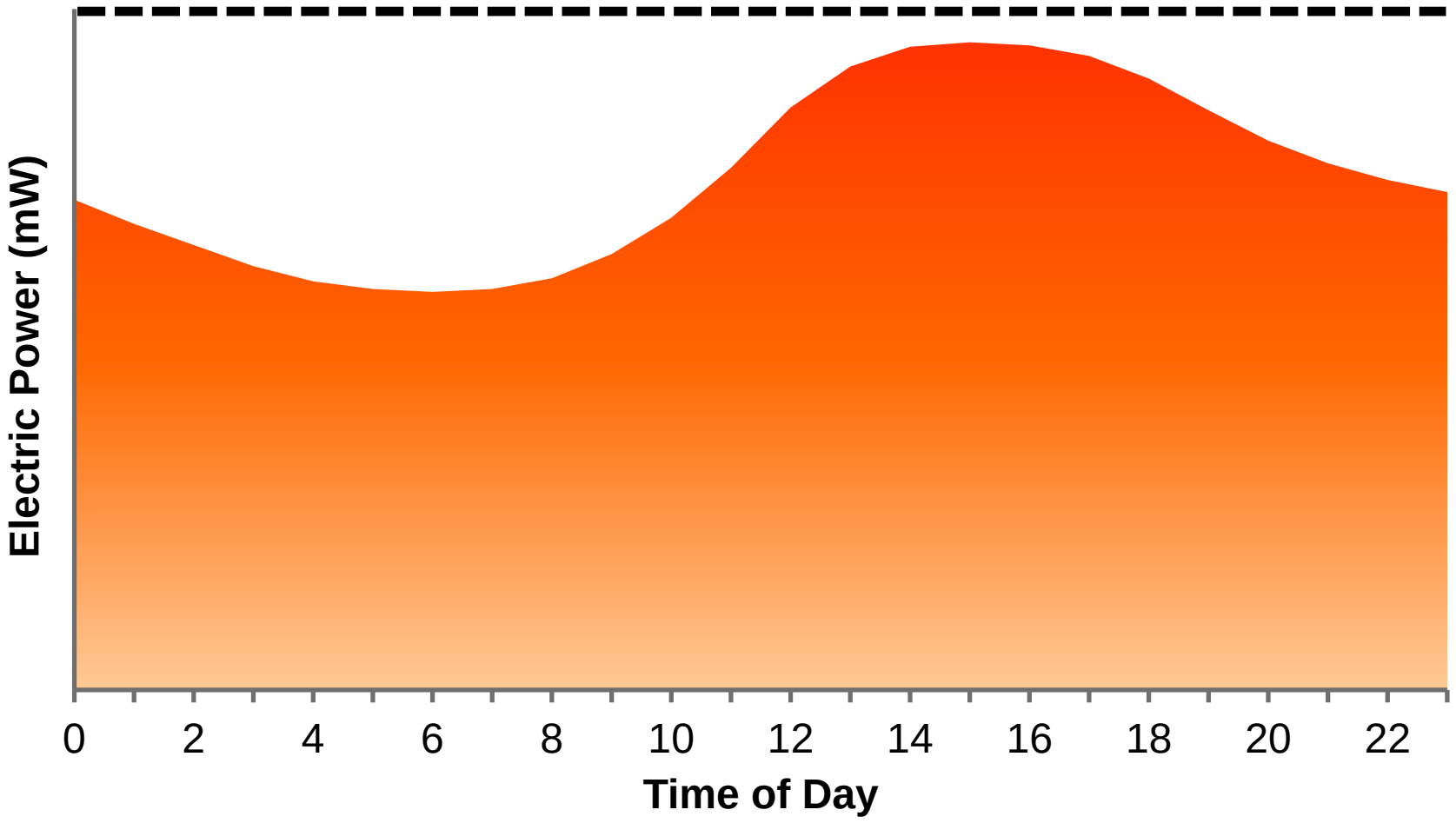
Thermal Energy Storage for District Cooling

