

Microgrids: Relevant aspects for Europe¹ from a ~~US-American~~ Californian viewpoint

presentation at the
1st International Symposium on
“Distributed Generation and Smart Grids”
TECHbase Vienna, Austria

18-19 October 2006

by

Chris Marnay

C_Marnay@lbl.gov - <http://der.lbl.gov>

research supported by the U.S. Dept of Energy and the California Energy Commission

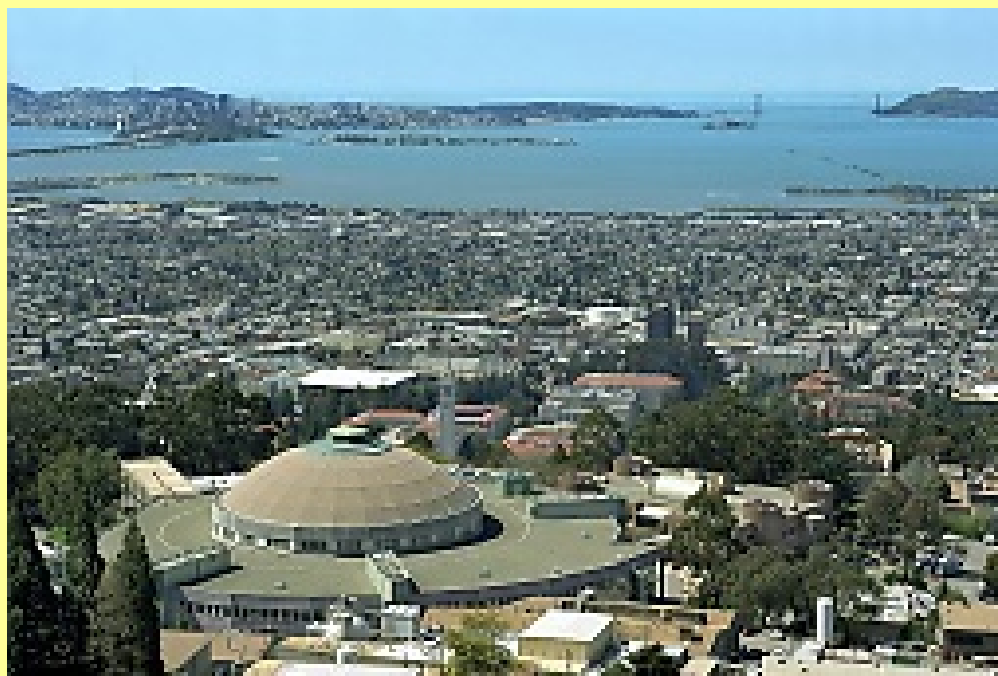


Environmental Energy Technologies Division

Ernest Orlando Lawrence Berkeley National Laboratory

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- U.S. Department of Energy research laboratory
- managed by the University of California, increasingly funded by the State of California
- ~4000 employees
- ~~10~~ 11 Nobel Laureates
- no classified research
*visiting researchers
from around the world
always welcome*



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Outline

1. Why California IS Different!
2. Two Competing Visions of Our Future Power System
3. Homogeneous & Heterogeneous Security, Quality, Reliability, & Availability (SQRA)
4. Introduction to the CERTS Microgrid



California Energy Sketch

- **population: currently ~ 37.5 million, 1.5 %/a growth**
 - L. A. basin: 16 M, Bay Area: 7 M, San Diego Co.: 3 M
 - area: 411 000 km² or > 90 c/km² (Japan ~ 340)
- **growing total energy use (32.5 million vehicles)**
- **total electricity sales ~270 TWh/a**
- **almost 1000 power plants, 63 GW total capacity**
- **dependent on imported energy**
 - 12.5% of U.S. population, 12% of oil production, 2% of NG
 - 12% of power generation still from instate hydro
 - some traditional sources declining, e.g. Pacific Northwest electricity
 - history of energy problems, e.g. 2000-2001 electricity market fiasco
 - strong environmental and efficiency policies



When California is a country...

