

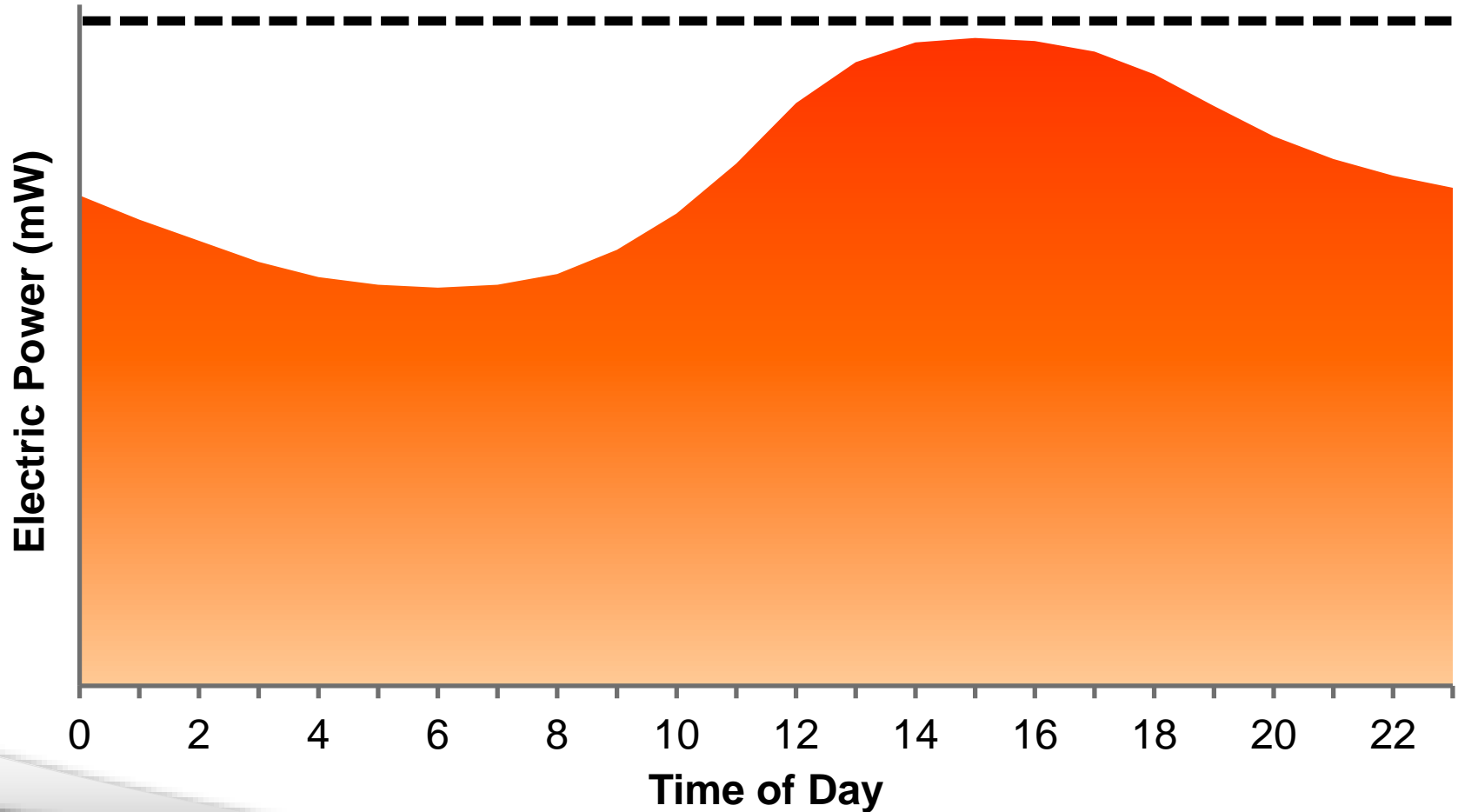


Simplifying the Selection of Thermal Energy Storage for District Cooling

Steve Benz

**Director of Global Thermal Storage
and District Energy**

Energy Demand vs. Supply



Addressing Energy Supply Problems

- Rolling blackouts

We are likely to load shed on most days in the near future



- Adequate generation capacity available to meet demand and reserves
- Constrained generation capacity with sufficient supply to meet demand and reserves. Medium probability of load shedding
- Insufficient generation capacity unable to meet demand and reserves. High probability of load shedding

