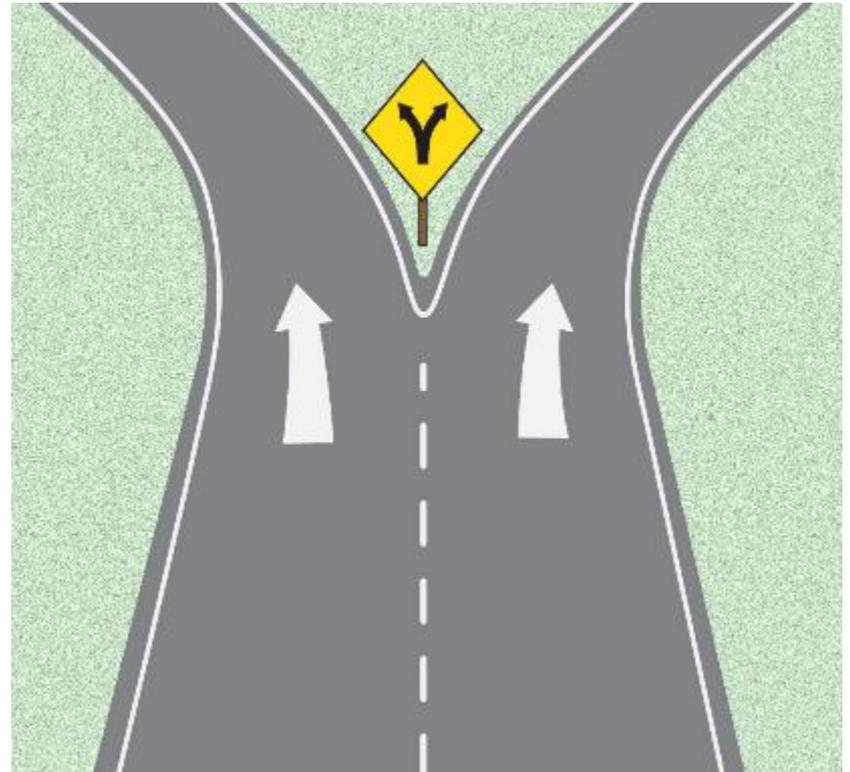
Build it bigger

- 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



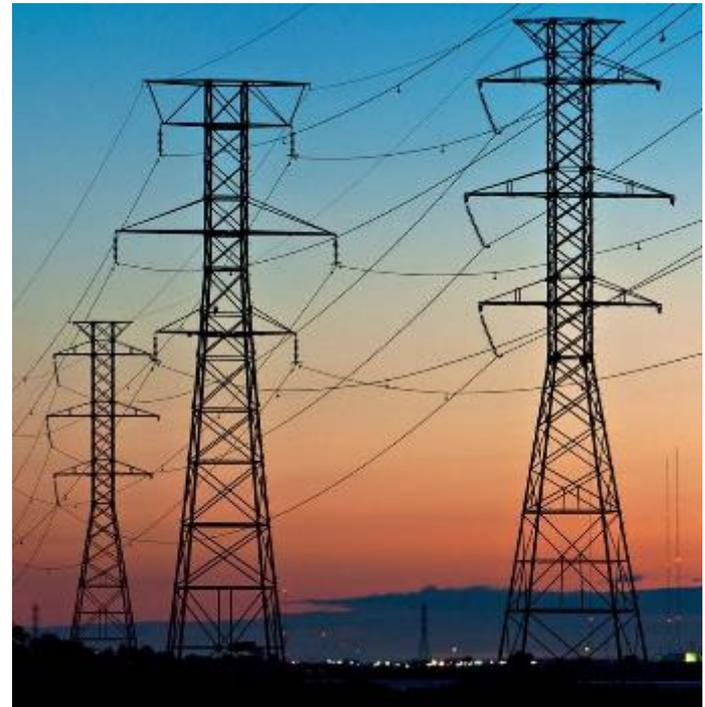
Challenges in the energy frontier

- Aging infrastructure
- Increased regulation
- Intermittent resources
- Varying hydropower production
- More customer-side resources
- Changing markets
- Security



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



Megatrend: Carbon/Capacity Conflict

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



California is ground zero for the carbon/capacity conflict

- IMHO, there is plenty of blame to go around
- Improper incentives lead to poor choices
- Crushed energy prices constrain capital
- Keeping the lights on is a physics & engineering challenge, not a political decision