Country**	kgC/2000\$GDP
China	0.738
Brazil	0.197
Canada	0.197
United States	0.151
Germany	0.124
Italy	0.112
United Kingdom	0.096
California*	0.089
Japan	0.067

Country**	tC/capita-yr
United States	5.7
Canada	4.8
California*	3.5
Germany	2.8
Japan	2.6
United Kingdom	2.5
Italy	2.1
France	1.8
China	0.8
Brazil	0.7

* including coal power generation out-of-state

** selected countries

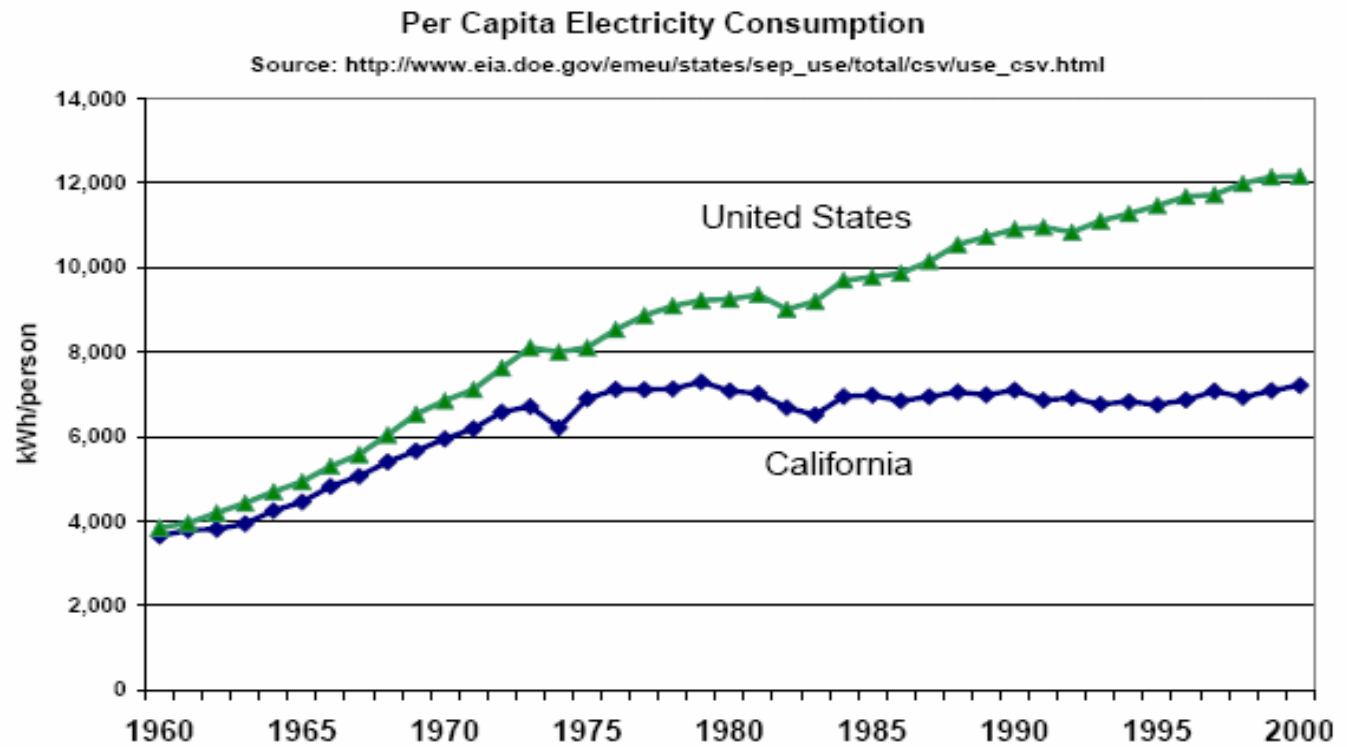
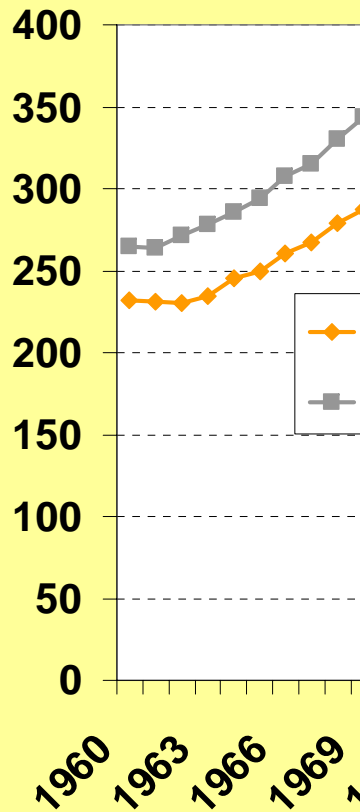
sources: GDP and Fossil-Fuel CO₂ – IEA; California GSP- US Dept. of Commerce; California CO₂ – California Energy Commission, out of state emissions, Price, et al, 2002, population: U.S. Census



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California per capita Energy Consumption is Lower than U.S.