Jan-15

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

Feb-15

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28

Mar-15

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

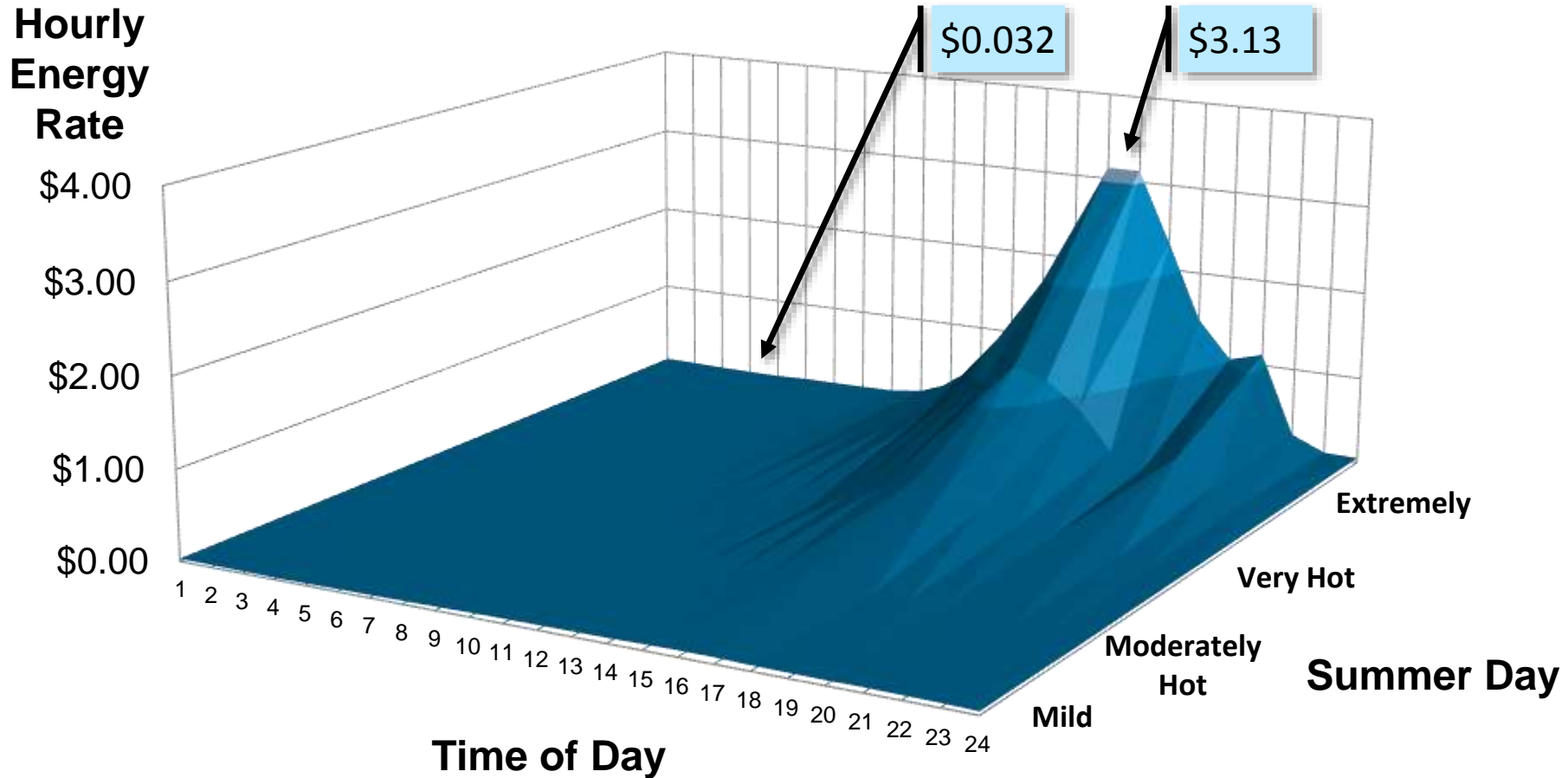
Apr-15

Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

Addressing Energy Supply Problems

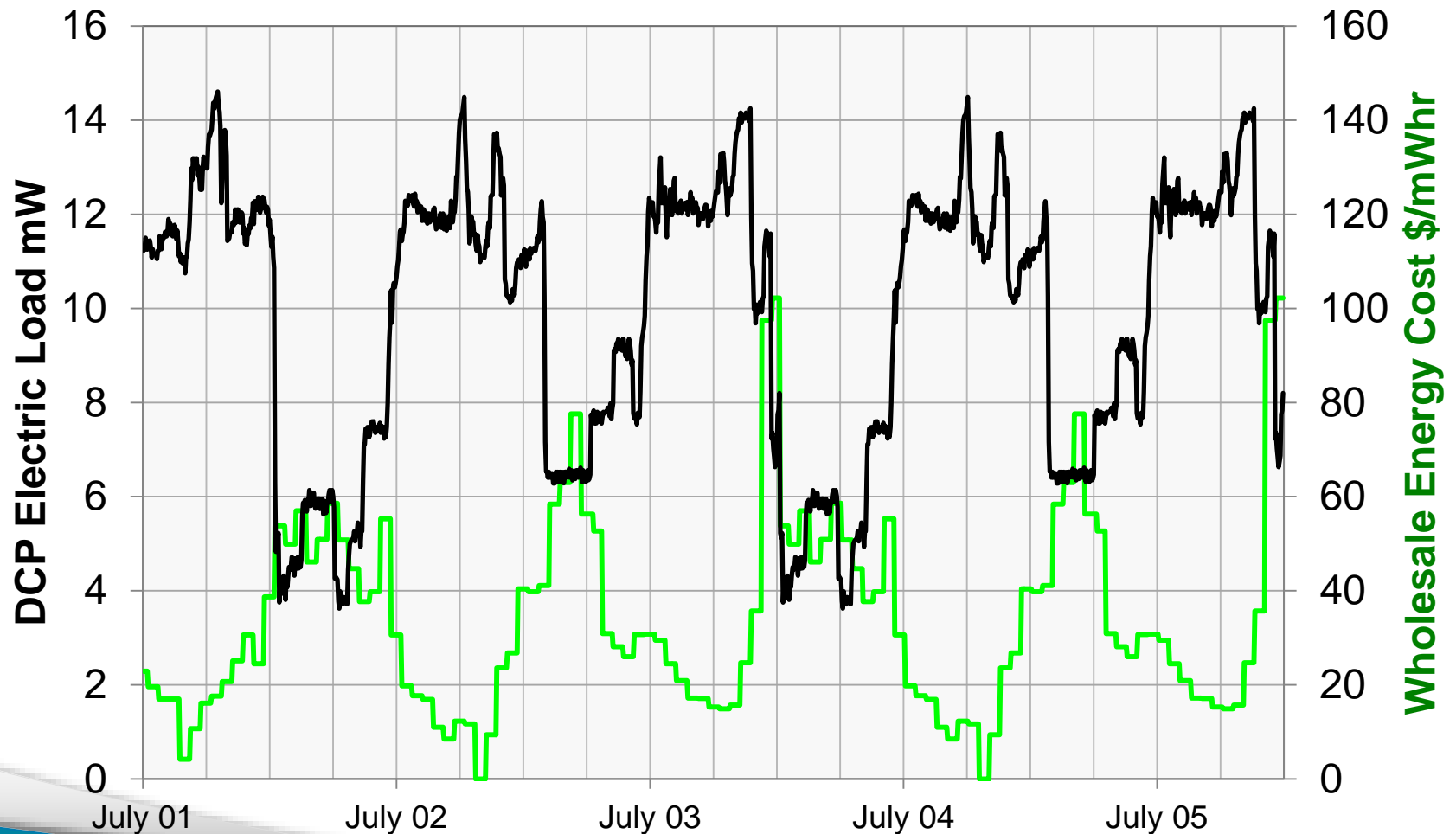
- Rolling blackouts
 - Cash incentives
 - Higher energy costs
 - Demand charges
 - Energy charges
 - Connection charges
- Tariff-Based
or
Market-Based**

