

**An Enormous  
Emerging Opportunity  
for  
District Cooling Developments**

*John S. Andrepont, President*  
**The Cool Solutions Company**

IDEA Annual Conference  
Seattle, Washington - June 9, 2014

# Outline

- Introduction: District Cooling (DC) Challenges
- Electric Power Dilemma & Reaction:
  - Variable elec demand + intermittent renewables
  - California Energy Storage (ES) Mandate
- DC Opportunities:
  - Customer Storage - TES at existing DC systems
  - Generation Storage - DC at CT power plants
  - Examples of DC at CT power plants
- Summary and Conclusions

# Terminology

- CAES - Compressed Air Energy Storage
- CHW - Chilled Water
- CT - Combustion Turbine
- DC - District Cooling
- ES - Energy Storage
- IOU - Investor Owned Utility
- IPP - Independent Power Producer
- MCF - Mission Critical Facility
- PH - Pumped Hydro-electric
- TES - Thermal Energy Storage
- TIC - Turbine Inlet Cooling

# Introduction

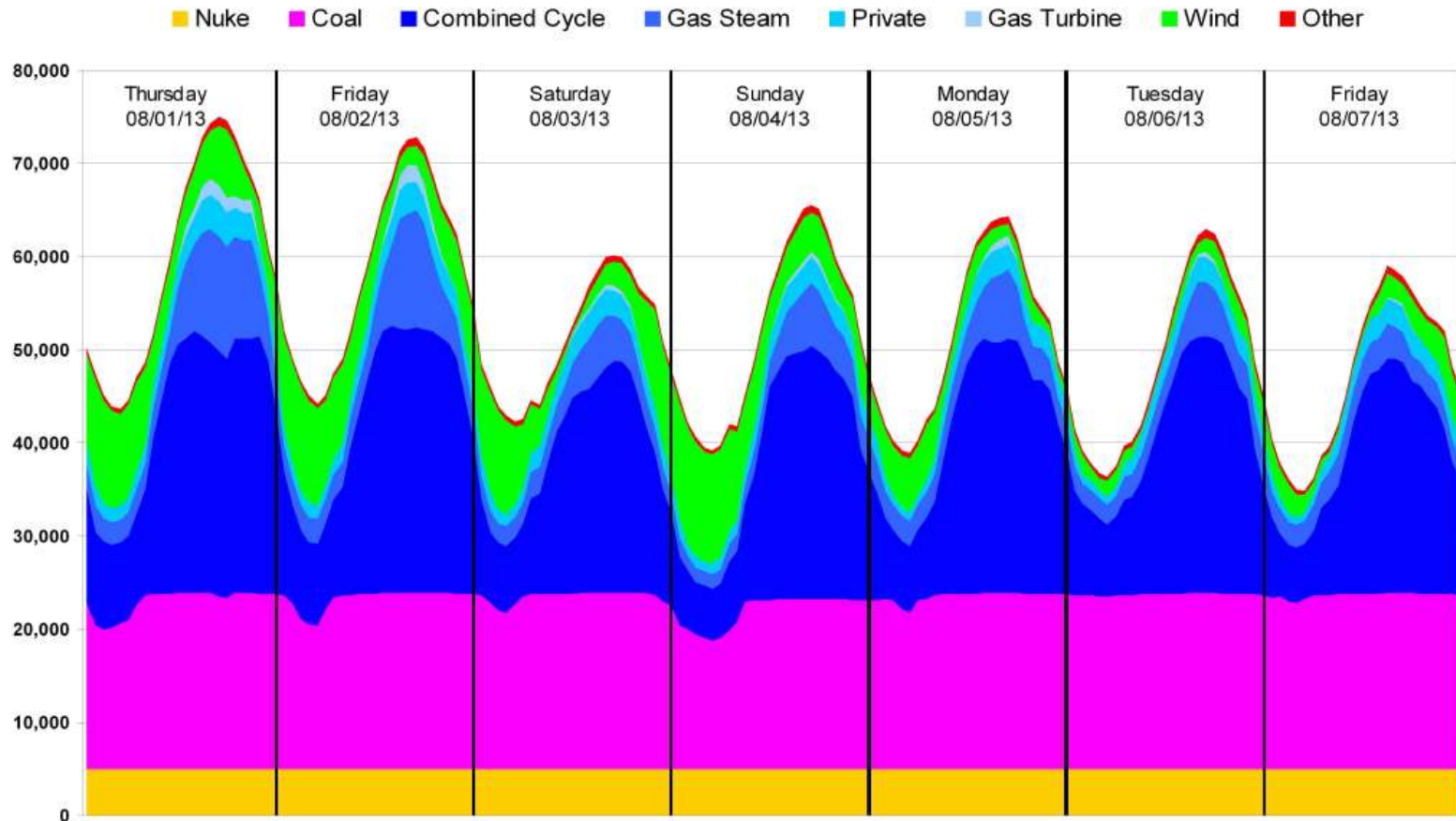
District Cooling (DC) has big challenges:

