

# **Innovation & disruption at the grid's edge**

**CSIRO conference**

30 Nov 2017

Newcastle, NSW

**Fereidoon P. Sioshansi, Ph.D.**

**Menlo Energy Economics**

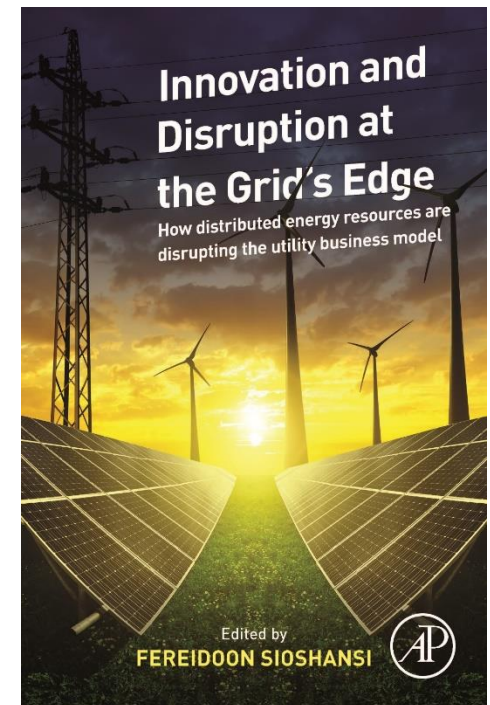
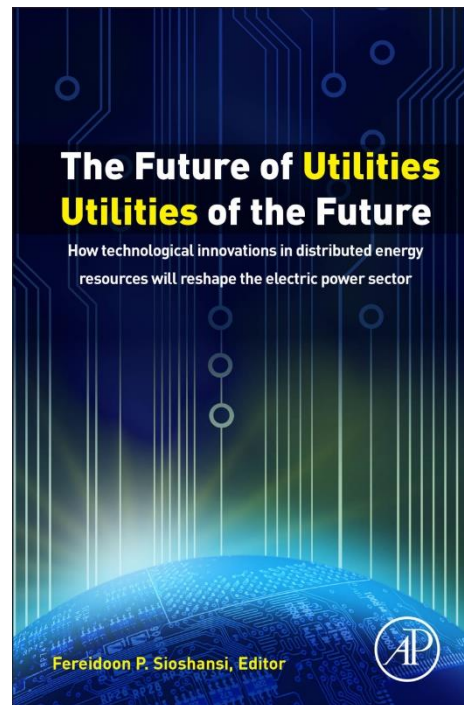
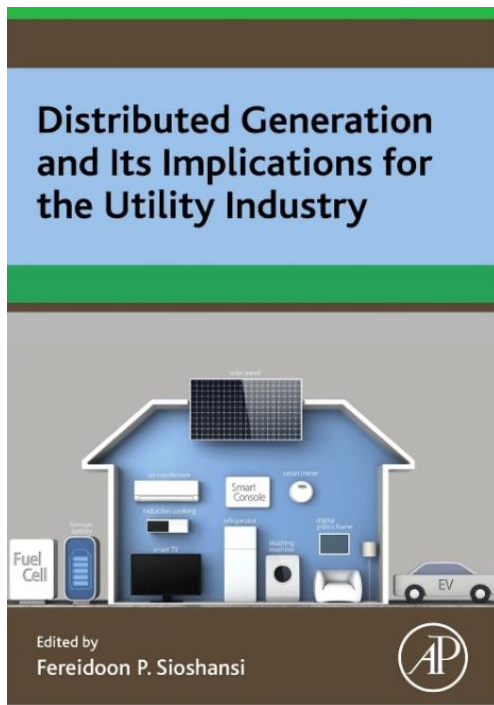
San Francisco CA

[www.menloenergy.com](http://www.menloenergy.com)

# Thank you

- ♦ First
  - Thanks to organizers for including me
- ♦ Second
  - ♦ NOT a micro-grid guru, have been “adopted”
- ♦ Third
  - Strongly influenced by recent work ...
  - ... will speculate on how innovation leads to disruption ...
  - ... and how the evolution of distributed generation, storage and similar developments impact traditional utility business models

# On my mind lately ...



# Main message

- ◆ Product & service **innovation** => **disruption**
  - Implications?
  - **Customer stratification**
  - New mindset for services, pricing & regulation
- ◆ Future of storage, like everything else, is **not** in hardware
  - Implications?
  - Value is mostly in intelligence & mgmt. of flows
  - How will micro-grids take advantage of emerging opportunities
  - How do micro-grids fit in?

# Outline

- ♦ 1<sup>st</sup> – Context
  - Innovation => disruption => customer stratification
- ♦ 2<sup>nd</sup> – Emerging role of storage
  - Preaching to the choir
- ♦ 3<sup>rd</sup> – Where is the value?
  - Who/how can it best be monetized?