Steve Benz

Director of Global Thermal Storage and District Energy

Daily Electricity Demand vs. Supply



Addressing Electric Supply Problems

- Rolling blackouts

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

Eskom

- 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

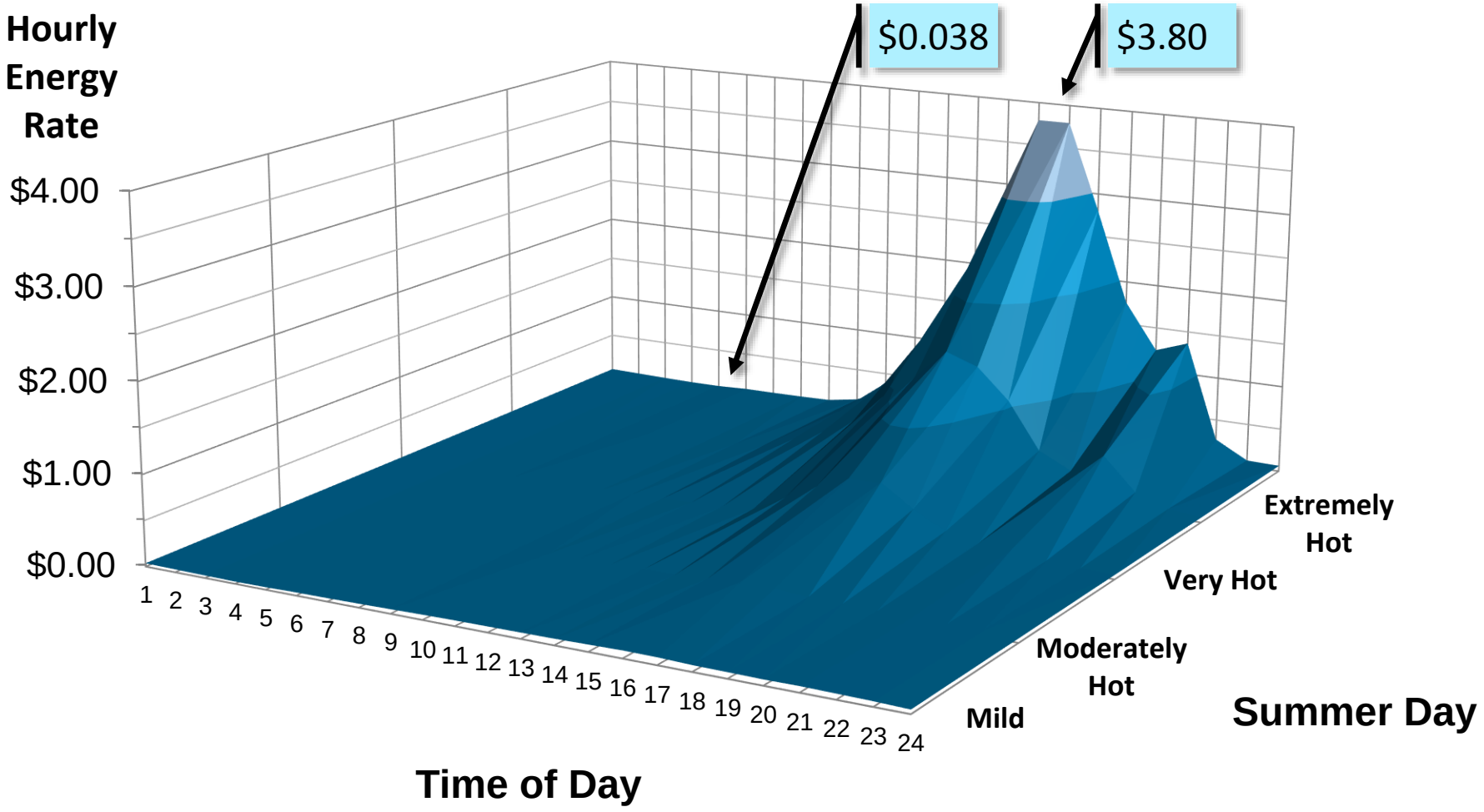
Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