GJ/person/a



California Global Warming Solutions Act (2006)

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Chronicle / Frederic Larson



Chronicle / Frederic Larson

- return to 1990 GHG emissions rate by 2020
- declining cap and trade 2012-2020
- compulsory reporting and compliance
- California Air Resources Board to implement
- regulations to be in place by 1 Jan 2008

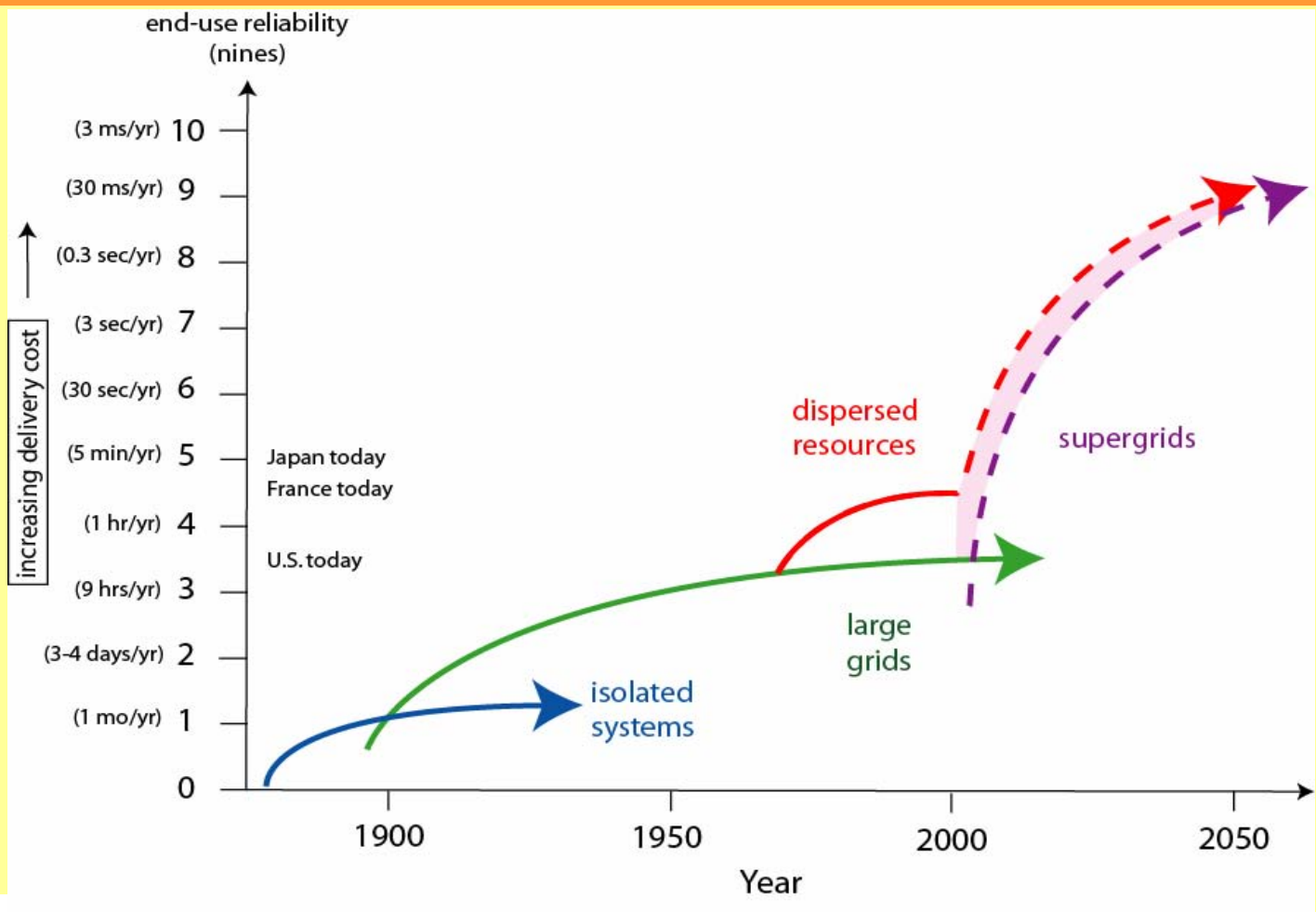
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2. Two Competing Visions of Our Future Power System