# Disrupters hard at work

or hardly working?



Source: <http://www.yeloha.com/about>

# New electric company: Your home

Wall Street Journal 21 Jan 2015





# **ZNE house: Not rocket science**

CA 2020 mandate for new residential, 2030 commercial





# ZNE village: Ditto

West Village, Univ. CA Davis



# ZNE campus: Why not?

Office parks, shopping malls, hospitals, universities, whole cities



Source: NREL



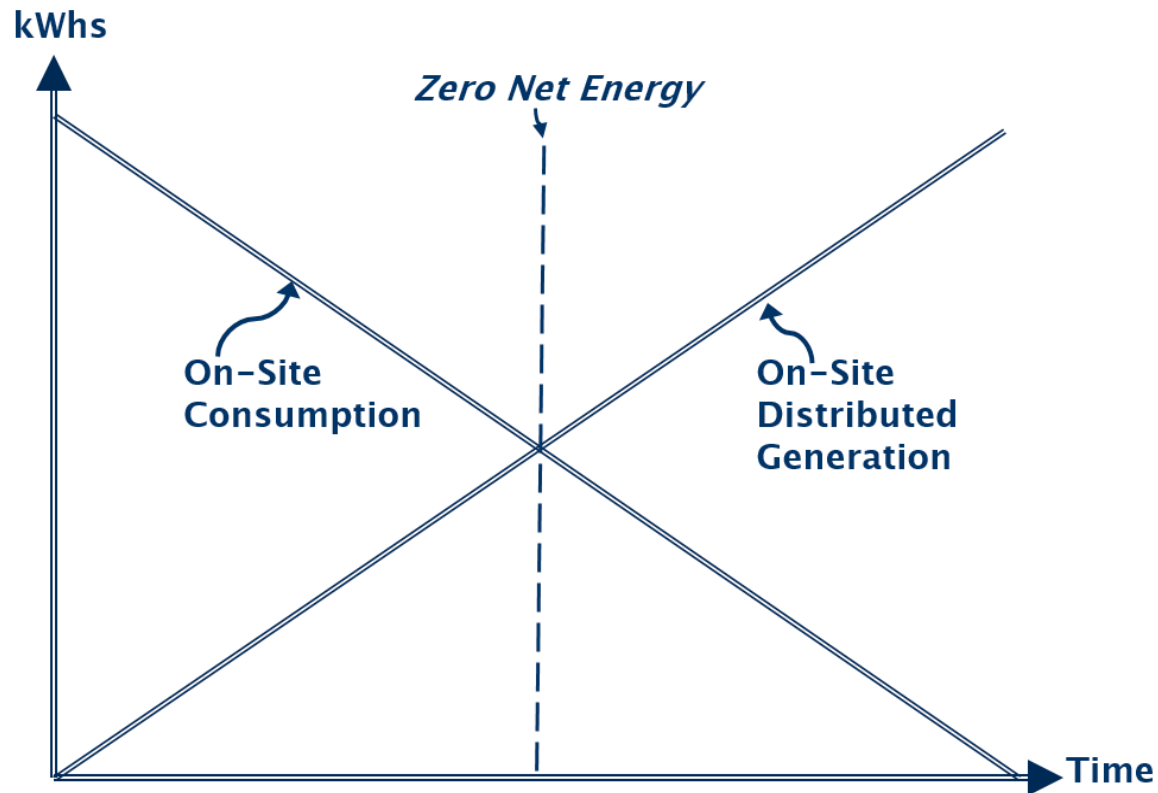
# ZNE office

Apple's new headquarter going beyond ZNE



# Zero Net Energy

Will apply to new residential buildings in CA starting 2020



# **Distributed solar**

**1 in 3 homes in Queensland are solar**





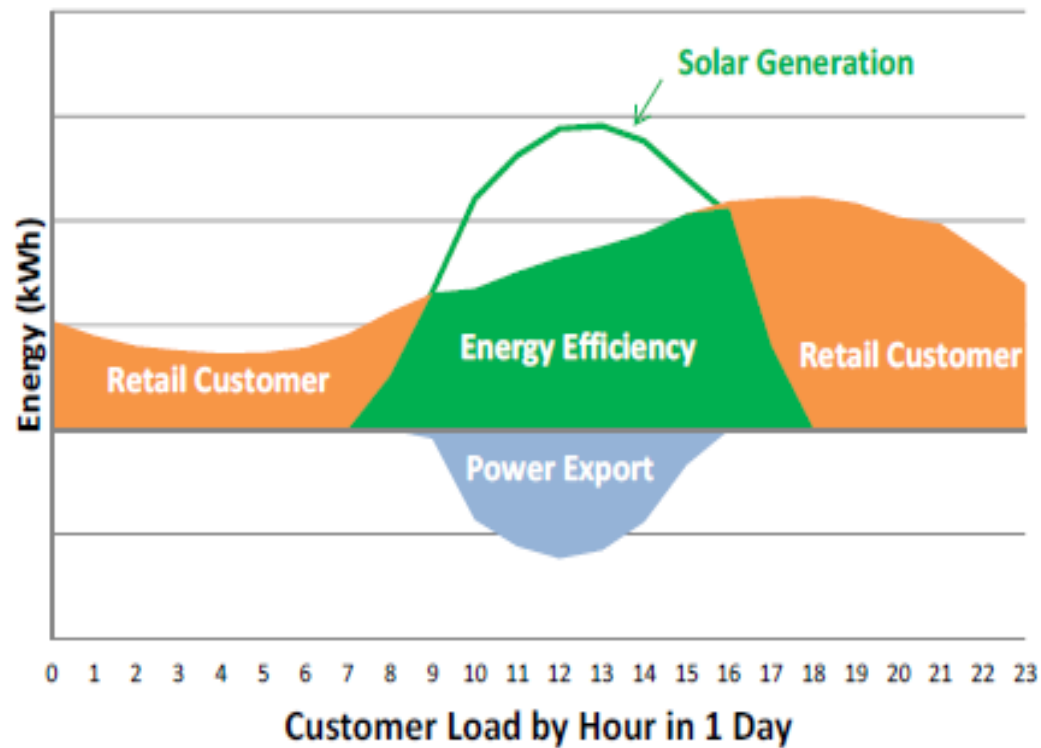
# Beyond ZNE: Solar ordinance

City of Lancaster, CA: 2 W per sq. ft. living space





