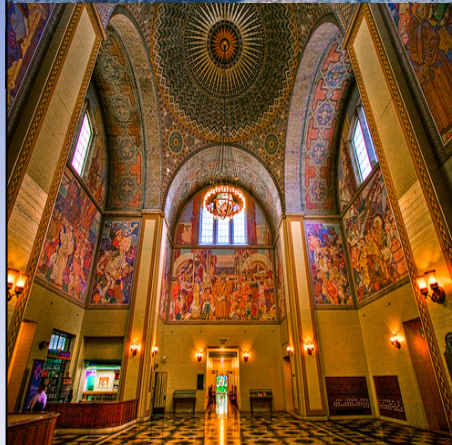




Power Industry Overview & Timeline

***Office of Public
Accountability/
Ratepayer Advocate
City of Los Angeles
opa@LAcity.org
tel. 213-978-0220***

January 22, 2019



Overview

– Scale of North American electric system

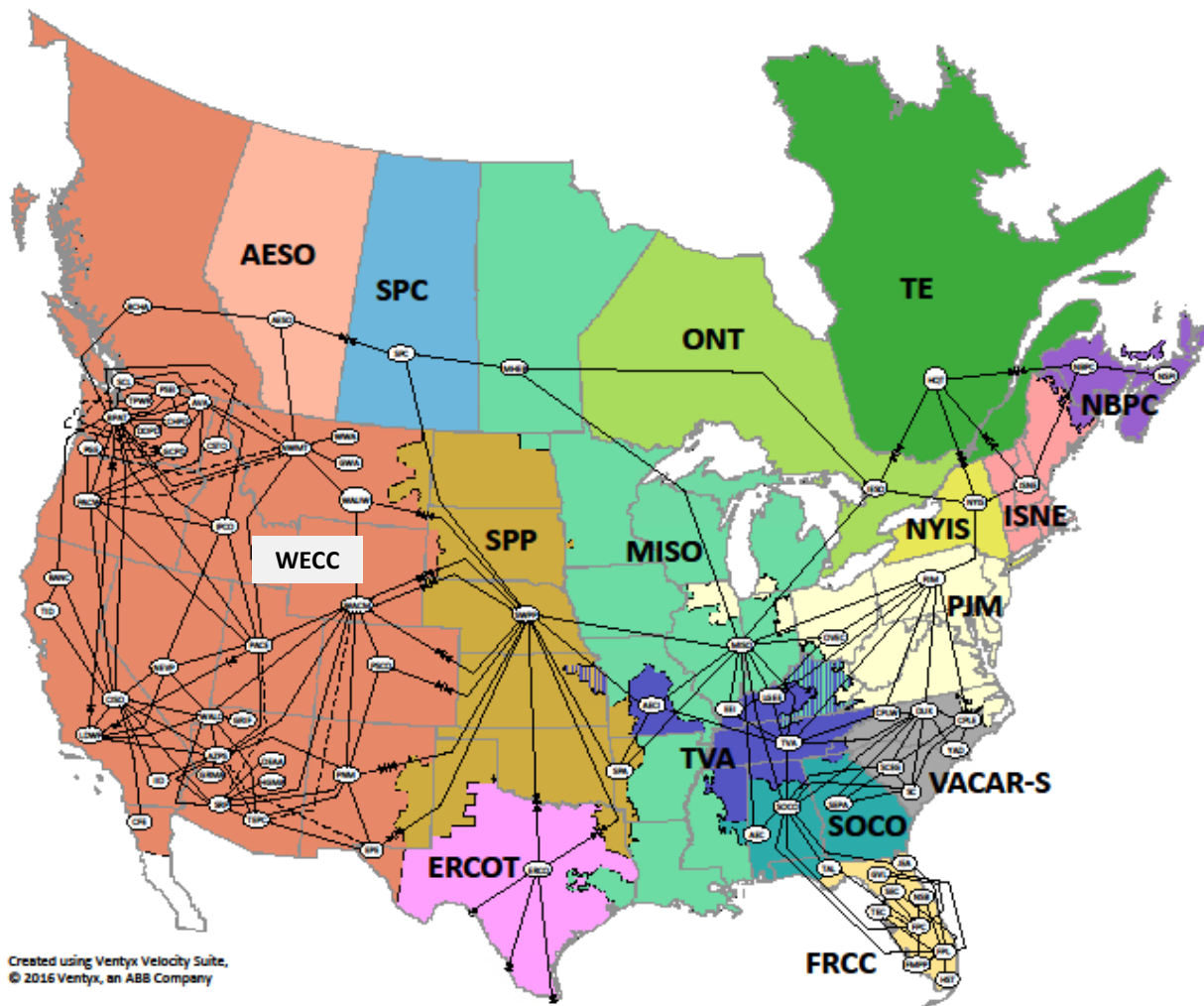
- Geographic scope
- How big is big in power and energy?
- Scope of DWP's system
- Segments of the technology

– Power industry timeline

- Power systems generation & transmission planning & operation timeline
- Timeline with bulk power markets



Today's National Electric Reliability Corp.