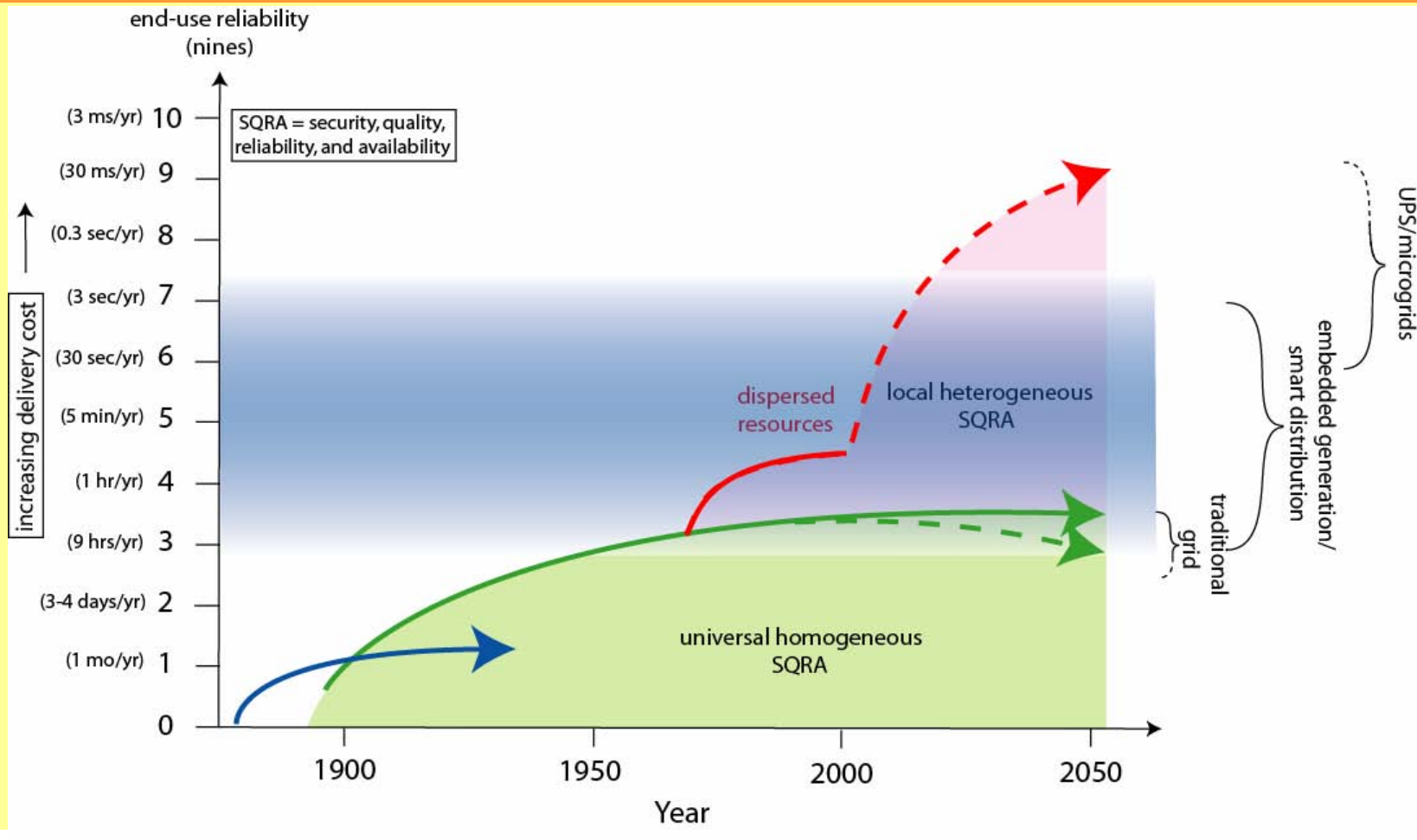


Super Grid Vision (a near perfect all around grid)