# Consumer => Prosumer



Source: Evaluating the benefits and costs of NEM laws in California, prepared for Vote Solar, Jan 2013

# What comes after posumer?

Add storage and you get “prosumager”



Source: The Wall Street Journal 2 May 2015

# Distributed storage

Tesla's \$5 billion gigafactory near Reno, NV



# BIPVs

Turning exteriors of buildings into powerhouses



Source: Onyx



# BIPVs

Entire surface of buildings generates power



Source: Skanska

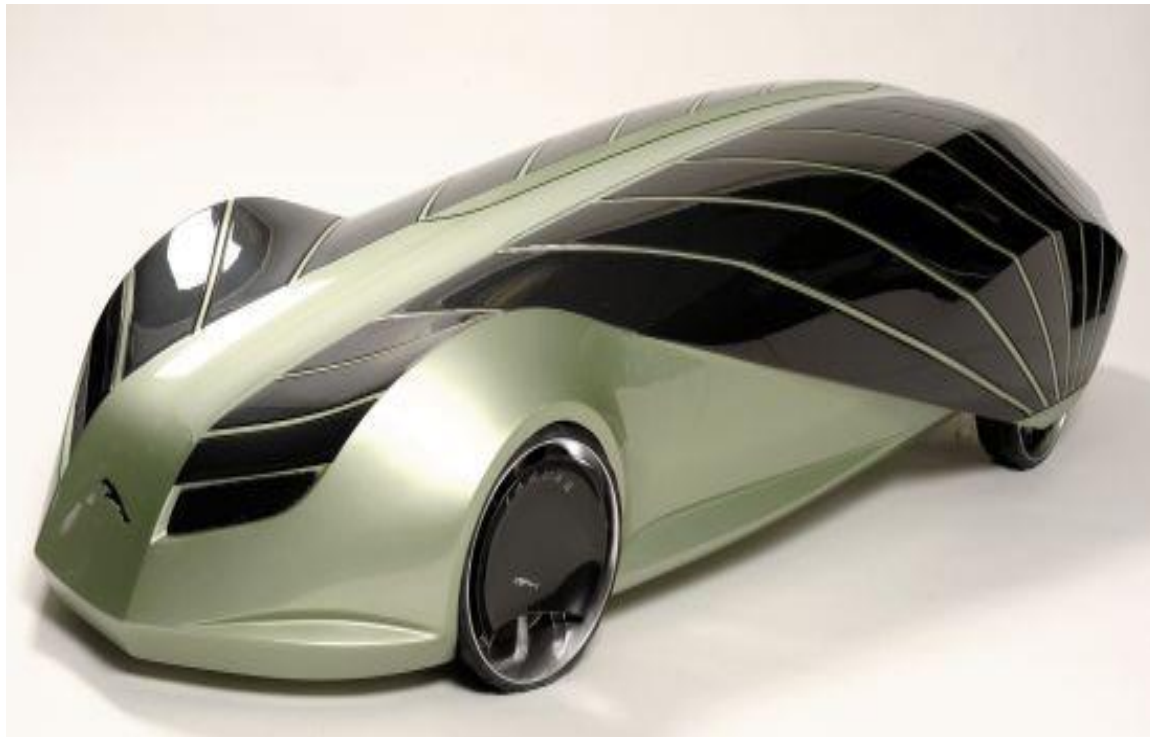
# Solar car



Source: RenewEconomy showing Univ. of Adelaide entry in solar race



# Solar “augmentation”



Jaguar solar concept car, *The Energy Post*, 26 Oct 2017

# Solar tiles

In any color you like



# Solar Block



Source: Univ. of Exeter

# Solar window

Clearly electric



Source: [solarwindow.com](http://solarwindow.com)