About 350 million people, 1,000 GW capacity, 211,000 miles HV transmission, and over \$1 trillion in assets



NERC Balancing Authorities

As of October 1, 2015

-  Dynamically controlled generation
-  Back-to-Back DC Converter

Submit changes to balancing@nerc.com

How Big is Big, in Power Capacity?

• LED light equivalent to 60 W incandescent	9 watts or 0.009 kW
• Standard incandescent light	60 watts or 0.060 kW
• Typical house load	1 - 4 kW
• Big stand-by generator	1000 kW or 1 MW
• 100,000 sq ft office building	1200 kW or 1.2 MW
• 100,000 sq ft “server farm”	12,000 kW or 12 MW est.
• Refinery	100 MW
• 1,000,000 sq ft “server farm”	120 - 200 MW est.
• Typical new generation plant	300-600 MW
• Nuclear unit	650 - 1200 MW
• City of Los Angeles DWP, 2015 resources	7,640 MW
• Southern California Edison	22,771 MW
• California peak resources, summer	53,458 MW
• WECC summer peak resources (US, BC, BC, AB)	184,000 MW
• US & Canada, peak resources, summer	1,012 GW or 1,012,000 MW

Sources: F H Pickel, NERC ESD 2017 for 2017, SCE and CAISO reports, LADWP 2015

Power is an instantaneous measurement, typically measured in Watts, which are Volts times Amperes.

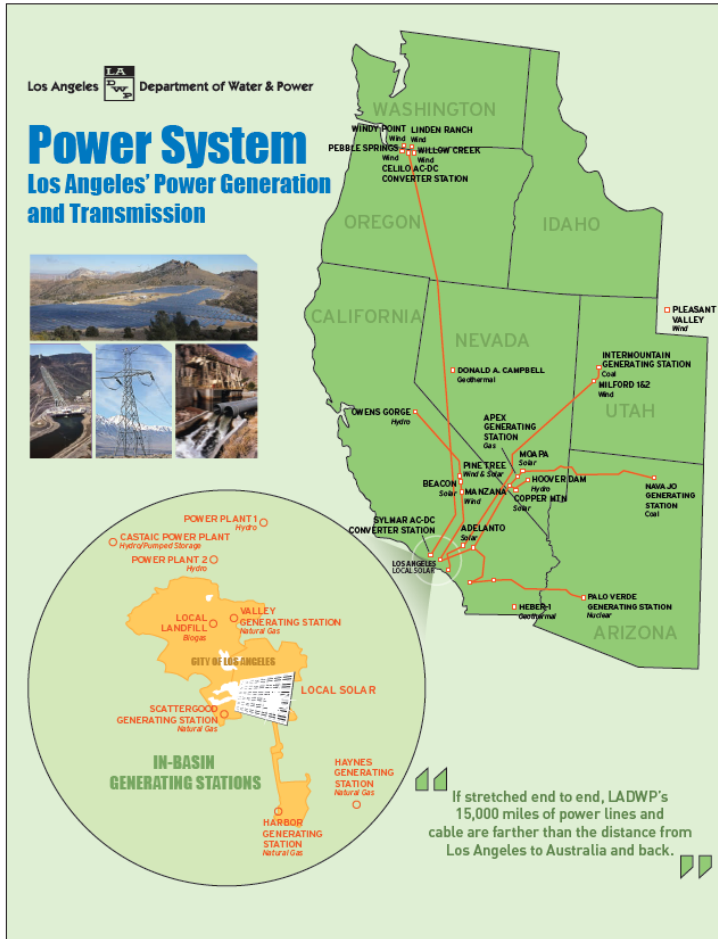
How Big is Big, in Energy Terms?

- LED 60 W equivalent, half time 3.3 kWh/month
- 60 W incandescent, half time 21.9 kWh/month
- Single family residential bill 300 - 1000 kWh/month
- Average US residential user 10,000 kWh/year
- Average US commercial user 70,000 kWh/year
- Standby generator, 200 hr 240,000 kWh/yr
1,200 kW for 200 hours
- Average US industrial user 1,900,000 kWh/year or
or an average of 220 kW for 24/7
- Average US nuclear unit 5,600,000,000 kWh or 5,600,000 MWh
or 5.6 TeraWh/yr (TWh)
or annual average of 650 MW 24/7
- City of Los Angeles DWP, 2017 22,700,000,000 kWh/yr or 22,700 GWh or 22.7 TWh
- SoCal Edison customers, 2017 72,200,000,000 kWh/yr
or 72.2 TeraWatt-hours/yr (TWh)
- All California generated 271 TWh or 271 billion kWh/yr
- US, Baja, Canadian WECC generated 893 TWh or 893 billion kWh/yr
- US and Canada generated 4,550 TWh