Addressing Electric Supply Problems

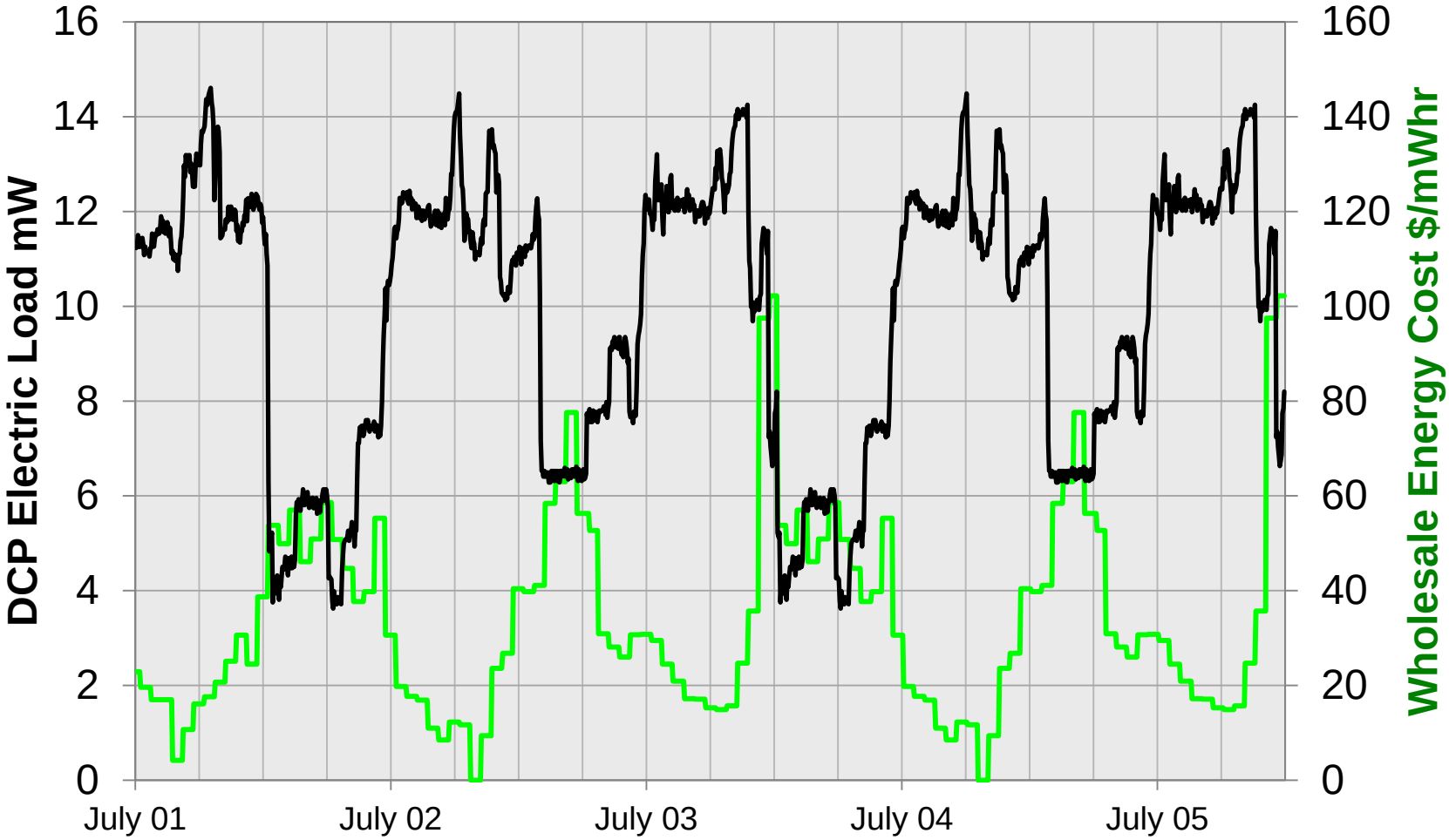
- Rolling blackouts
- Cash incentives
- Higher energy costs
  - Demand charges
  - Energy charges
  - Connection charges