Southern California Edison, Schedule TOU-8-RTP General Service-Large, Real Time Pricing*



* Hourly UG Rate – From 2 kV to 50 kV; Effective January 1, 2018

Buy Low-Sell High Discharge Strategy



Addressing Energy Supply Problems

- Rolling blackouts
- Cash incentives
- Higher energy costs
 - Demand charges
 - Energy charges
 - Connection charges
- Industry mandates or regulations

Thermal Energy Storage (TES)

Typical Project Drivers / Benefits

Shift cooling from peak to off-peak periods.

Reduce peak power demand & energy costs.

Provide low-capital-cost peaking capacity.

Add redundancy / reliability / resiliency.

Improve operational flexibility.

Improve balance of thermal & electric loads for CHP.

Enhance DC network capacity (via temp or location)

Types of TES for District Cooling

Latent Heat TES Systems (phase change)

- Typically, **Ice TES**

Freeze water at night; melt it the next day.

Sensible Heat TES Systems (temp change)

- Typically, **Chilled Water (CHW) TES**
- Also, **Low Temp Fluid (LTF) TES**

Chill water (or fluid) at night; use it the next day.

Inherent Characteristics of TES

(typical generalizations only)

Volume

Footprint

Modularity

Economy-of-Scale

Energy Efficiency

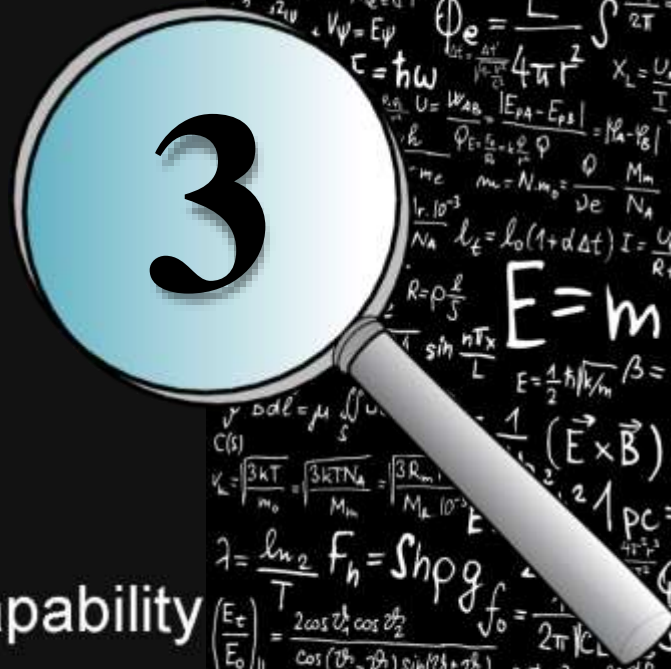
Low Temp Capability

Ease of Retrofit

Rapid Charge/Dischrg Capability

Simplicity and Reliability

Can Site Remotely from Chillers



[illegible]