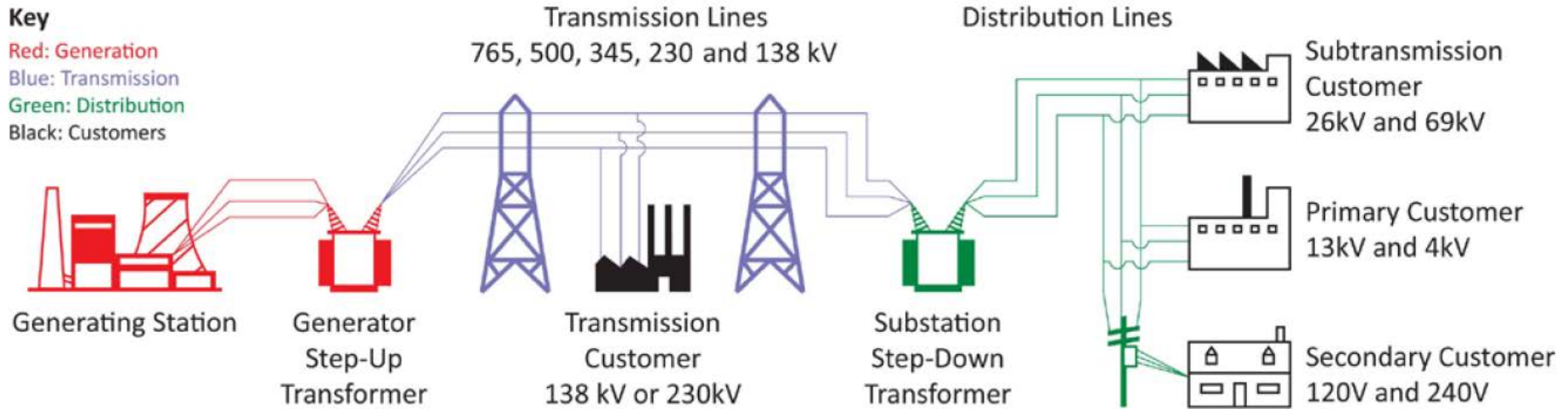
Sources: F H Pickel, NERC ESD 2017 for 2017, SCE and CAISO reports, DOE/EIA 2017
Electric energy is typically measured in Watt-hours, which is Watts times hours.

Geographic reach of Water & Power

(15th US on power revenue, 32nd on MWh sales, 18th on customers)