# Buckingham Palace



Source: Aurora Solar



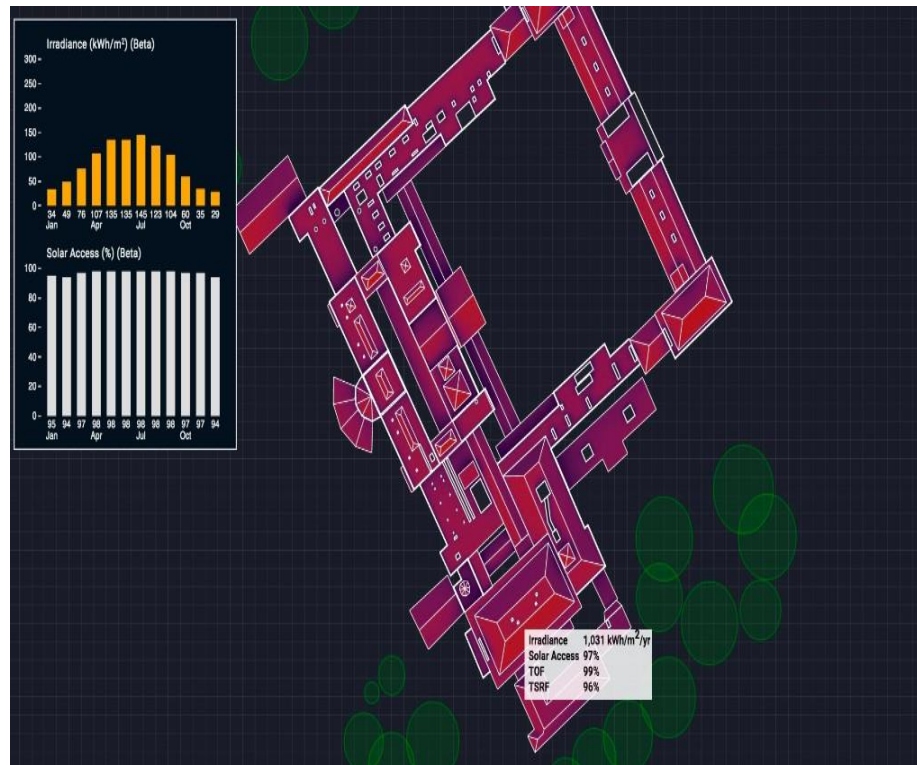
# Solar fit for the queen



Source: Aurora Solar



# Optimally designed



Source: Aurora Solar

# Portable solar



Source: [SolarPad.com](https://solarpad.com)

# Integrated services?

Tesla energy: PVs, EVs & storage



Source: Tesla unveils residential solar roof and new Powerwall battery, Utility Dive, 28 Oct 2016

# Customer stratification

- ◆ Over time consumers will self-select
- ◆ Based on
  - Retail tariffs
  - Regulations/policy
  - Product & service innovation
- ◆ And this leads to “stratification”
  - Regulated “bundled service option” may not fit all

# What is there not to like?

High tiered tariffs, zero money down, generous NEM, lots of sun



The advertisement features a comparison of two electric bills. On the left, under the heading 'Before', is a bill from 'electricbill' with a 'Monthly Bill' of \$303.89 circled in red. On the right, under the heading 'After', is a similar bill with a 'Monthly Bill' of \$69.10 circled in green. Below the bills, a call to action is provided with a list of benefits and a button for quotes.

**Home Solar Rebates**

Lower Your Electric Bills By Going Solar!