Tariff-Based or Market-Based

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



Buy Low-Sell High Discharge Strategy



Addressing Electric 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)

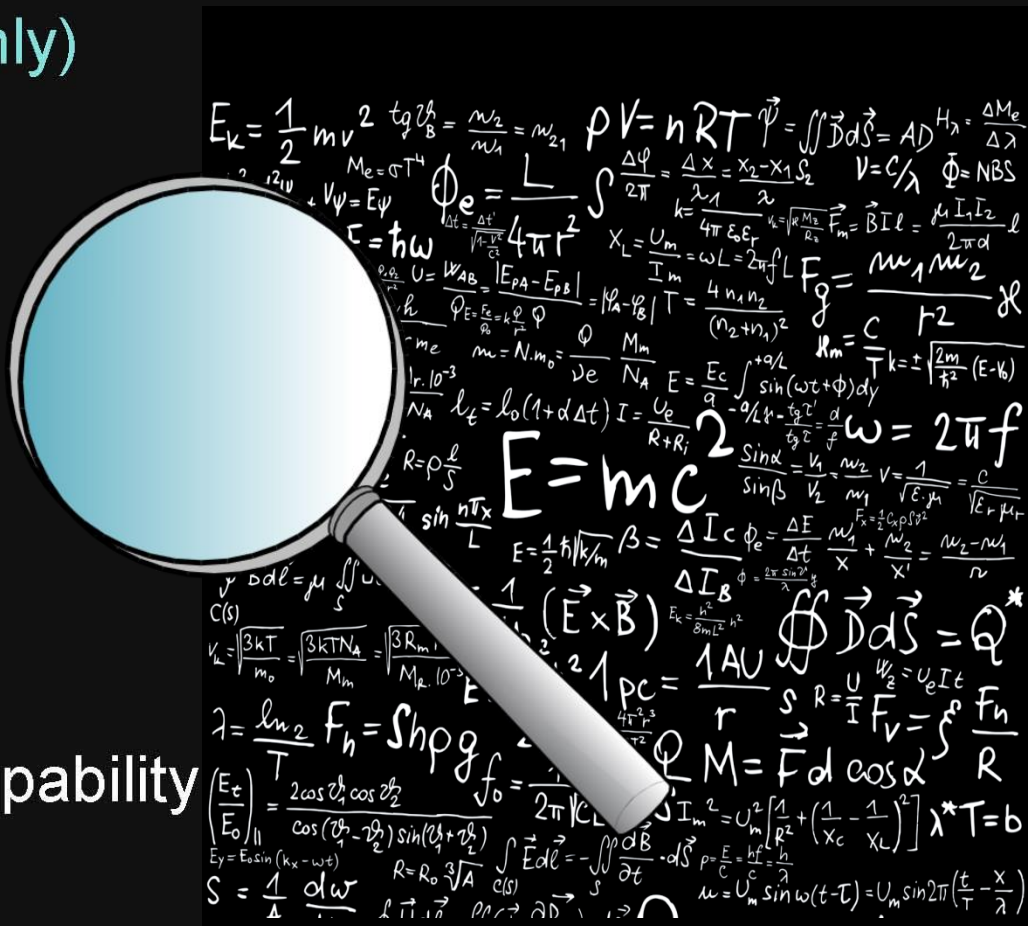
- Typically, Chilled Water (CHW) TES
- Also, Low Temp Fluid (LTF) TES