- Needs large cooling loads
- Needs dependable long-term customers
- Often needs many customer contracts
- Typically, complex & phased development
- Capital intensive & often difficult to finance

*But what if . . . there are large DC prospects,  
each needing only 1 customer, and  
those customers had multiple similar sites?*

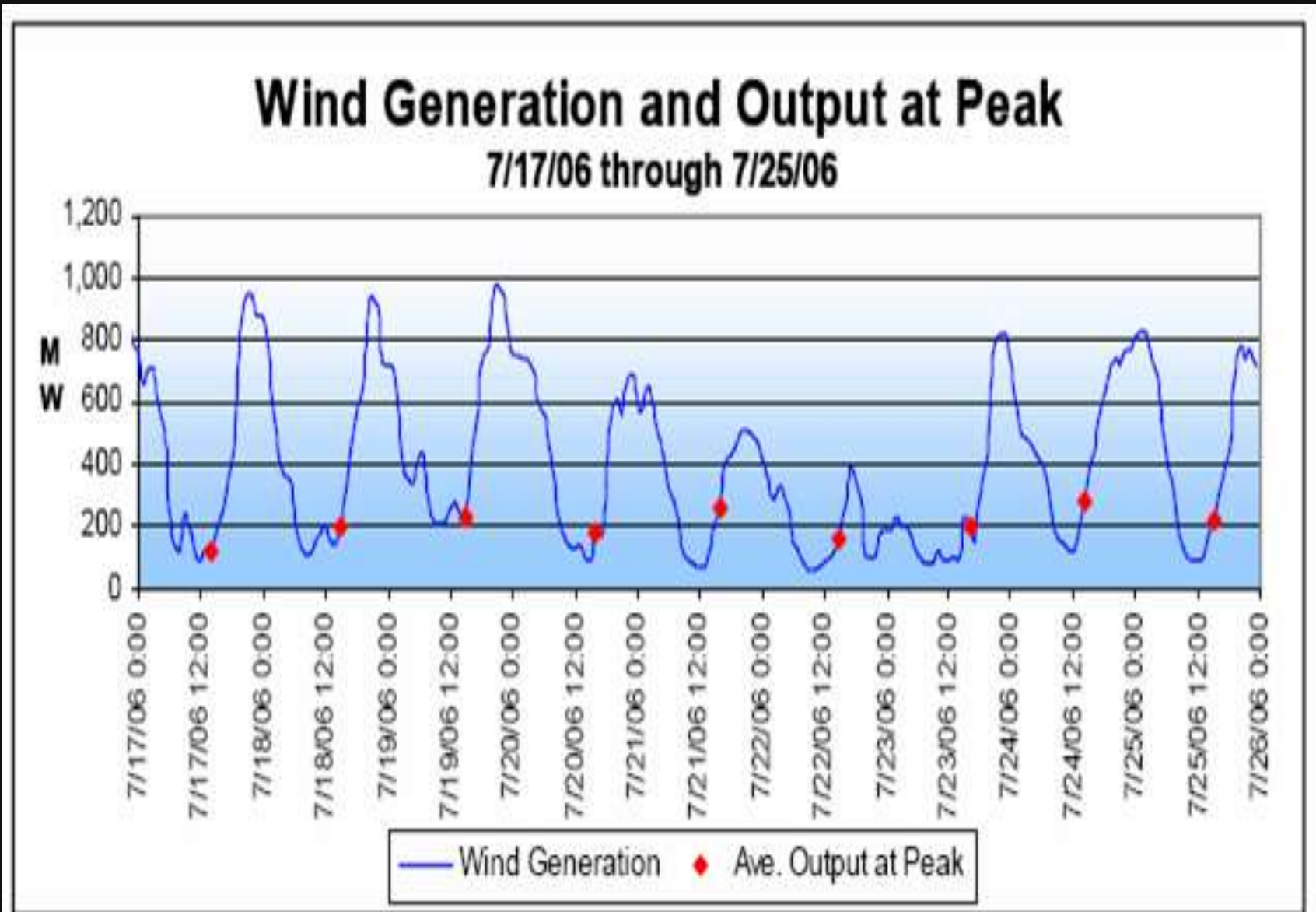
# Elec Gen Mix Serves Variable Load

## 2013 Peak Load Week - Generation by Fuel Type

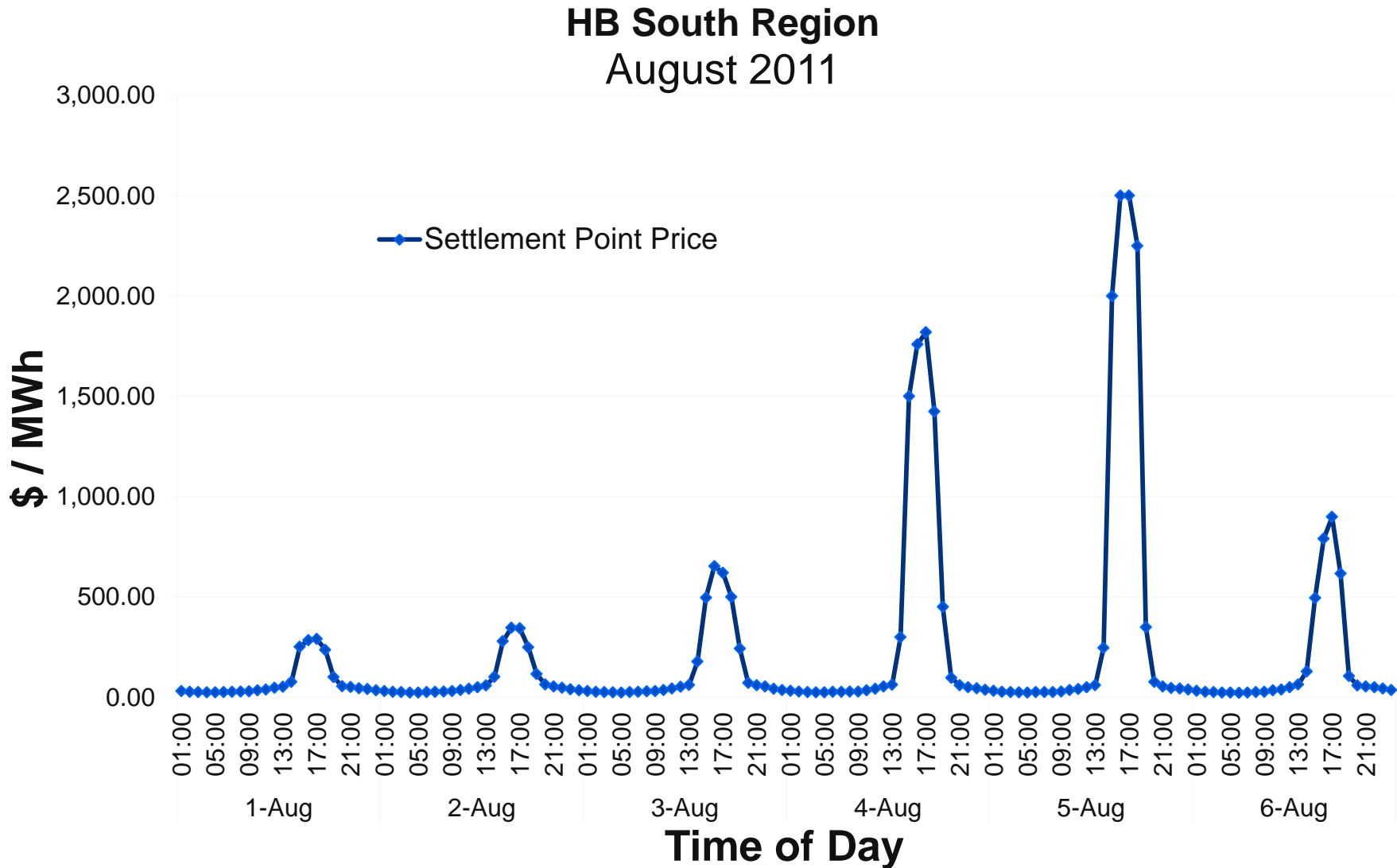


Note – no changes to existing reserves requirements were assumed for this analysis

# Wind Output Only 20% at Peak Dmnd



# Value Varies: +\$2.50 to -\$0.10 / kWh



# Cal PUC - Energy Storage Mandate

- 3 Calif. IOU's (PG&E, SCE, and SDG&E):