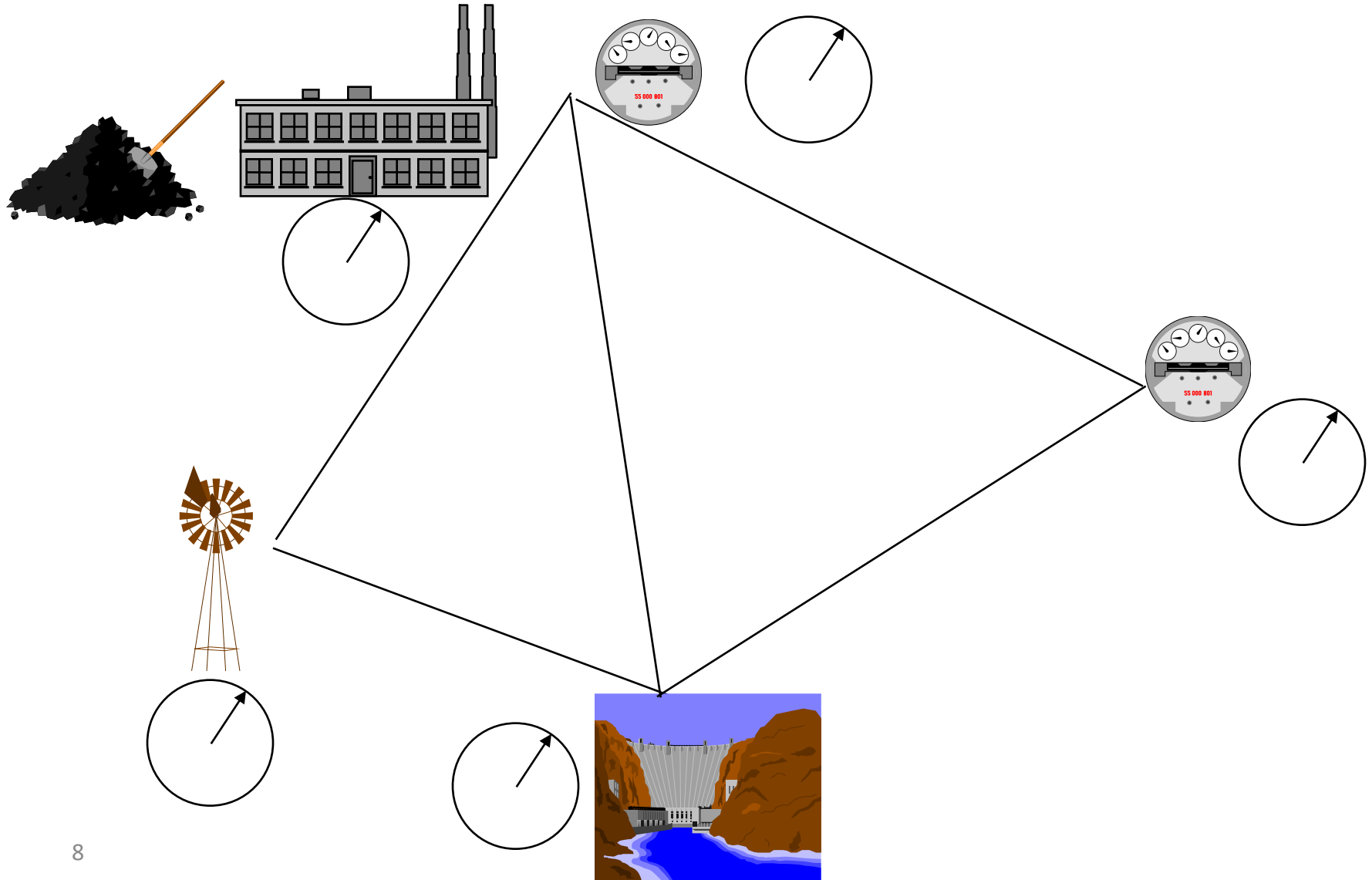


“Bulk Power System”