*Paradise, CA, destruction from 2018 Camp Fire
Courtesy of NBC News*

California wildfires 5-year overview

Year	Acres Burned	Number of Fires	Loss of Life	Structures Damaged or Destroyed
2019	259,823	7,860	3	732
2018	1,963,101	7,639	100	24,226
2017	1,548,429	9,270	47	10,280
2016	669,534	6,954	6	1,274
2015	880,899	8,283	7	3,159

Importance of vegetation management



Before



After

ROW reclamation



- Removing incompatible species
- Promoting low-growing, fire-resistant plant communities



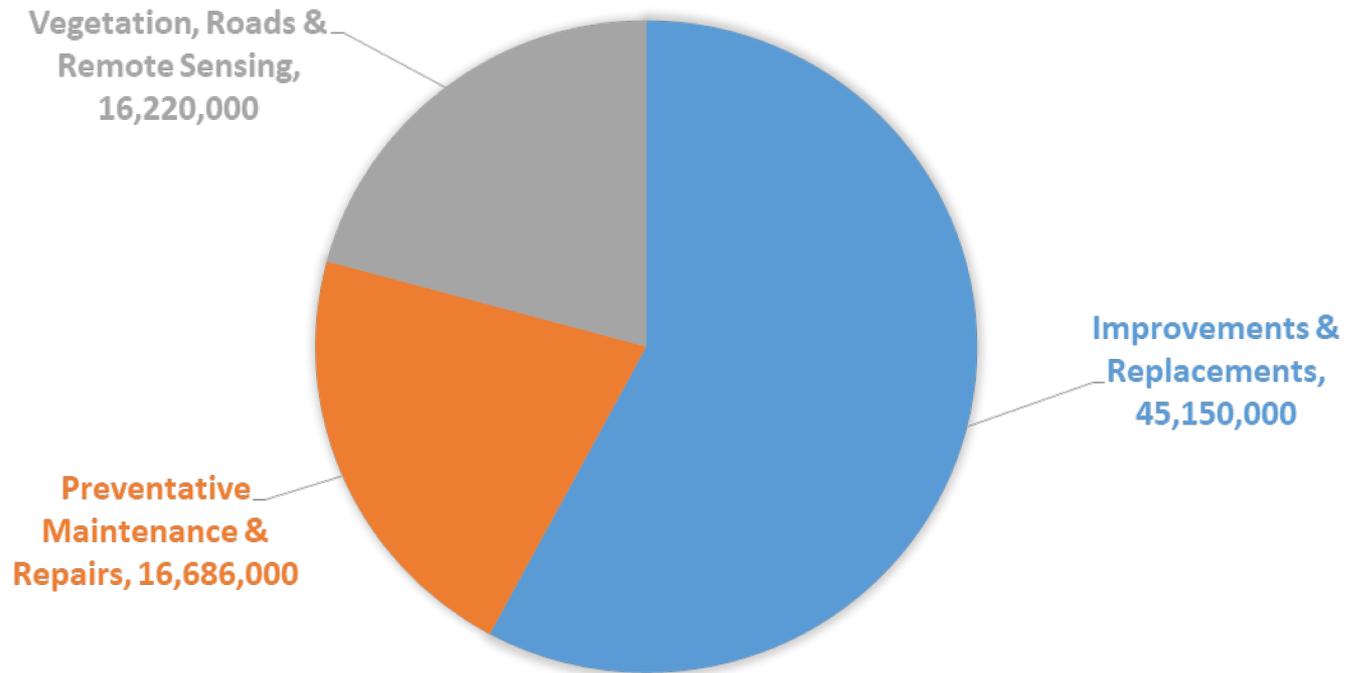
WAPA's wildfire mitigation plan

- Prevent, combat and respond to wildfires
- Minimize probability of being the origin or contributing source
- Communication protocols regarding potential de-energization of lines
- Details operation and maintenance procedures to mitigate wildfires



Re-investing in assets & managing grid

5-YEAR REINVESTMENT TOTAL



2018 Carr Fire



Impact on WAPA



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!