**Before**

**After**

**electricbill**

**Account Summary**

Item	Amount
Bill for 09/16/15	-\$314.23
Payment Received 09/20/15	-\$314.23
Bill for 10/16/15	-\$303.91
Payment Received 10/19/15	-\$303.91

**Monthly Bill**  
**\$303.89**

**electricbill**

**Account Summary**

Item	Amount
Bill for 09/16/15	-\$30.15
Payment Received 09/20/15	-\$30.15
Bill for 10/16/15	-\$26.55
Payment Received 10/19/15	-\$26.55

**Monthly Bill**  
**\$69.10**

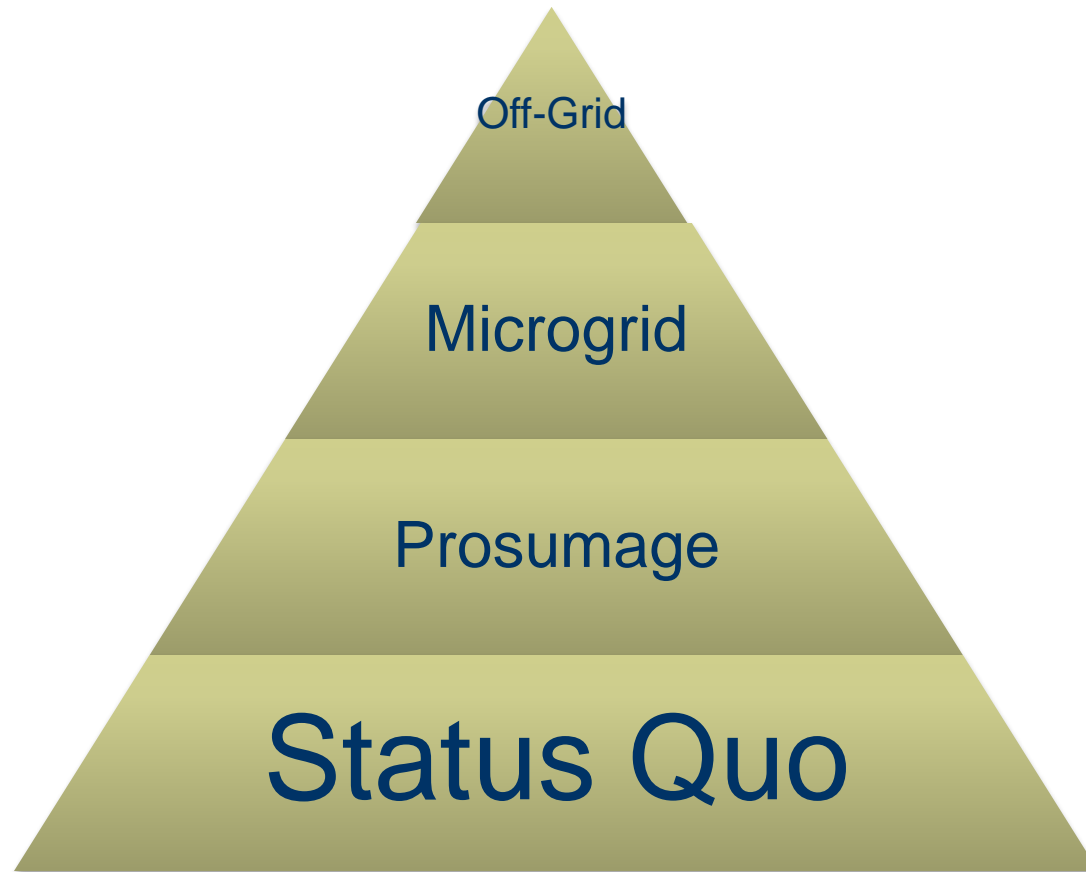
**Find out how much you can save today!**

- ✓ Limited-Time 2015 Solar Rebates Available Now
- ✓ \$0 Down Leasing for Qualified Homeowners
- ✓ Protect Against Rising Energy Costs

**Click Here For FREE Quotes**

# Customer stratification

Over time, consumers will self-select what works best





# New interface/relationship

- |              |  |
|--------------|--|
| Consumers    | Content with status quo: Bundled, regulated tariffs<br>ALL kWhs provided by/thru existing network<br>Maintain existing relationship/interface/tariffs  |
| Prosumers    | Take few/fewer <i>net</i> kWhs from network<br>Require different pricing/service relationship  |
| Prosumagers  | Ditto, but even more so<br>Radically different pricing/service/interface relationship  |
| More exotic? | Service aggregated/enabled/assisted by intermediaries<br>Semi-autonomous micro-grids<br>P2P trading & transactive energy<br>Integrated energy services |