Dispersed Vision

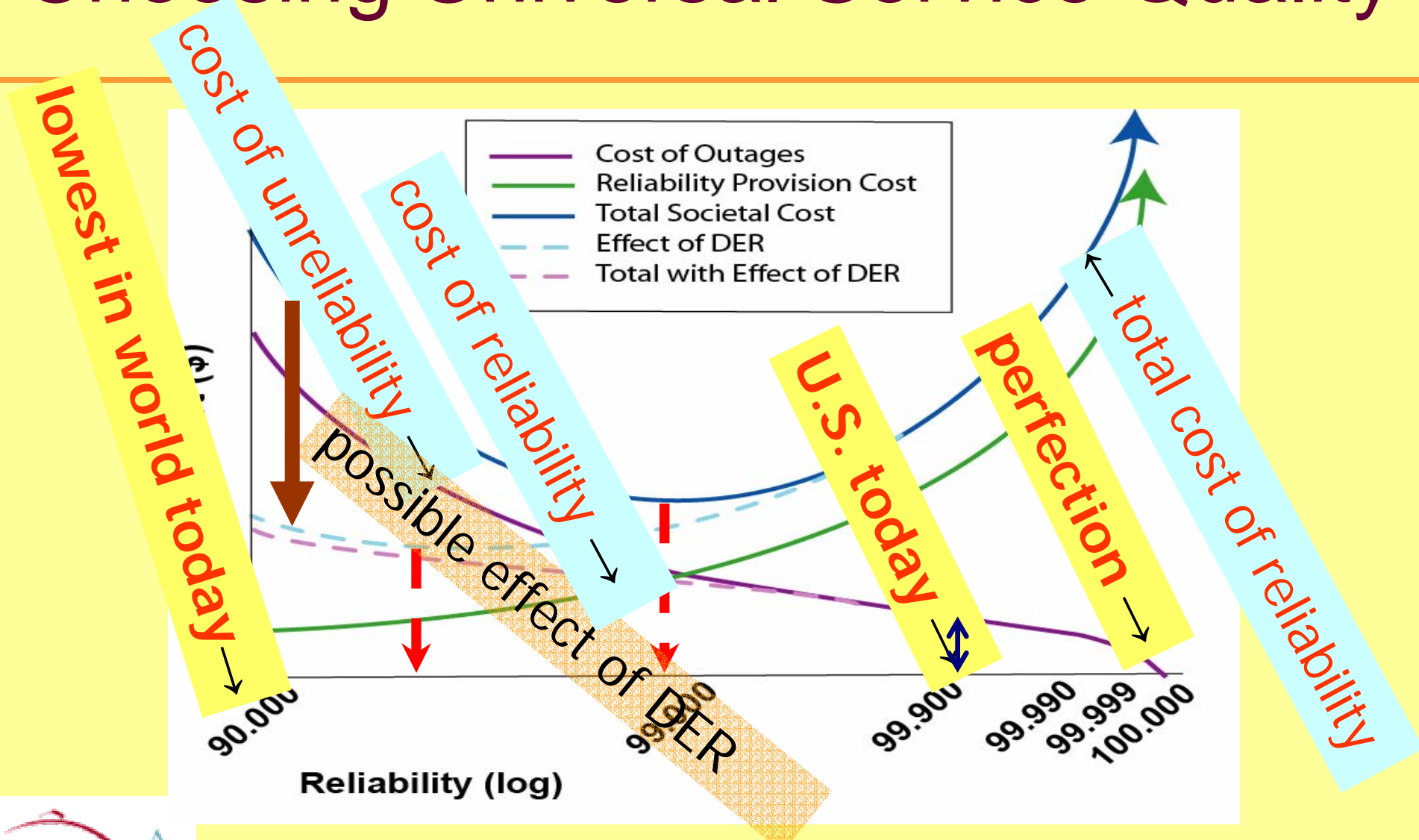
(distributed control & heterogeneous service)