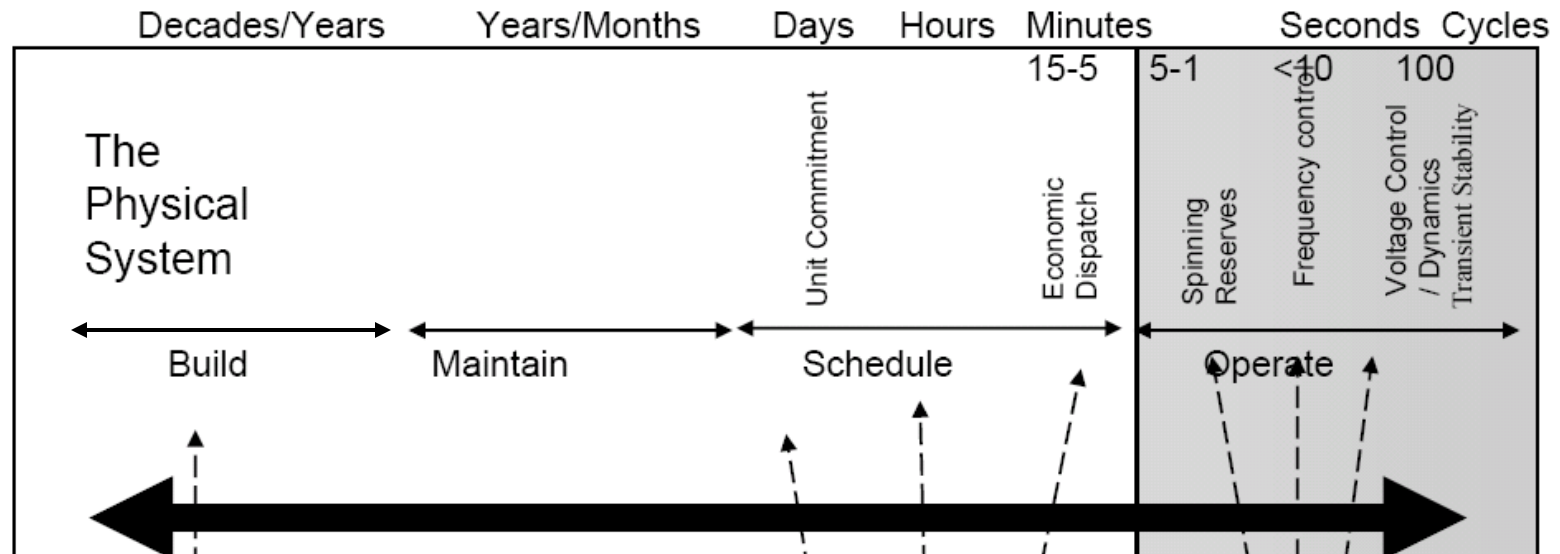


Source: NERC

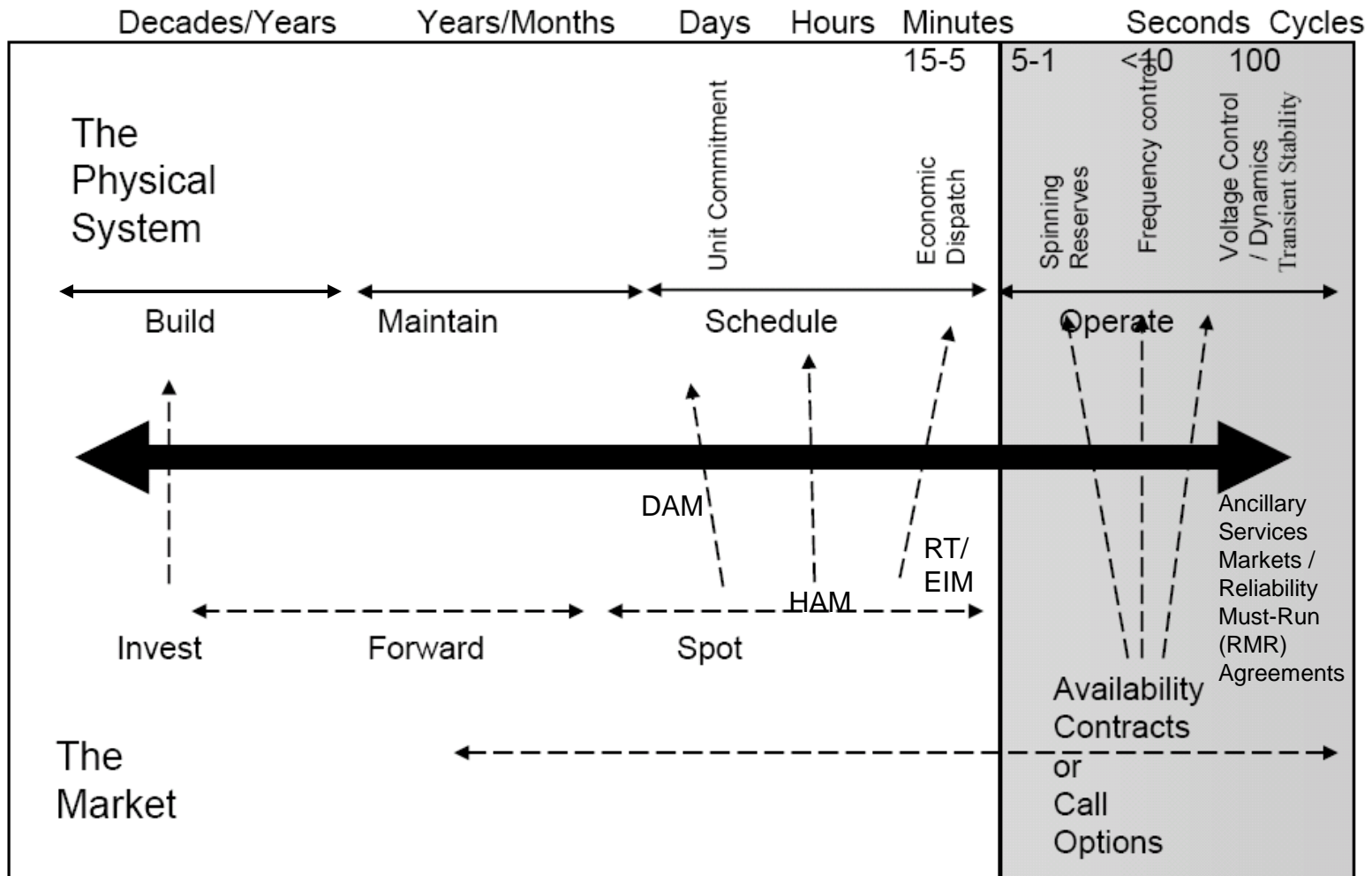
Transmission Networks



Power Systems Generation & Transmission Planning & Operation Timeline



Timeline With Bulk Power Markets



APPENDIX

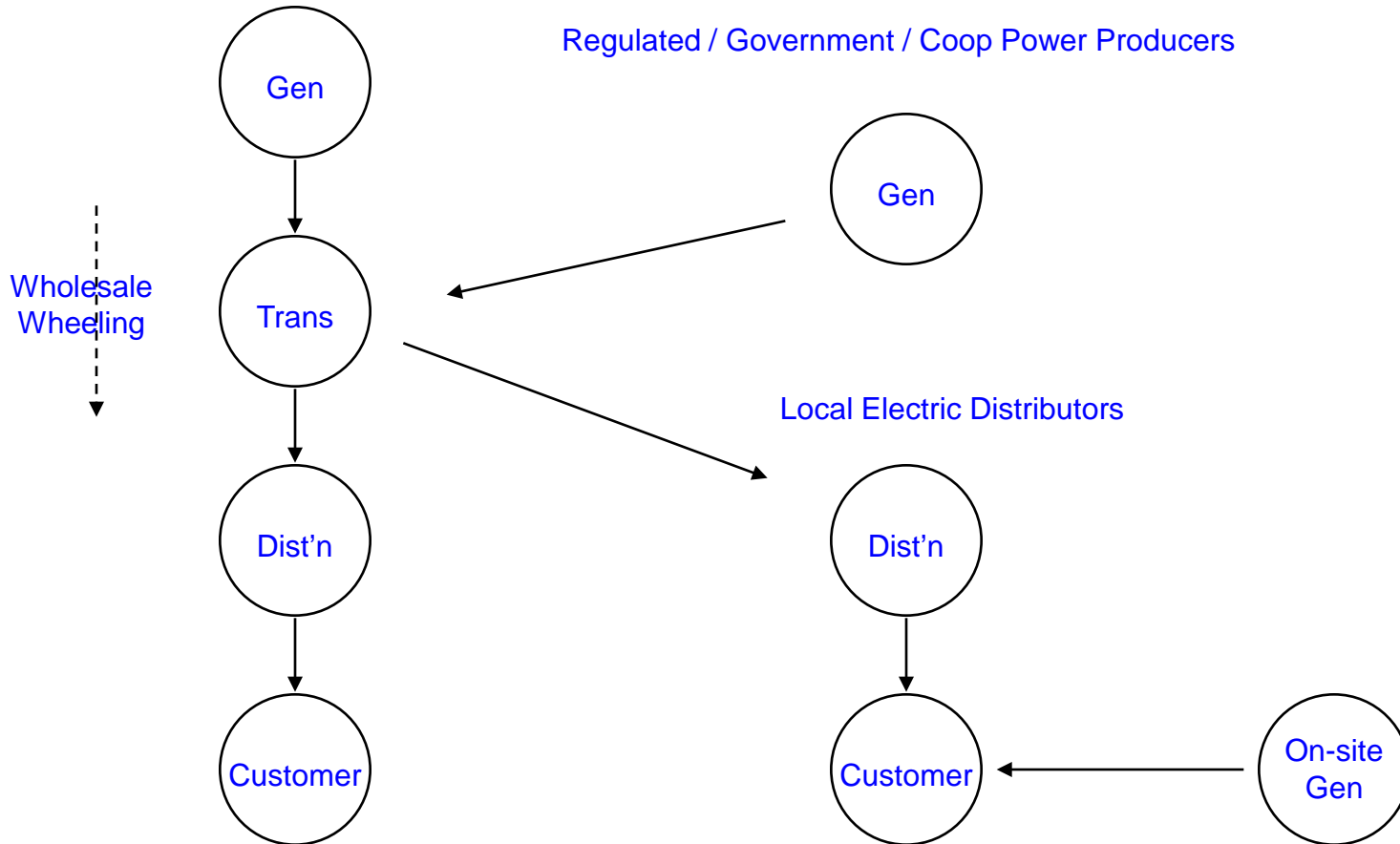
2017 Energy Information Admin Form 861					TOTAL		
Utility Name	Service Type	State	Ownership	BA Code	Revenues	Sales	Customers
					Thousand Dollars	Megawatt-hours	Count
Pacific Gas & Electric Co.	Bundled	CA	Investor Owned	CISO	12,401,905.0	61,827,985	4,546,272
Florida Power & Light Co	Bundled	FL	Investor Owned	FPL	10,969,756.0	108,513,594	4,901,846
Southern California Edison Co	Bundled	CA	Investor Owned	CISO	10,763,409.0	72,196,041	4,971,014
Georgia Power Co	Bundled	GA	Investor Owned	SOCO	7,737,463.4	82,400,878	2,501,473
Virginia Electric & Power Co	Bundled	VA	Investor Owned	PJM	6,841,523.6	76,497,814	2,454,141
Alabama Power Co	Bundled	AL	Investor Owned	SOCO	5,457,826.0	53,709,666	1,475,042
DTE Electric Company	Bundled	MI	Investor Owned	MISO	4,777,824.8	42,243,910	2,184,813
Duke Energy Carolinas, LLC	Bundled	NC	Investor Owned	DUK	4,616,183.5	56,293,559	1,974,982
Consolidated Edison Co-NY Inc	Bundled	NY	Investor Owned	NYIS	4,348,461.0	19,226,835	2,583,808
Consumers Energy Co	Bundled	MI	Investor Owned	MISO	4,210,442.1	33,248,491	1,816,948
Duke Energy Florida, LLC	Bundled	FL	Investor Owned	FPC	4,098,421.8	38,024,012	1,775,327