# What about variable generation?

Sept 2017 in Denmark, Oct in Germany



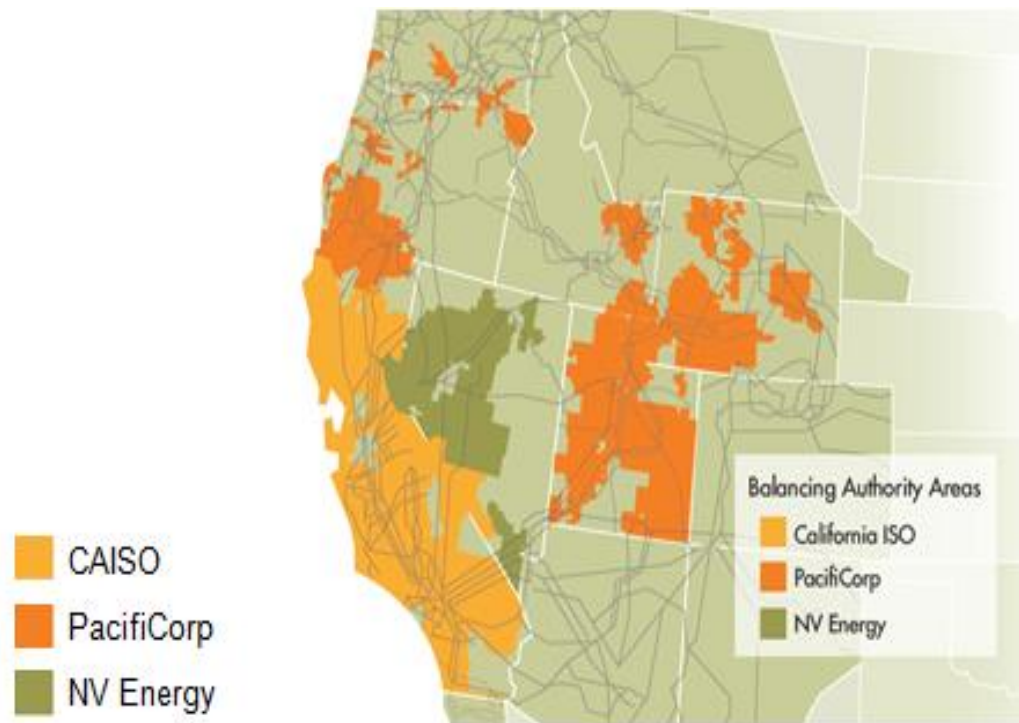
Source:  
<https://www.thelocal.dk/userdata/images/article/fc302fc903eabe253d96b20f5d72be8c79a4dc486ddf6559f5957ffc648951b7.jpg>

# The options?

- ◆ Diversified portfolio/Expanded footprint
  - CAISO's Energy Imbalance Market (EIM)
  - Supergrids allow expanded geographic footprint
- ◆ Get demand to tango with generation
  - Demand response/variable pricing
- ◆ Storage
  - Wide spectrum of options
  - Centralized/utility-scale
  - Decentralized, aggregated & enabled