3 Key Decision Drivers

- Chiller selection
- Size
- Chilled water temperatures

Chiller Selection Considerations

Chilled Water Storage

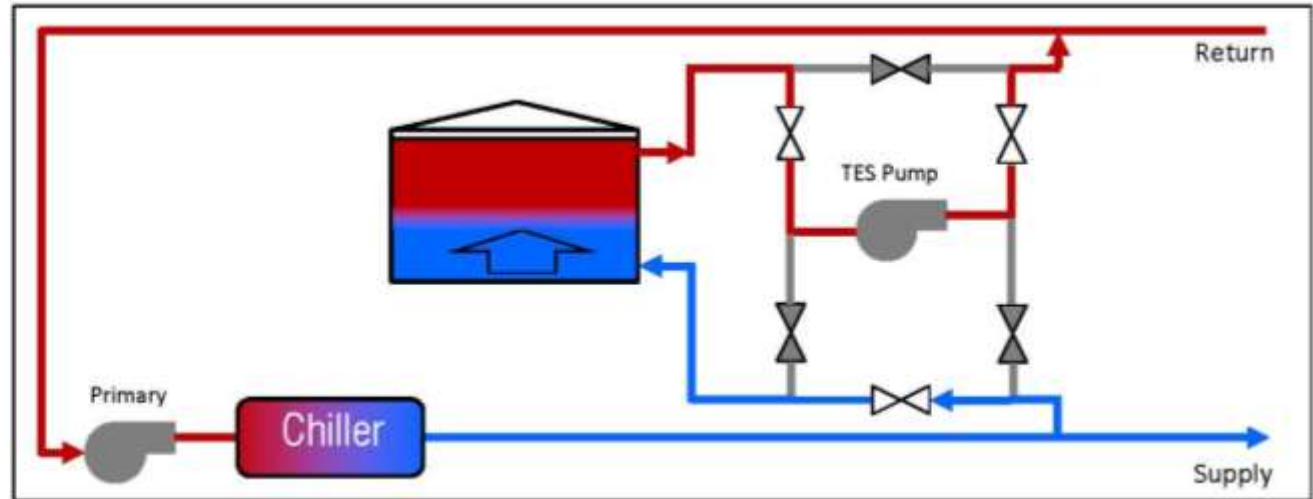
- Water as heat transfer fluid

Ice Storage

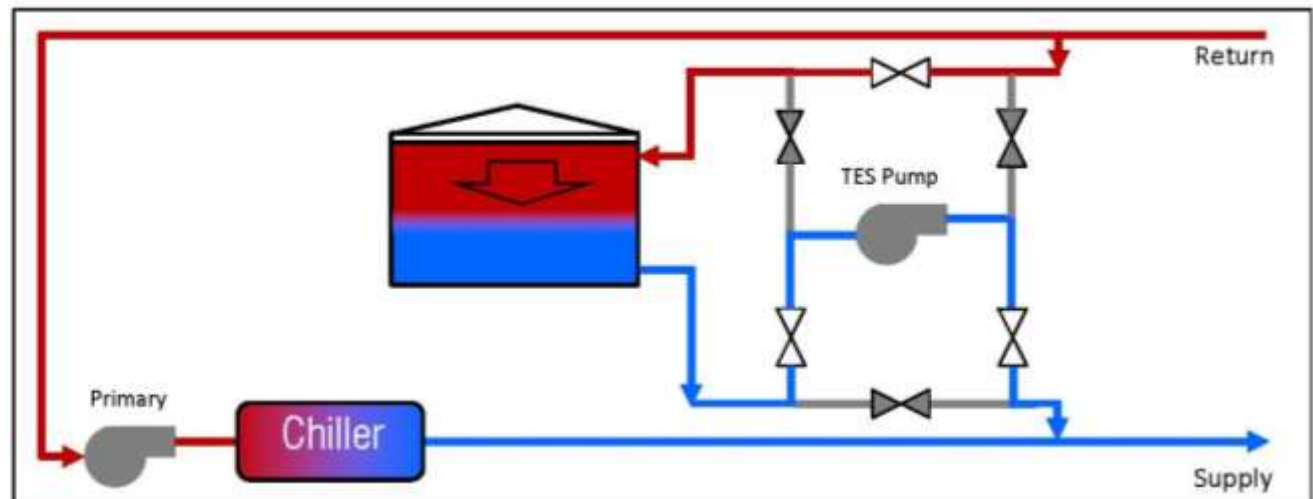
- Glycol as heat transfer fluid

Stratified Chilled Water Storage

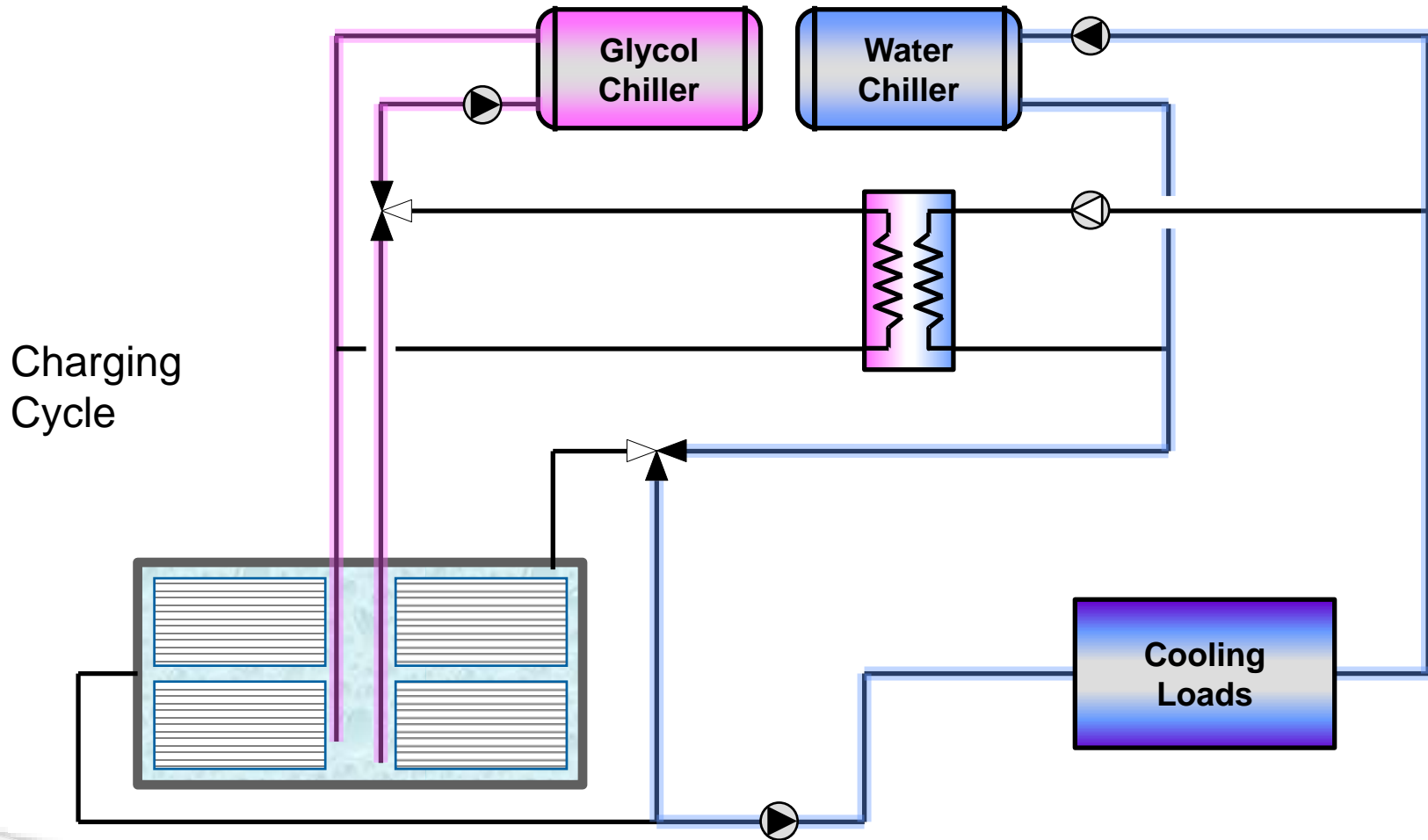
Recharging Cycle



Discharging Cycle



Ice Storage Storage



Chiller Selection Considerations

Chilled Water Storage

- Water as heat transfer fluid
- Lift capability
- Higher production efficiency
- Ease of retrofit
- Can locate TES tank at remote loop location

Ice Storage

- Glycol as heat transfer fluid
- Lift capability

Size Matters

Chilled Water Storage
is 6 to 8 times larger than
Ice Storage

Entergy Solutions – Houston, Texas

88,000 Ton-Hours (310 mW-Hours)



Los Angeles, California



Sacramento, California



Photos courtesy of CB&I.



District Energy is Green Energy!