Reliant Energy Retail Services LLC	Bundled	TX	Retail Power Marketer	ERCO	3,884,972.1	42,932,929	1,365,067
TXU Energy Retail Co, LLC	Bundled	TX	Retail Power Marketer	ERCO	3,803,923.0	37,847,022	1,616,756
Entergy Louisiana LLC	Bundled	LA	Investor Owned	MISO	3,731,956.0	55,243,264	1,078,545
Los Angeles Dept. of Water & Power	Bundled	CA	Municipal	LDWP	3,587,659.7	22,678,466	1,426,865
Arizona Public Service Co	Bundled	AZ	Investor Owned	AZPS	3,407,017.0	28,018,011	1,214,627
Consolidated Edison Co-NY Inc	Delivery	NY	Investor Owned	NYIS	3,334,402.0	36,091,014	862,295
Long Island Power Authority	Bundled	NY	State	NYIS	3,308,794.1	17,225,147	1,123,626
San Diego Gas & Electric Co	Bundled	CA	Investor Owned	CISO	3,281,733.5	15,623,082	1,434,025
Northern States Power Co - Minnesota	Bundled	MN	Investor Owned	MISO	3,224,654.0	29,746,782	1,279,507
Duke Energy Progress - (NC)	Bundled	NC	Investor Owned	CPLE	3,188,785.0	37,023,167	1,390,064
Puerto Rico Electric Pwr Authority	Bundled	PR	State	NA	3,006,326.0	13,558,282	1,465,437
Commonwealth Edison Co	Bundled	IL	Investor Owned	PJM	2,969,046.5	25,783,309	2,589,987
Union Electric Co - (MO)	Bundled	MO	Investor Owned	MISO	2,944,964.2	31,597,238	1,215,790
Public Service Elec & Gas Co	Bundled	NJ	Investor Owned	PJM	2,862,701.0	20,198,012	1,945,910
Salt River Project	Bundled	AZ	Political Subdivision	SRP	2,826,922.1	28,367,551	1,044,846
Wisconsin Electric Power Co	Bundled	WI	Investor Owned	MISO	2,801,176.4	23,655,601	1,122,770