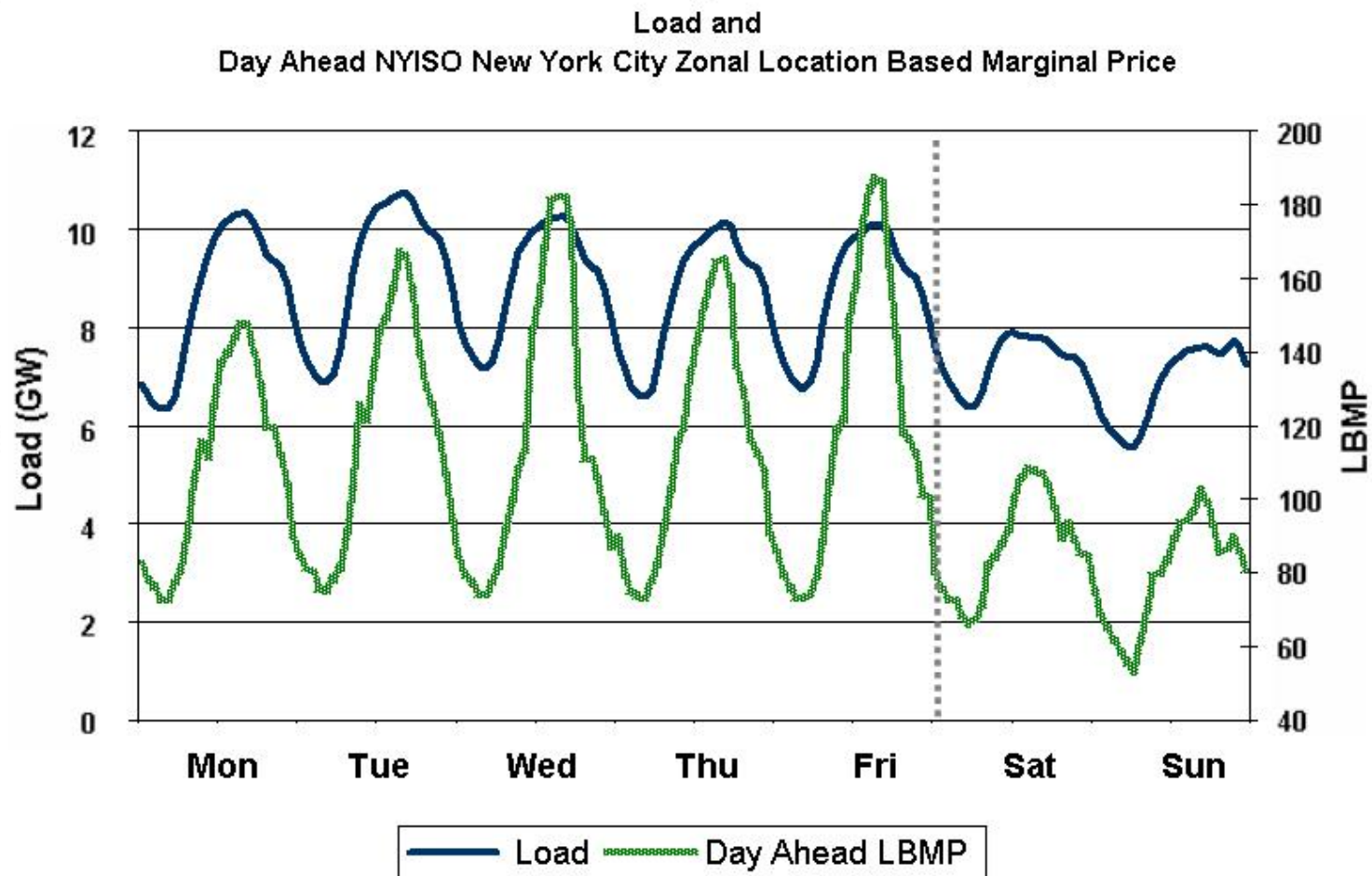
3. Homogeneous & Heterogeneous Security, Quality, Reliability, & Availability (SQRA)