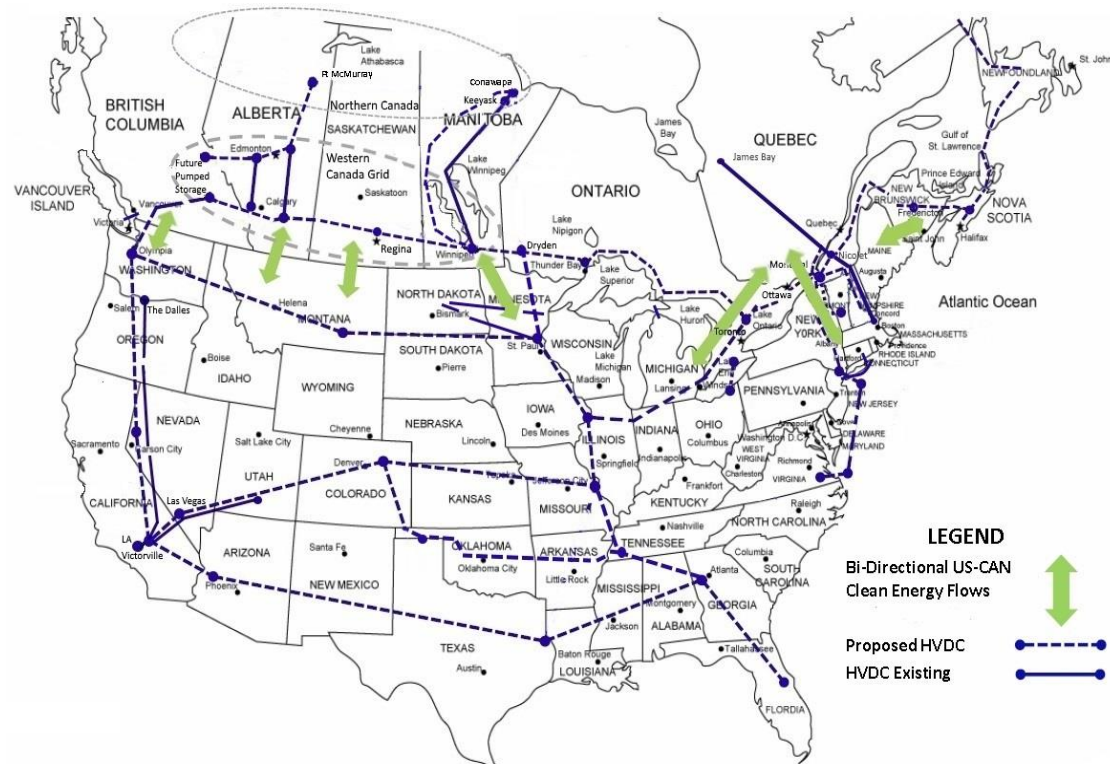
# Lean on neighbors

## CAISO's expanding EIM



Source: CAISO

# Supergrid



Map courtesy of Dennis Woodford & MISO



# Get demand to Tango with generation

Next Kraftwerke, Cologne, Germany



Source: <https://www.next-kraftwerke.com/wp-content/uploads/2015/09/Next-Kraftwerke-Building.jpg>

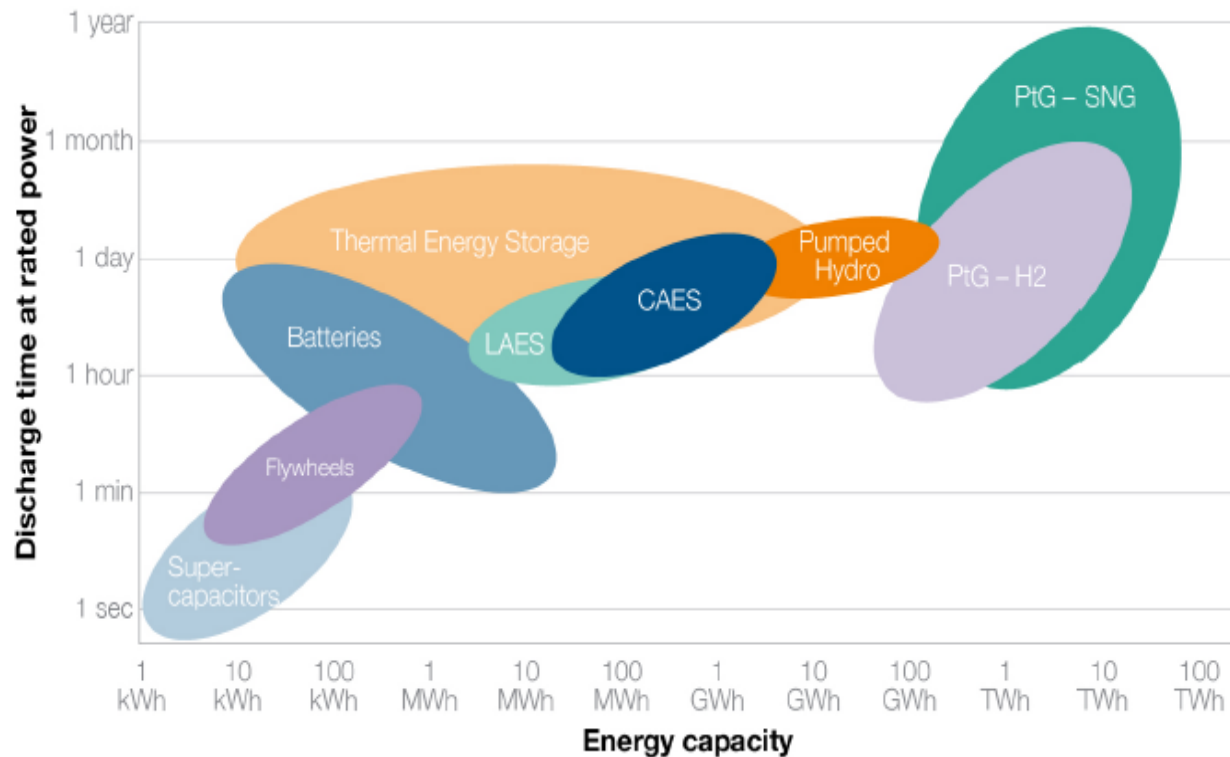
# It takes two to Tango



Source: <https://www.cleanenergywire.org/sites/default/files/images/dossier/50-hertz-transmission-control-centre.jpg>