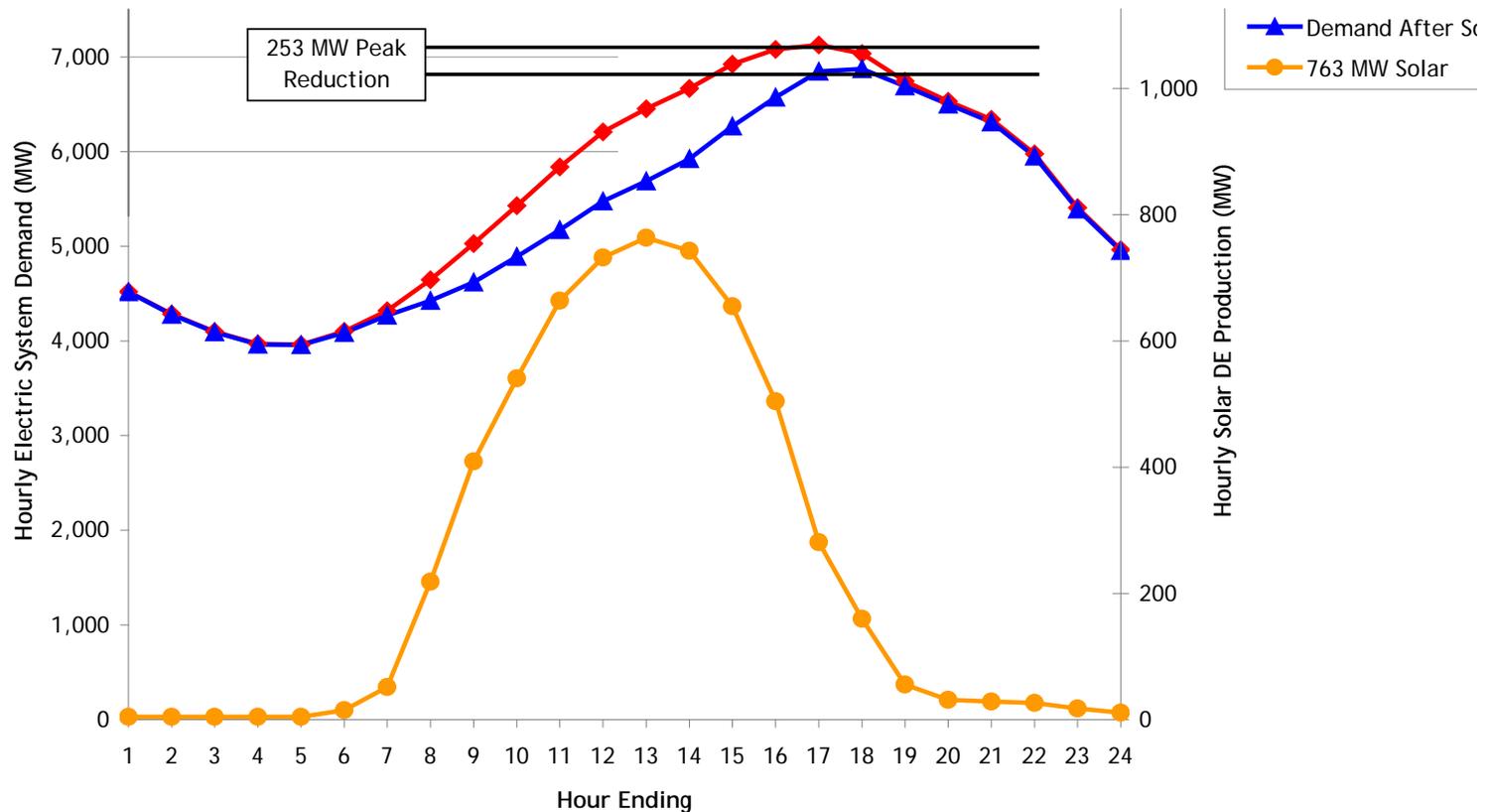
Energy vs capacity



The physics barrier is real