Phoenix, Arizona



Singapore



Advantages of Colder Chilled Water Supply Temperature

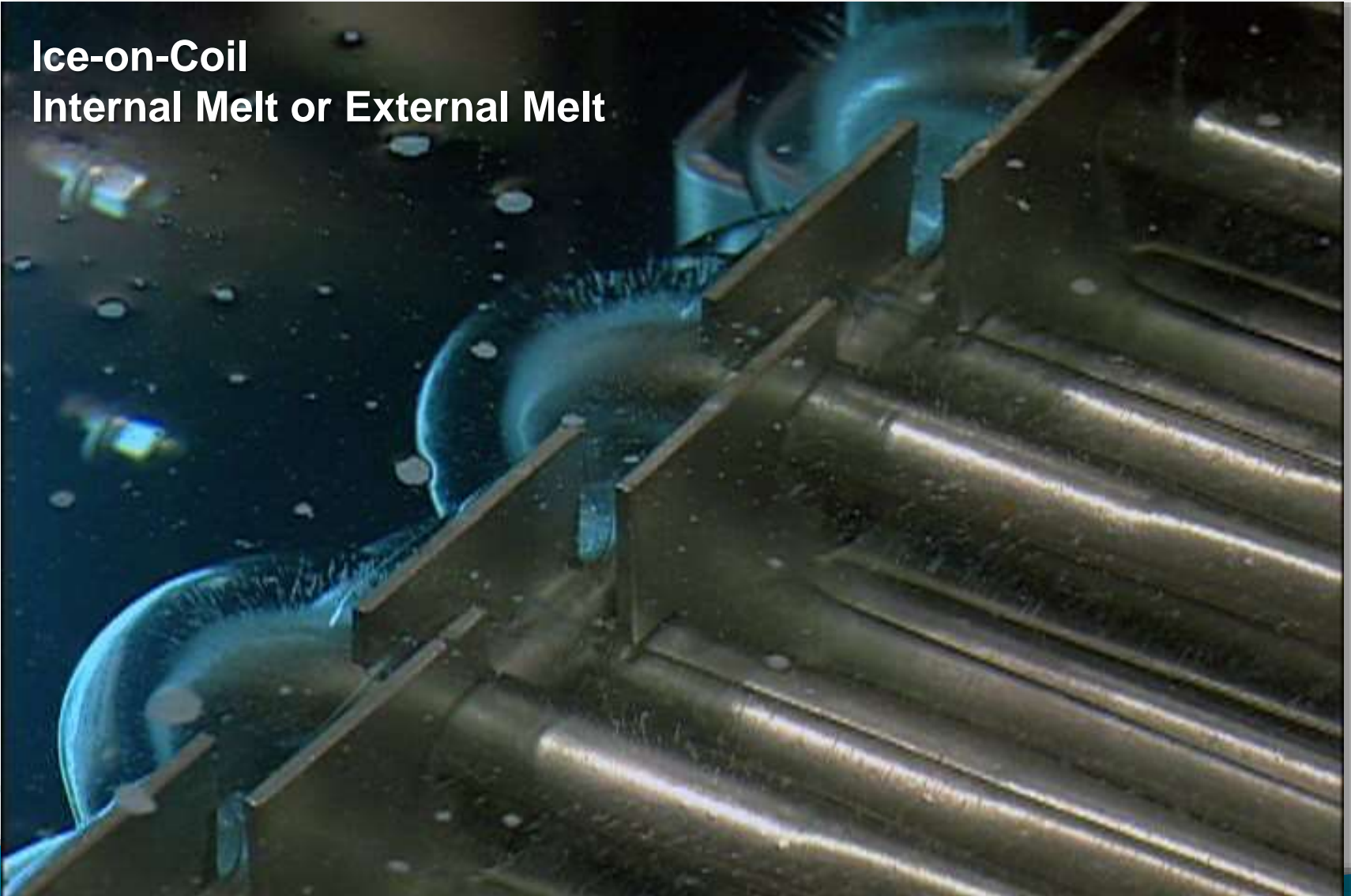
- Reduced CHW loop flow
 - Reduced pumping energy
 - Maximize distribution piping asset value
- More economical building isolation (energy transfer station) with smaller heat exchangers