  - **1.3 GW** Energy Storage (ES), 4 x 2-yr phases, all procured by 2020 & installed by 2024.
- ES applications to be in 3 areas:
  - Transmission, Distribution, and Customer ES.
- ES technologies can be:
  - Batteries, CAES, PH (<50 MW), fuel cells, flywheels, or Thermal Energy Storage (TES).

***Util's can own only 50% of the ES assets!***



# Cal PUC - Energy Storage Mandate

Utility	ES Type	<u>ES to be procured by IOUs (MW)</u>				Totals
		2014	2016	2018	2020	
PG&E	Transmiss'n	50	65	85	110	310
	Distribution	30	40	50	65	185
	Customer	10	15	25	35	85
SCE	Transmiss'n	50	65	85	110	310
	Distribution	30	40	50	65	185
	Customer	10	15	25	35	85
SDG&E	Transmiss'n	10	15	22	33	80
	Distribution	7	10	15	23	55
	Customer	3	5	8	14	30
<b>Total MW</b>	<b>All ES</b>	<b>200</b>	<b>270</b>	<b>365</b>	<b>490</b>	<b>1,325</b>

# Multi-hour Energy Storage Options

Type of <u>ES Tech</u>	Devel't <u>Status</u>	Effic <u>(%)</u>	Life <u>(yrs)</u>	<u>Unit Capital Costs</u>	
				<u>(\$/kW)</u>	<u>(\$/kWh)</u>
P Hydro	mature	75-85	40+	1900-3800	310-380
Na-S batt's	mature	80	15	3900-4200	650-700
Lead-acid	mature	85-90	7-15	2000-3000	500-750
Adv'd batt's	demo	65-90	15-30	1500-4500	470-1125
Flywheels	demo	90	20	1950-2250	7800-9000
CAES	demo	70-80	40+	800-1200	80-150
CHW TES	mature	100+/-	40+	300*-1000	50*-150

*\* CHW TES Cap\$ can be zero or negative (capital savings),  
when TES avoids cost of equiv conv'l CHW capacity!*