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



3 Key Decision Drivers

- Chiller selection
- Size
- Chilled water temperatures

Chiller Selection Considerations

Chilled Water Storage

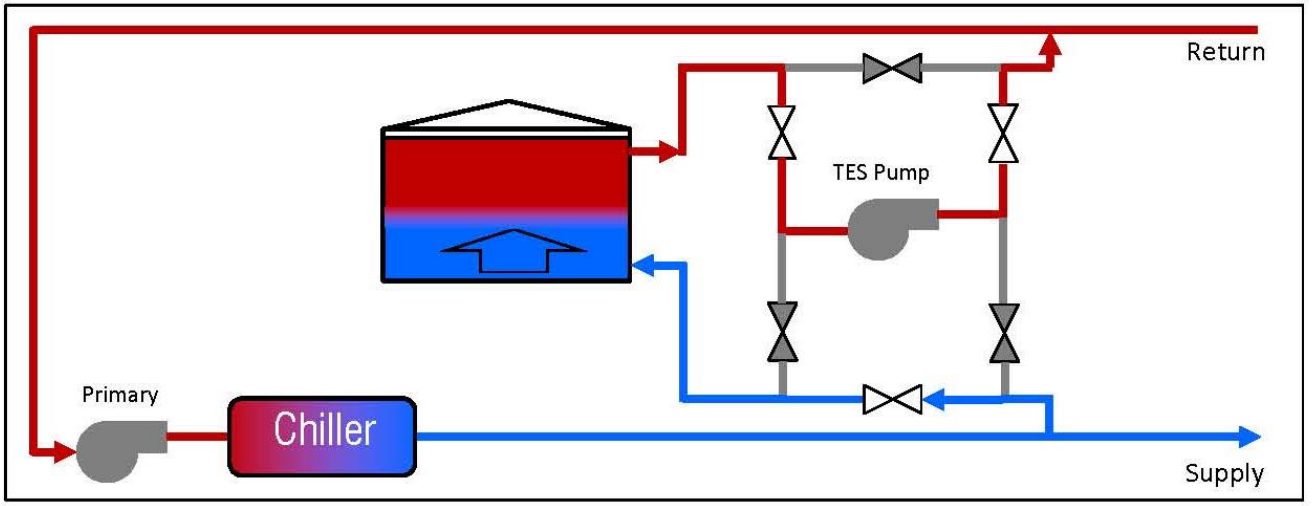