# Storage is more than batteries

From MWs & multiple MWhrs to kW & milliseconds

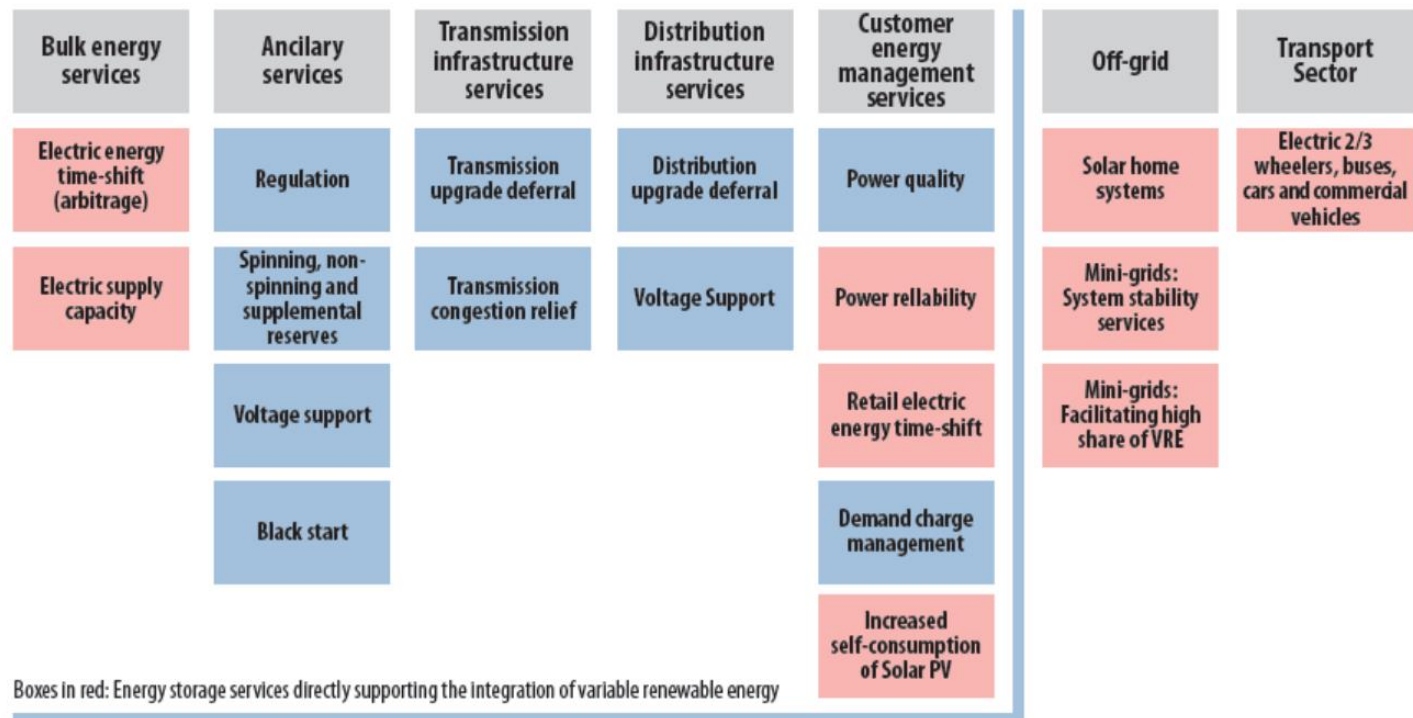


Source: World Energy Council, E-Storage: Shifting from cost to value, 2016

# Storage spectrum

From milliseconds to months & longer

## The range of services that can be provided by electricity storage



Source: Electricity storage & renewables, IRENA, Oct 2017

# Distributed, aggregated & enabled

## Sonnen's project in Prescott, AZ



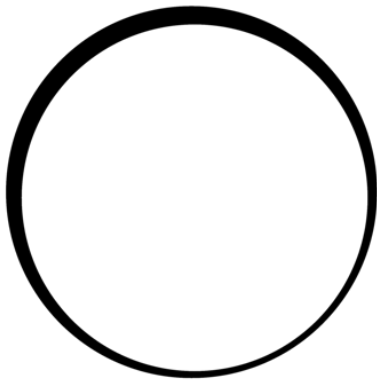
Source: <https://www.mapsofworld.com/usa/states/arizona/maps/arizona-state-map.jpg>



# Power of aggregation

- ◆ Sonnen's community of 3,000 homes
  - 11.6 MW capacity; 23 MWh potential output 23
- ◆ Next Kraftwerke
  - 3.4 GW from 4,824 participants
- ◆ What comes next?
  - Scaling up; you do the math

# Who is in this space, today?



sonnen



stem

# Where is the value?

- ◆ Not in the batteries

# Flower analogy instructive



## Who makes money in flower delivery business?

- ◆ **Not** the farmer who grows flowers in Kenya
- ◆ **Not** the airline that flies it to Europe/US
- ◆ **Not** the wholesaler or the auctioneer
- ◆ **Not** the distributor who delivers to shop
- ◆ **Not** the shop owner who arranges flowers
- ◆ **Not** the delivery man who drops it at door
- ◆ But the one who takes the order, collects money & manages delivery: Think Uber



# Ditto for storage business

... or, for that matter any other business

- ◆ Not the battery manufacturer
- ◆ Not the distributor
- ◆ Not the installer
- ◆ But the company that
  - Aggregates storage capacity of many devices
  - Manages when & how much energy is stored
  - Manages when & how much is released
  - Monetizes & maximizes value along the value chain