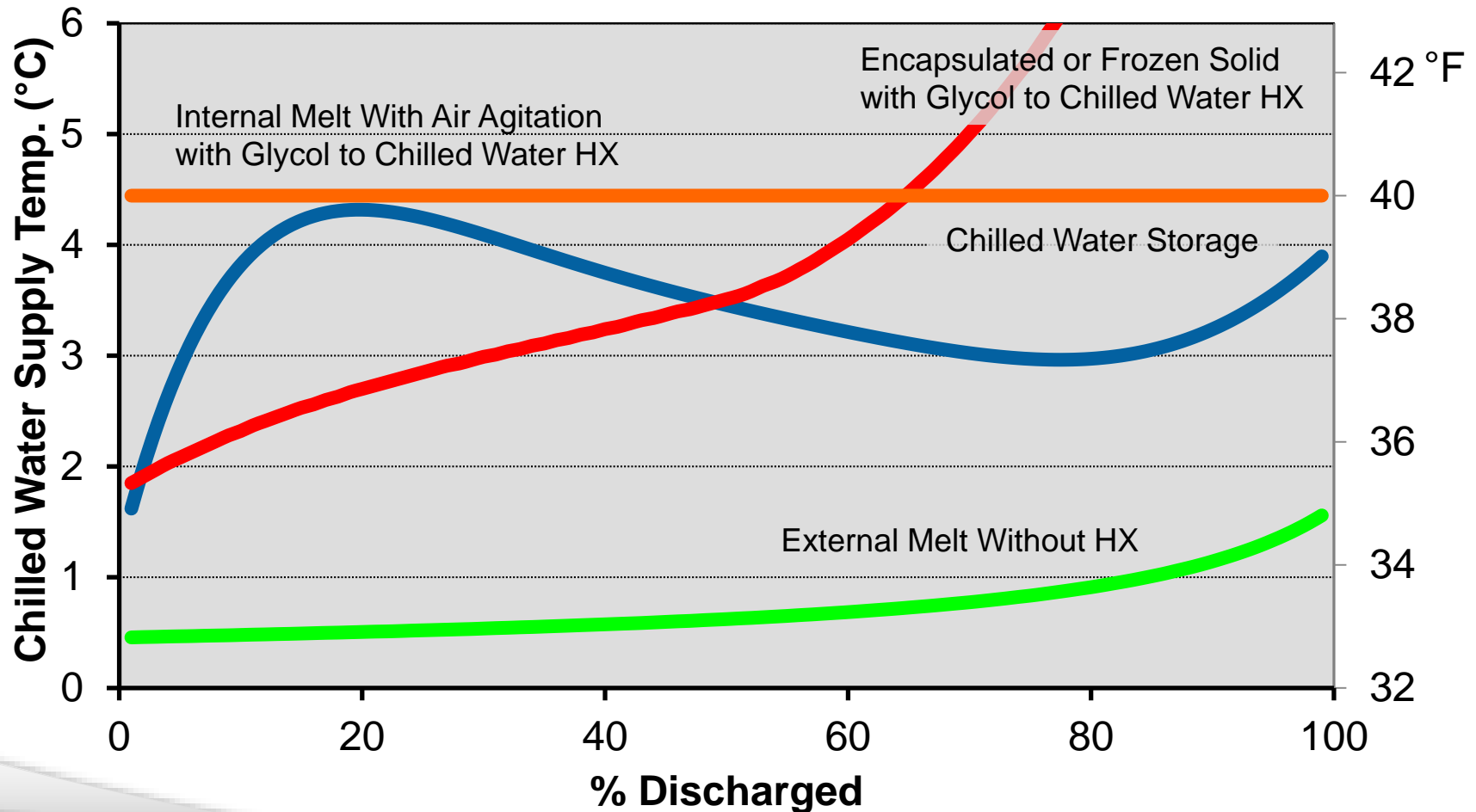
Photo Courtesy of Alfa Laval

Ice Storage System Types

Ice-on-Coil
Internal Melt or External Melt



Chilled Water Supply Temperatures



3 Key Decision Drivers

- Chiller selection
- Size
- Chilled water temperatures



Questions?

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