- Water as heat transfer fluid

Ice Storage

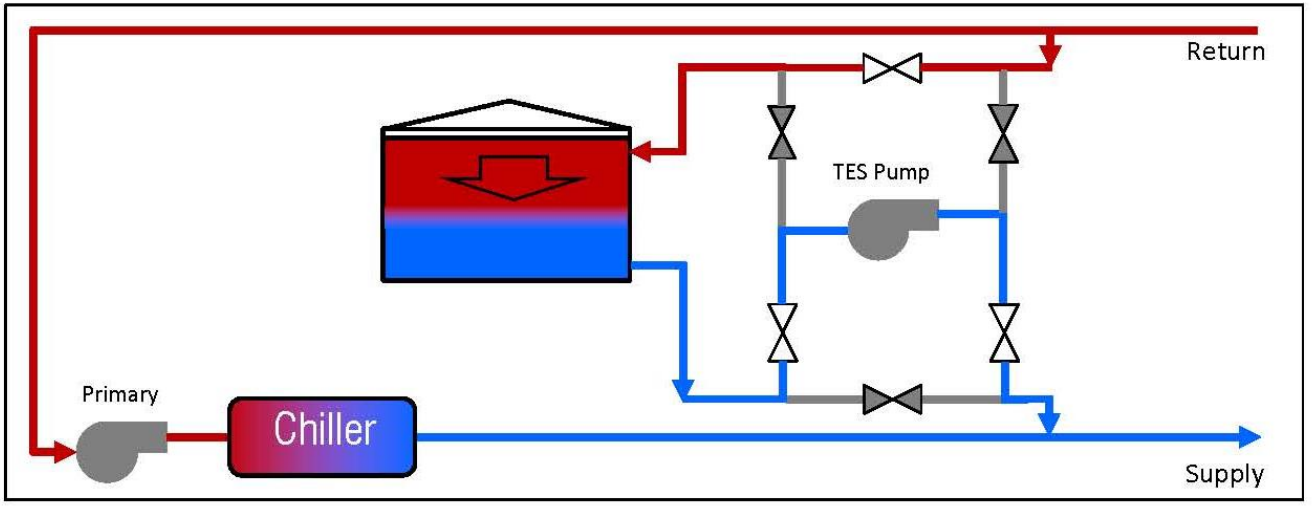
- Glycol as heat transfer fluid

Stratified Chilled Water Storage

Recharging Cycle

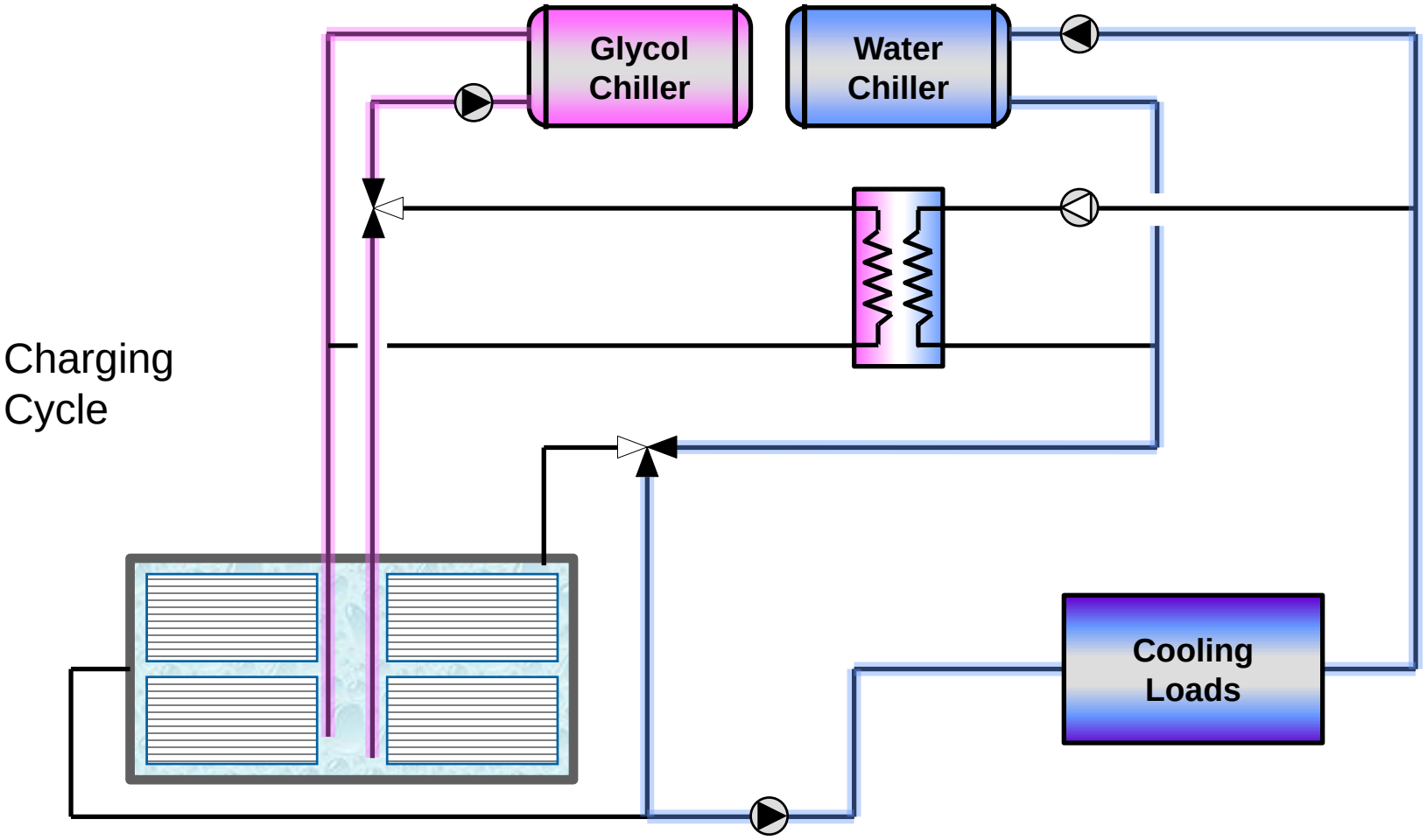


Discharging Cycle



Figures courtesy of CB&I.