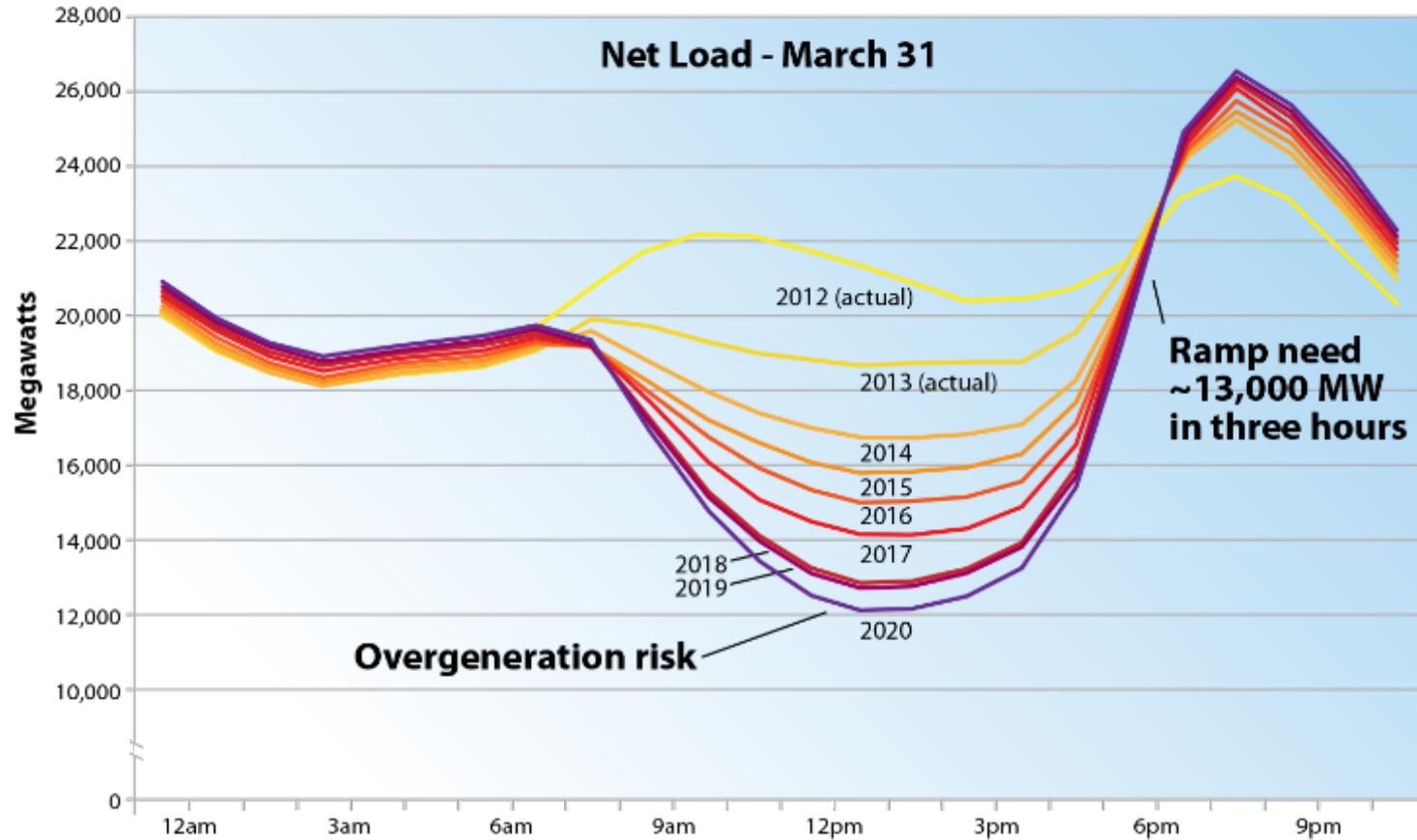
The Solar/Peak Conundrum

(even in Arizona)