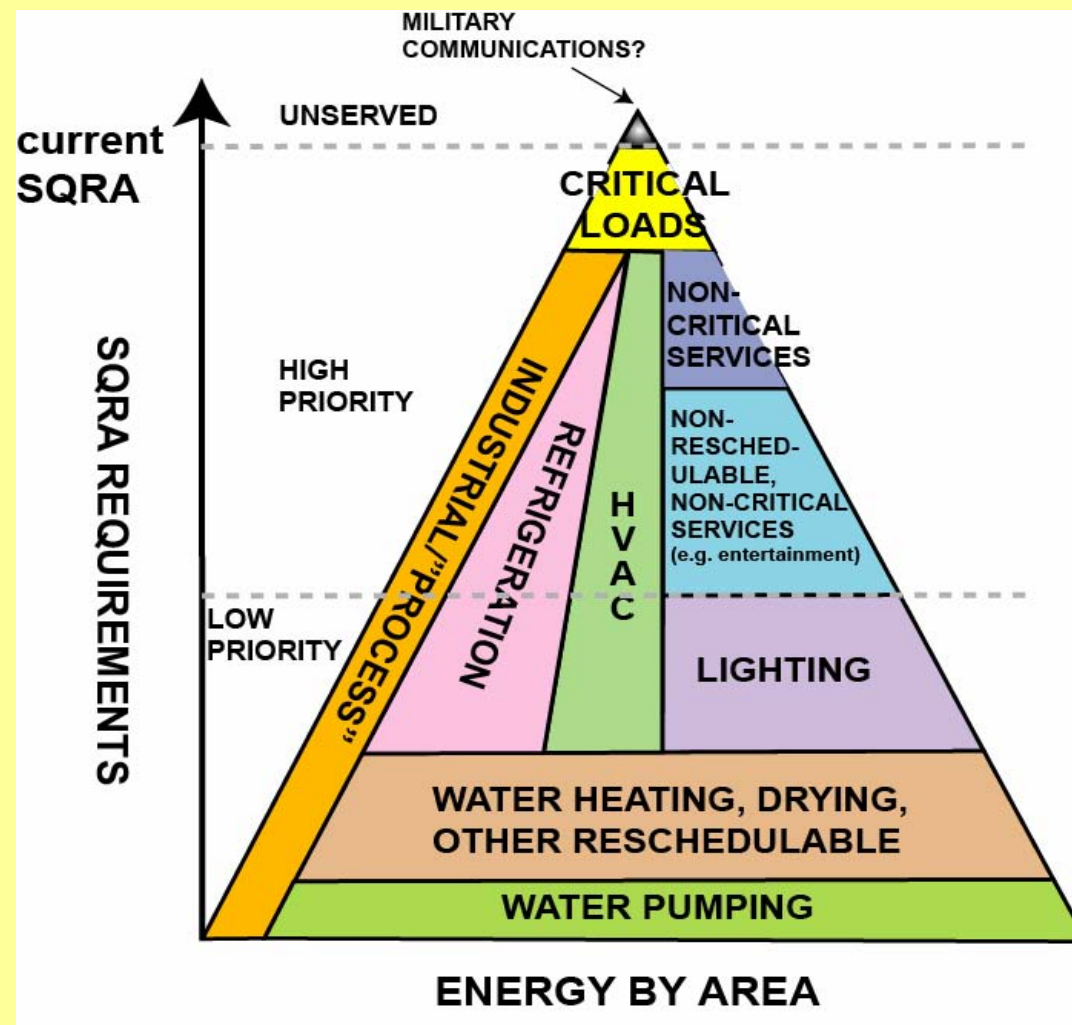
Choosing Universal Service Quality



Value Varies in Time (and Space)