# DC Opportunity: “Customer” ES

1. Add TES to your existing DC systems
  - Calif. IOU pays for the storage
  - Your DC system owns & operates the TES
  - And your DC gains peak capacity / redundancy
2. Add “merchant” TES to others’ DC systems
  - Calif. IOU pays for the storage
  - DC can be univ, med, airport, gov’t, MCF, etc.
  - DC developer could own & operate the TES

*And even more options for “Transmission” Storage.*

# DC Opportunity: “Transmission” ES

*CT power plants lose capacity in hot weather. But:  
Turbine Inlet Cooling (TIC) adds power (at low \$/kW).  
CHW TES adds more power + ES (& it saves cap\$)!*

1. Add TES-TIC to existing IOU CT plants
  - Calif. IOU pays for (and owns) the TES
  - Engrs / contractors design / install the TES-TIC
  - DC developer could operate (not own) TES-TIC
2. Add “merchant” TES-TIC to IOU (or IPP) CT plts
  - Calif. IOU pays for (but does not own) the TES
  - *Remember: IOUs cannot own >50% of the ES!*
  - DC developer could own & operate TES-TIC

# Electric Utility (repeat) CHW TES-TIC

4 projects by Dominion Energy in PA & VA, 2009-16:

1st Year Oper	No. of CTs	Plant Power (MW)	Increase due to TIC (%)	Increase due to TIC (MW)	<u>Elec Shift from CHW TES</u>		
					<u>(MWh/d)</u>	<u>(hrs/d)</u>	<u>(MW)</u>
2009	4	1,180	13	115	87	6	14
2011	2	590	14	60	55	7	8
2014	3	1,329	9	108	162	8 to 10	18
2016	3	1,329	9	108	188	10	19
Total	12	4,428	45	391	429	6 to 10	59
Avg.	3	1,107	11	98	123	8	15

Typical for one “average” DC plant for TES-TIC:

22,000 T load; DC = 12,000 T(chillers) + 176,000 T-hrs(TES)

# Electric Utility (repeat) CHW TES-TIC

2 projects by Saudi Electricity Co. in Riyadh, KSA, 2005-08:

1st Oper Year	No. of CTs	Plant Power (MW)	Increase due to TIC (%)	Increase (MW)	<u>Elec Shift from CHW TES</u>		
					<u>(MWh/d)</u>	<u>(hrs/d)</u>	<u>(MW)</u>
2005	10	750	30	180	288	6	48
2008	40	3,000	30	720	885	5	177
Total	50	3,750	30	900	1,173	5 to 6	225
Avg.	25	1,875	30	450	587	5	113

Typical for one “average” DC plant for TES-TIC:

90,000 T load; DC = 25,000 T(chillers) + 450,000 T-hrs(TES)

# CHW TES-TIC in Saudi Arabia (2005)

750 MW utility power plant (10 x 75 MW CTs).

But at 122 F, output derates to only 600 MW.

Wanted 30% more power; could just add 3 more CTs.



If use TIC w/ 31,000 T chillers, it nets 132 MW, at only \$435/kW !

But power most valued 6 hrs/d; they used TIC w/ CHW TES,

11,000 T chlrs + 193,000 T-hrs, nets 180 MW, at only \$250/kW !!

*Utility uses a DC system for TIC; later, another for 40 more CTs!*

# Summary and Conclusions

- Near-Term DC opportunities in California:  
*Large, single-customer DC, with repeat potential.  
Funding from Calif IOUs (PG&E, SCE, SDG&E).*
  1. Add TES to your existing DC systems
  2. Add “merchant” TES at others’ DC systems
  3. Add TES-TIC at utility (IOU) CT power plants
  4. Add “merchant” TES-TIC at IOU or IPP CTs
- Similar prospects should develop elsewhere.  
*A great business opportunity for IDEEA members:  
DC developers/owners, equip suppliers, eng’rs.*



# Questions / Discussion ?

Or for a copy of this presentation, contact:

*John S. Andrepont*

**The Cool Solutions Company**

CoolSolutionsCo@aol.com

tel: 630-353-9690