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

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

2008: 3rd International District Cooling Conference & Trade Show – Dubai

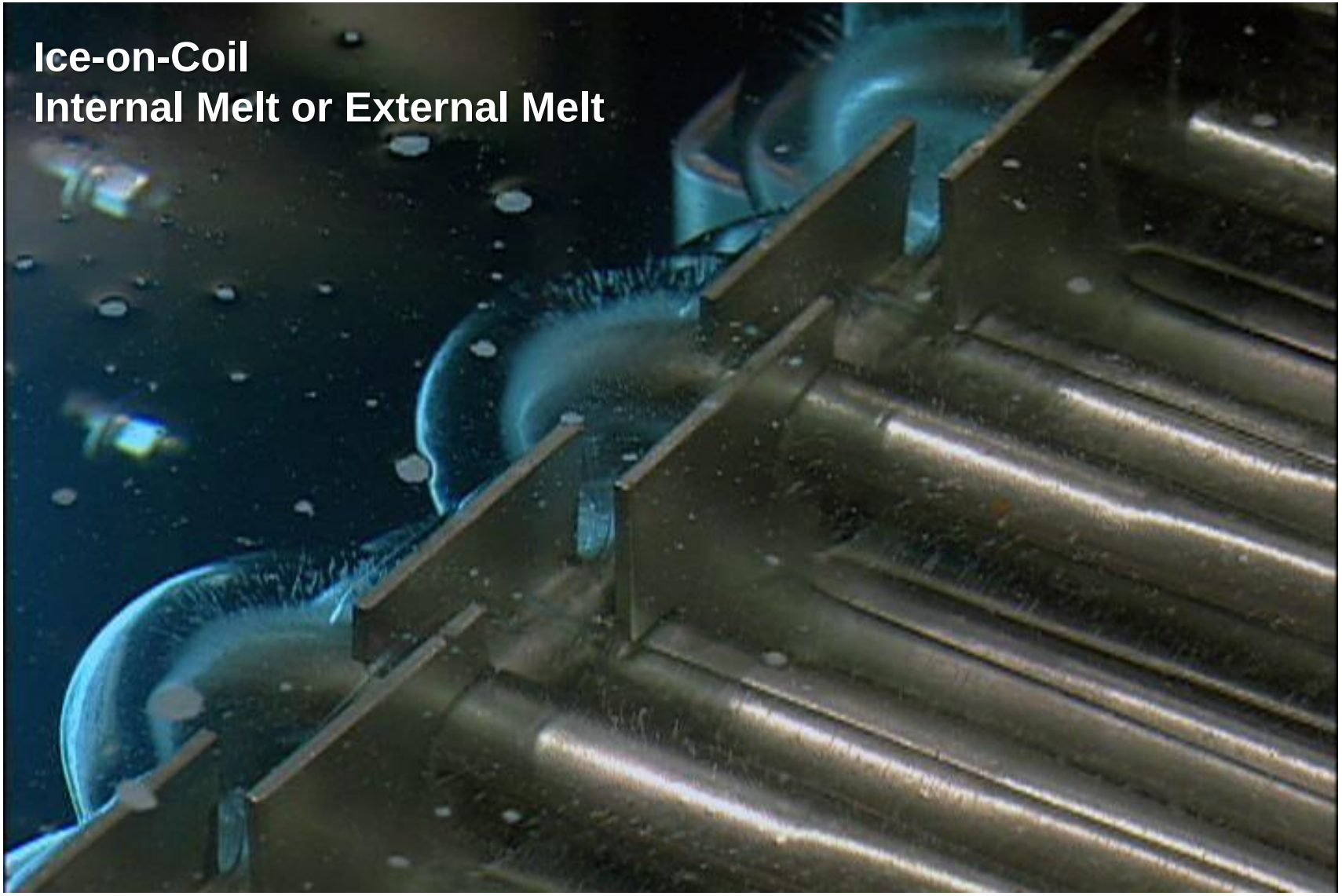
Photos courtesy of CB&I.