2017 Energy Information Admin Form 861					TOTAL		
Utility Name	Service Type	State	Ownership	BA Code	Revenues	Sales	Customers
					Thousand Dollars	Megawatt-hours	Count
Public Service Co of Colorado	Bundled	CO	Investor Owned	PSCO	2,693,212.8	28,628,812	1,459,117
South Carolina Electric&Gas Company	Bundled	SC	Investor Owned	SCEG	2,578,102.0	21,963,071	715,592
Duke Energy Indiana, LLC	Bundled	IN	Investor Owned	MISO	2,552,046.4	27,496,412	819,569
Puget Sound Energy Inc	Bundled	WA	Investor Owned	PSEI	2,256,626.5	21,316,397	1,135,020
City of San Antonio - (TX)	Bundled	TX	Municipal	ERCO	2,152,328.0	21,678,730	811,116
Nevada Power Co	Bundled	NV	Investor Owned	NEVP	2,117,515.0	20,570,469	1,018,321
Pacific Gas & Electric Co.	Delivery	CA	Investor Owned	CISO	2,075,847.0	20,805,448	933,622
PacifiCorp	Bundled	UT	Investor Owned	PACE	2,070,271.0	24,132,846	892,849

		Revenues Rank	Megawatthours Rank	Customer Count Rank
Los Angeles Dept. of Water & Power		15	32	18

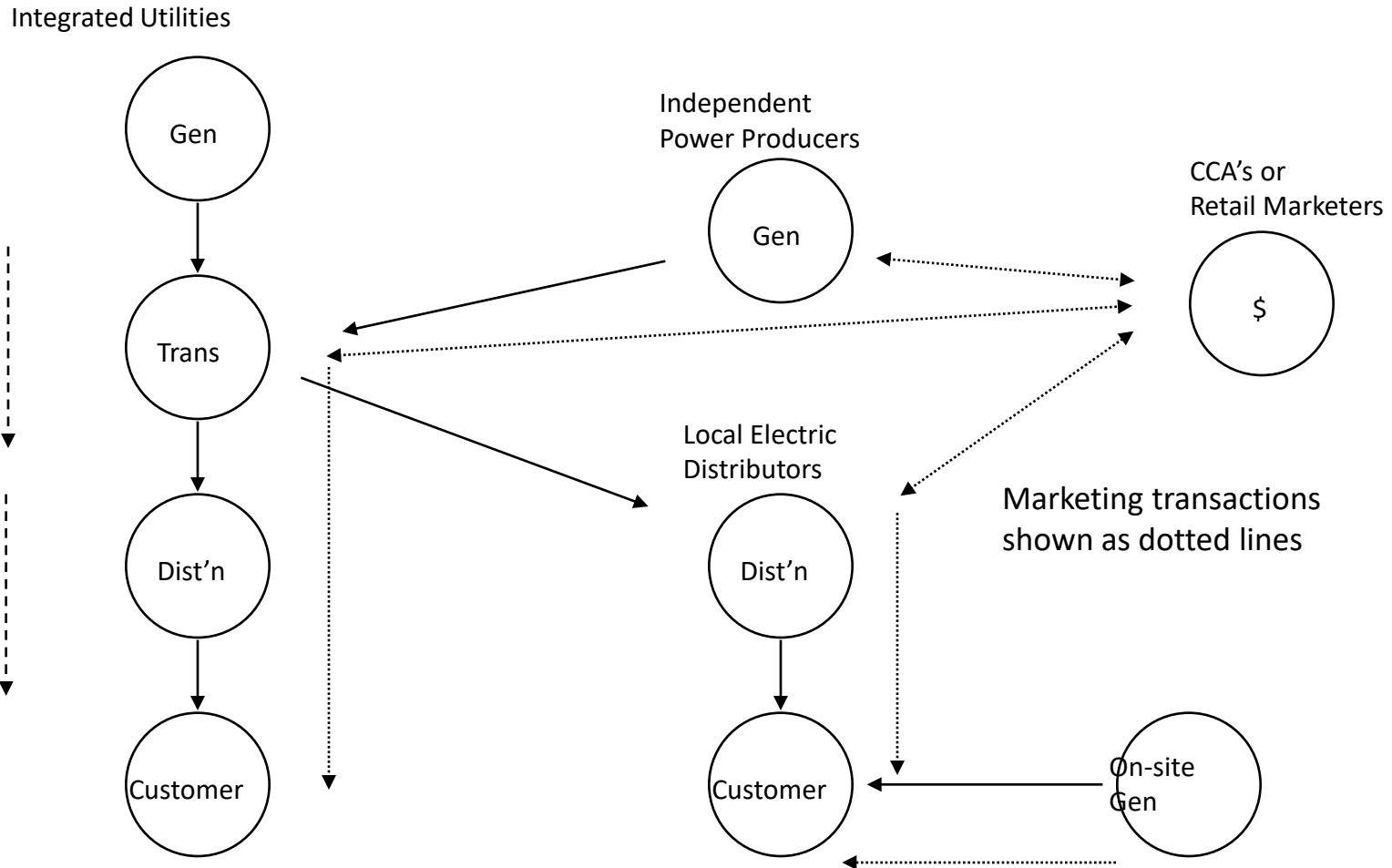
Who Were the Players?