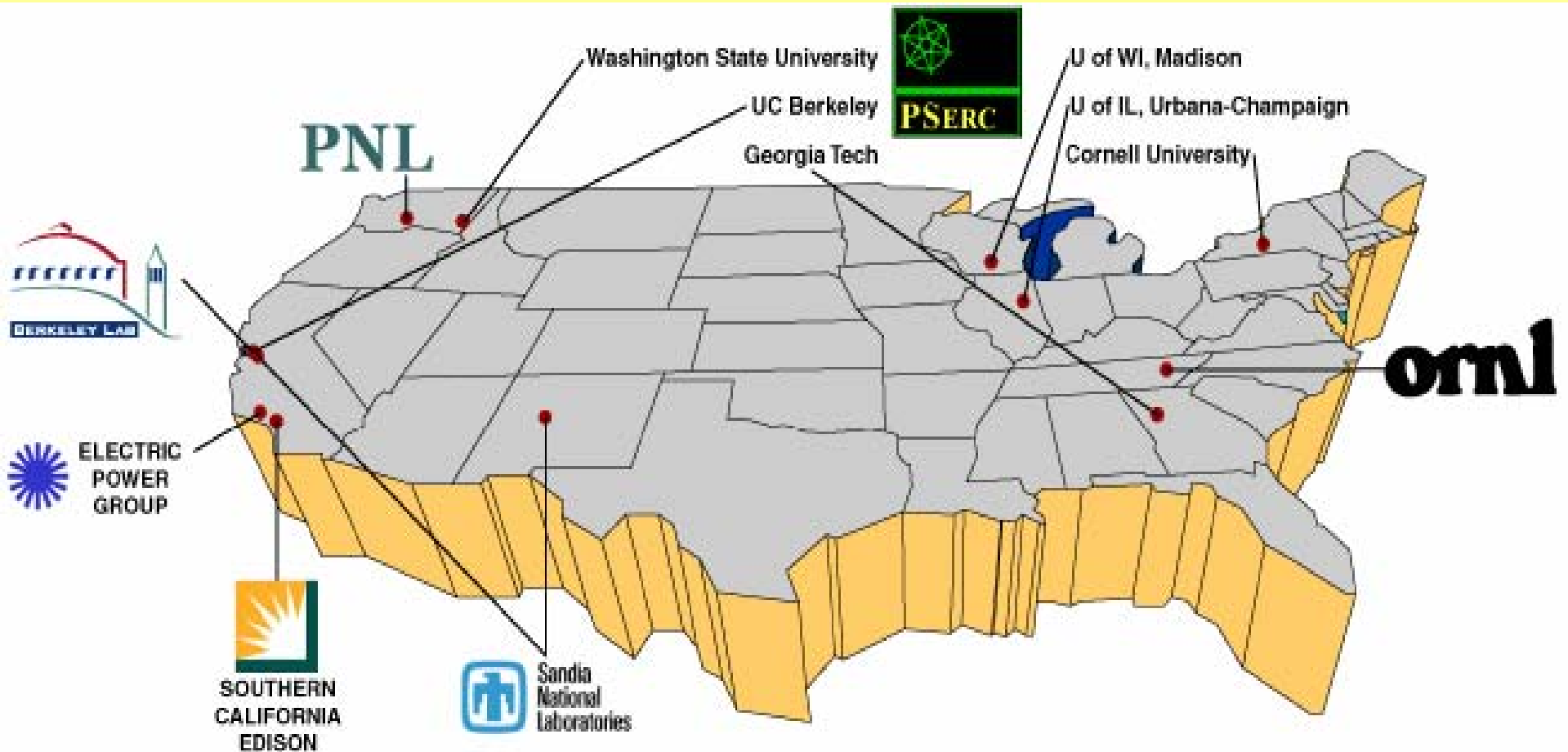
Matching SQRA to Requirements



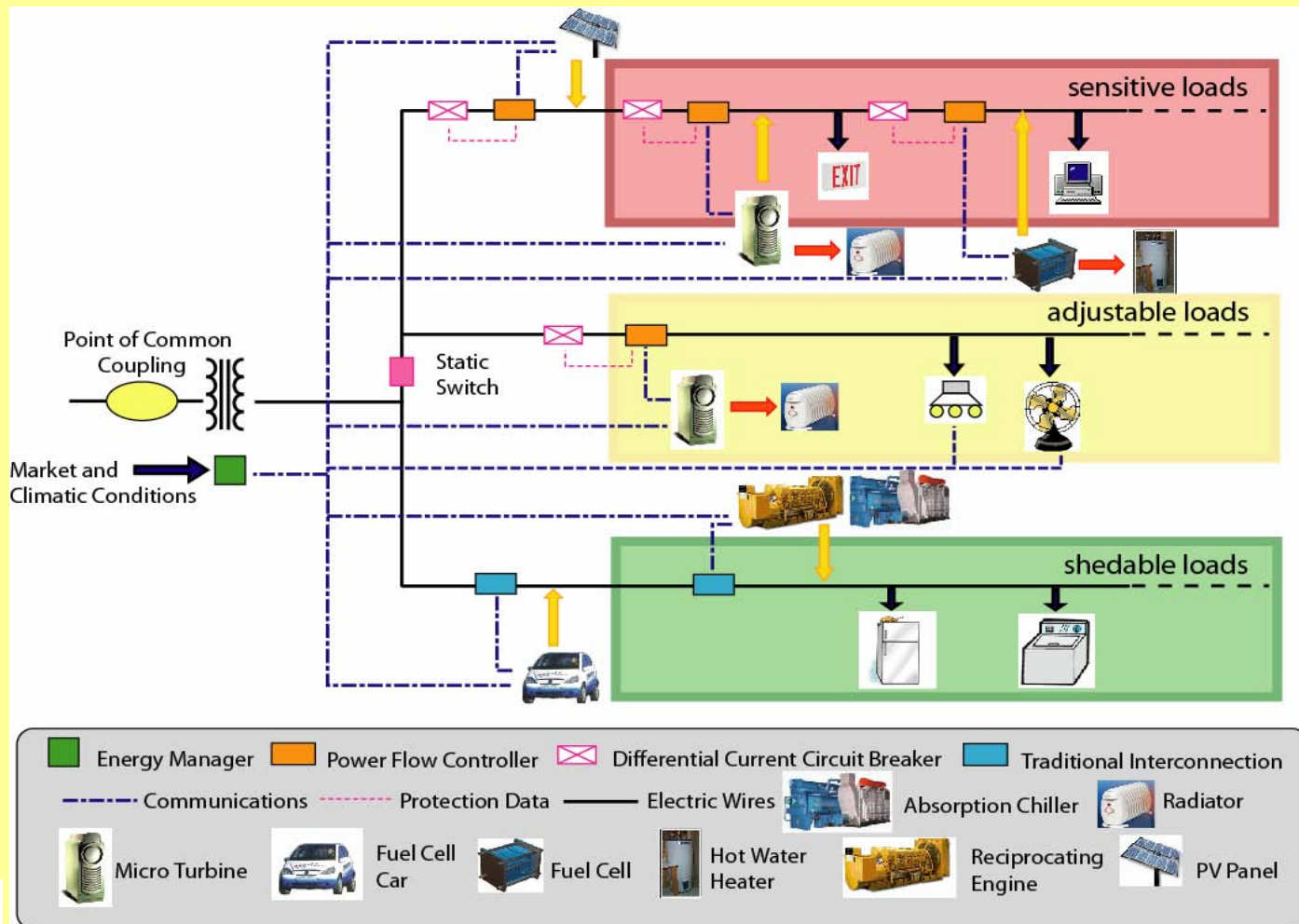
4. Introduction to the CERTS Microgrid



Major Research Performers



Example CERTS Microgrid



Dolan Tech Center, Columbus OH



<http://certs.aeptechlab.com/>



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Sources are 3 X 60 kW Gensets



Thanks!