Singapore

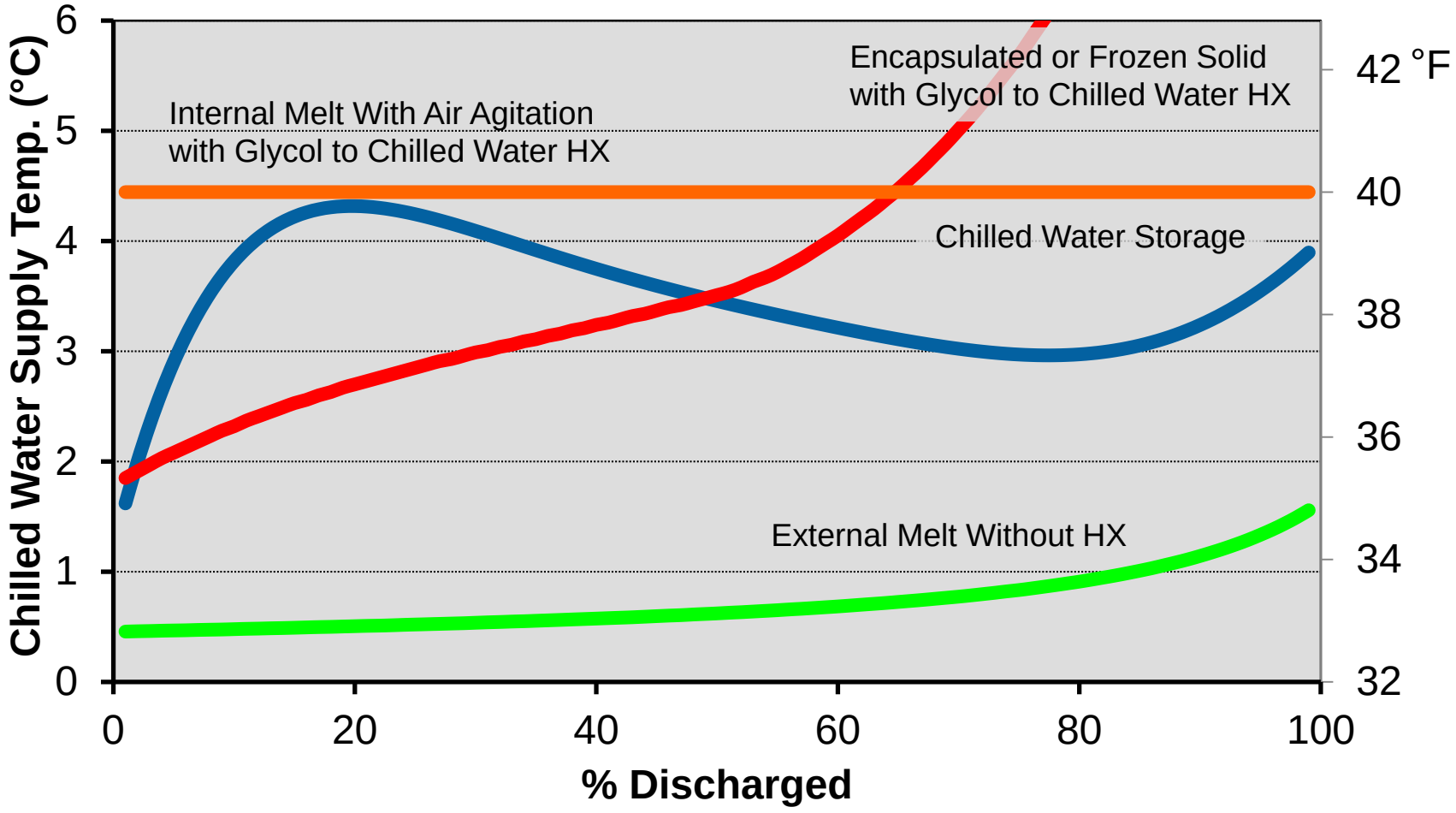
Advantages of Colder Chilled Water Supply Temperature

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

Ice Storage System Types



Chilled Water Supply Temperatures



3 Key Decision Drivers

- Chiller selection
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- Chilled water temperatures

Questions?

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