California duck curve

California Independent System Operator Duck Curve

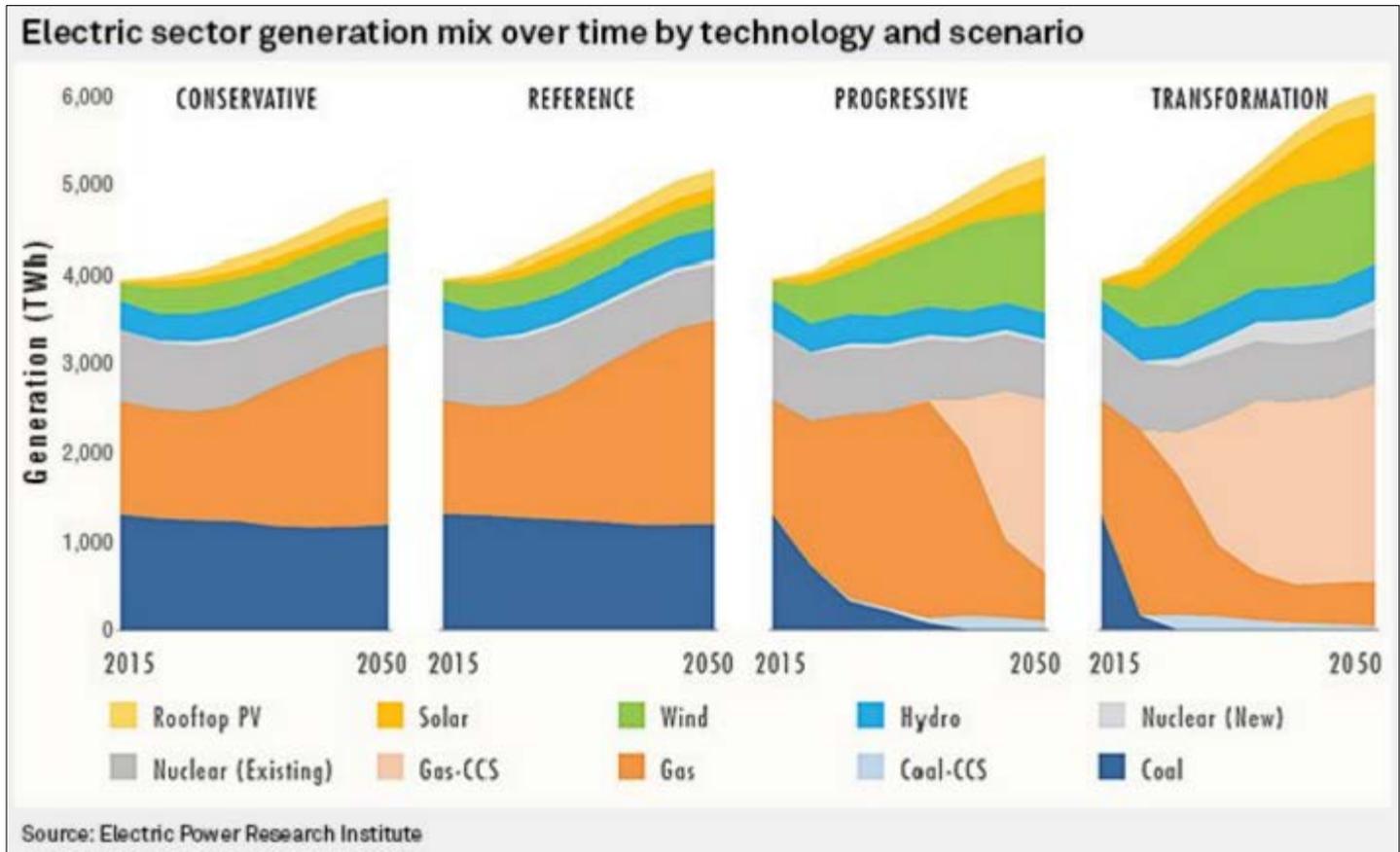


Fundamental change

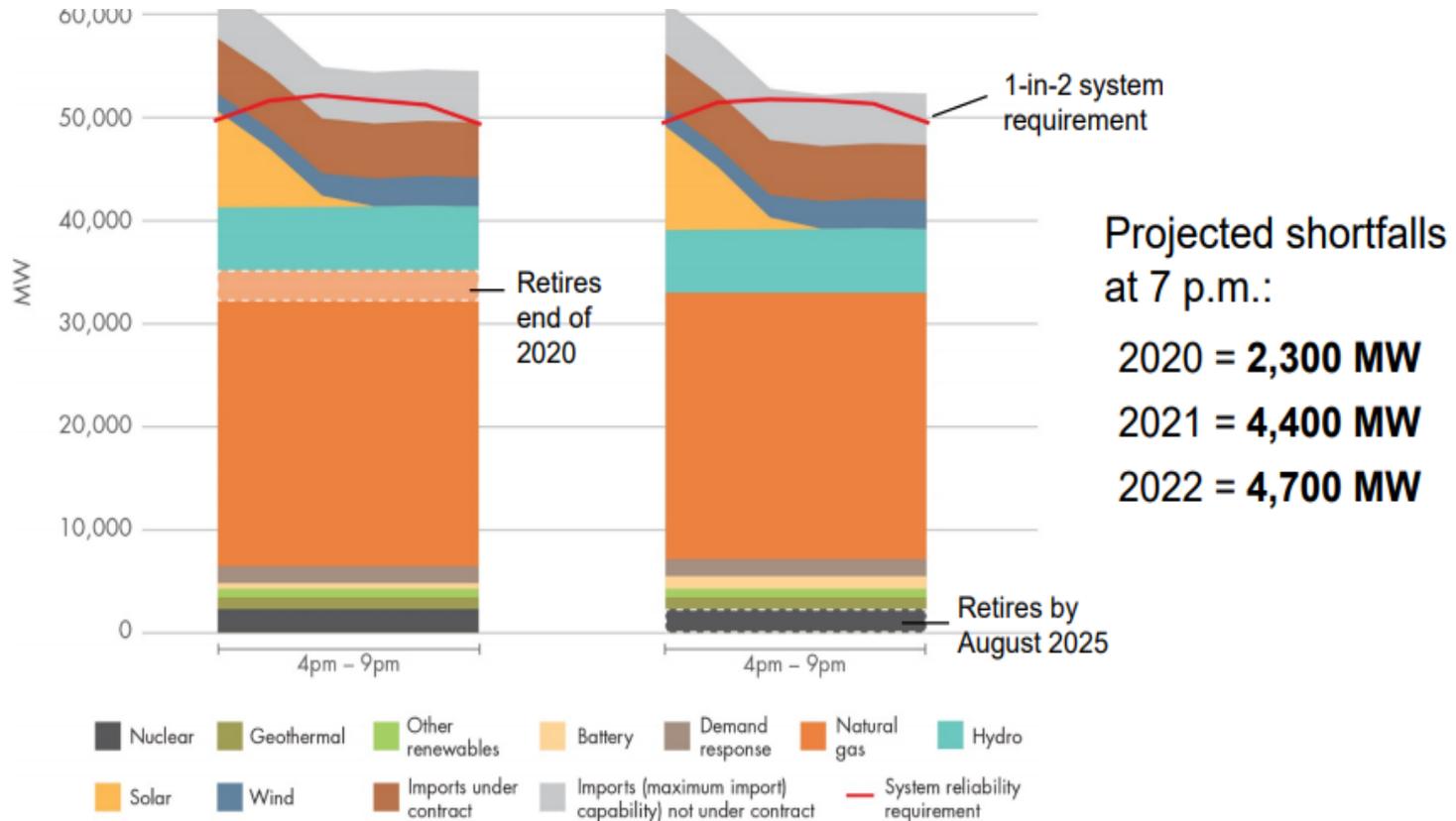
The challenge for the utility of today is not only what is real but what is perceived as real.



Generation mix



CAISO's expected resource shortage



¹ Assumes no transmission outages or other significant events affecting availability of generation