Integrated Utilities, Public & Investor

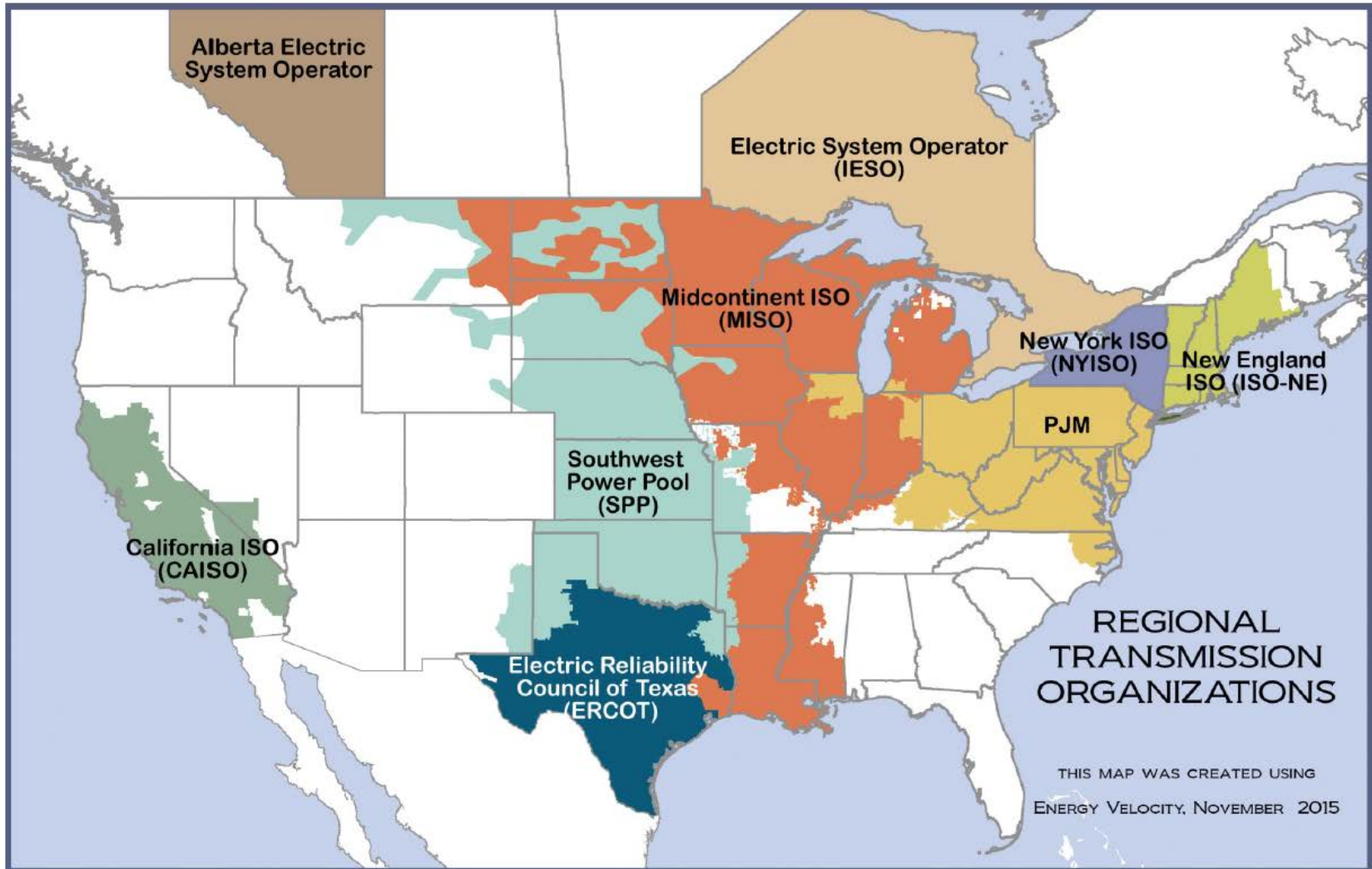


Who are the Players in the New Environment?

- The new environment created greater competition for energy sales via the development of marketing intermediaries



Organized vs. Traditional Bilateral Markets



EIM Map