Change is upon us

NEW WIND-PENETRATION RECORD

71.3%
AT 3:15 A.M.
FEB. 3, 2020

 **SPP** *Southwest
Power Pool*

USVI Solar Farm post hurricane

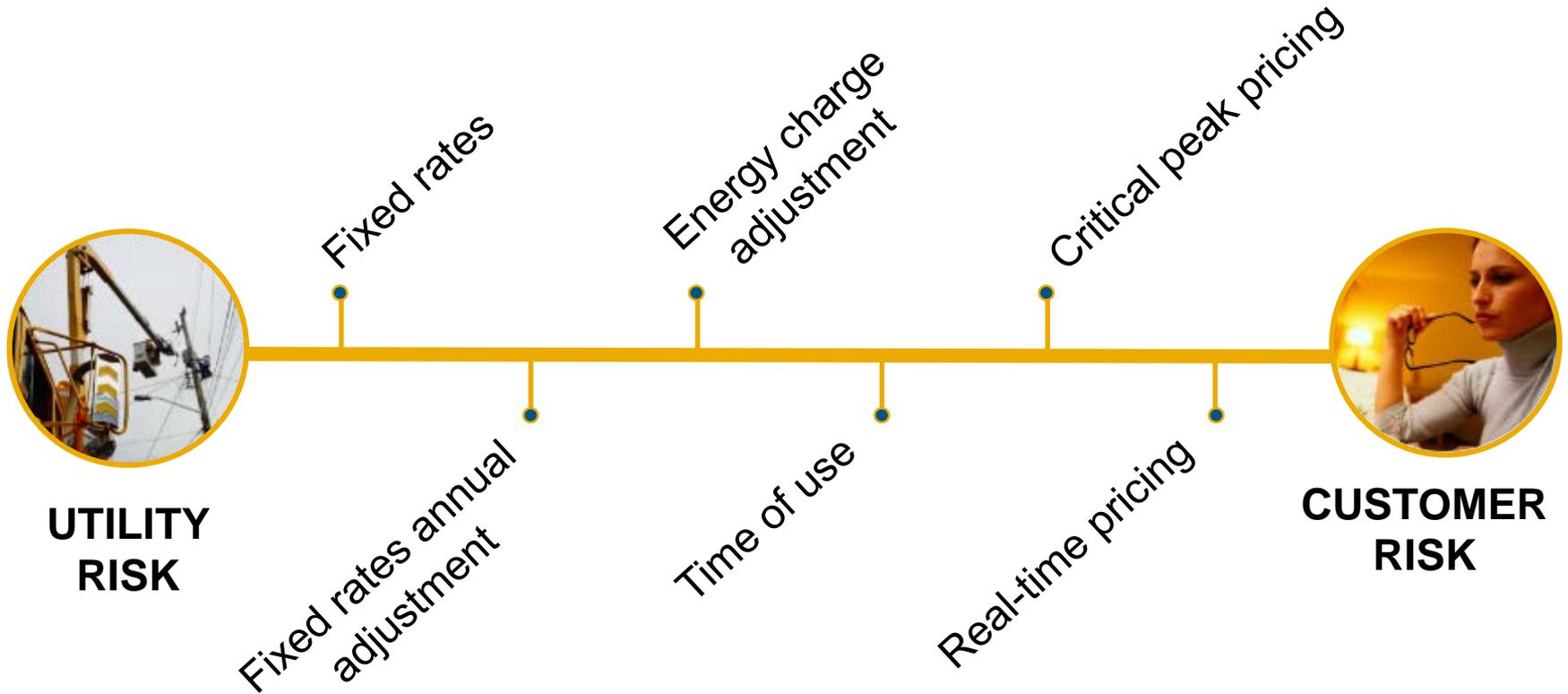


Contrasting world views

- 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



Choice vs. risk



Distributed generation

- Generation at point of consumption
- Increase dispatch and accessibility
- Retail driven
- Risks:
 - Diseconomies of scale
 - Strand existing assets



Home tech drives smart grid benefits

4.92 billion wireless devices globally / 66% penetration

Source: *Hootsuite, January 2017*



Storage scale

- WAPA has 10,000 MW of nameplate capacity
- 1 tractor trailer = 1 MW of storage
- Battery life = 4 hours
- Need 60,000 trailers to replace WAPA's hydro capacity



EV trip: New York to Florida

- 40 gallons of gasoline
- 286 pounds of coal
- 2,500 cubic feet of natural gas
- 7 days of 10-kW rooftop array
- 33 minutes of giant offshore wind turbine



Renewable vs carbon free

Renewable

- Wind
- Solar
- Biomass/gas
- Geothermal

Emissions free

- Wind
- Solar
- Biomass/gas
- Geothermal
- Hydropower
- Nuclear

Societal changes

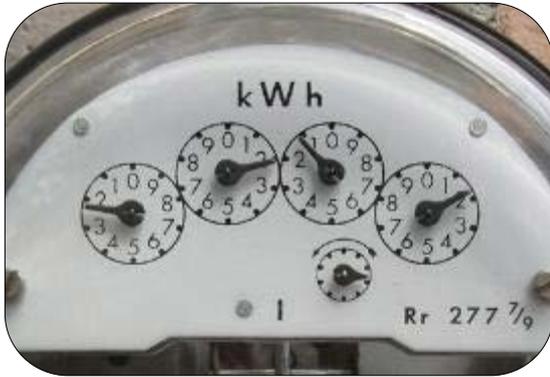


Economic challenge

How can we manage in a Twitter–centric world?



Radical thoughts



The kilowatt-hour
is dead



Time-of-purchase
vs. time-of-use



All-you-can-eat
energy

Key takeaways

The industry is changing at a rapid pace.
There is no microgrid without a macrogrid.
100% carbon free versus 100% renewable.
We need the best and the brightest to stay ahead
and remain competitive.



Contact/follow me

Mark A. Gabriel

720.962.7705

gabriel@wapa.gov



wapa.gov



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