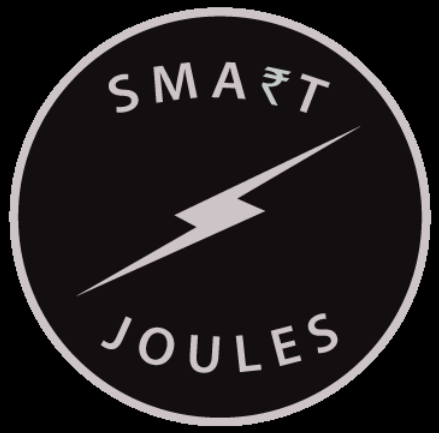
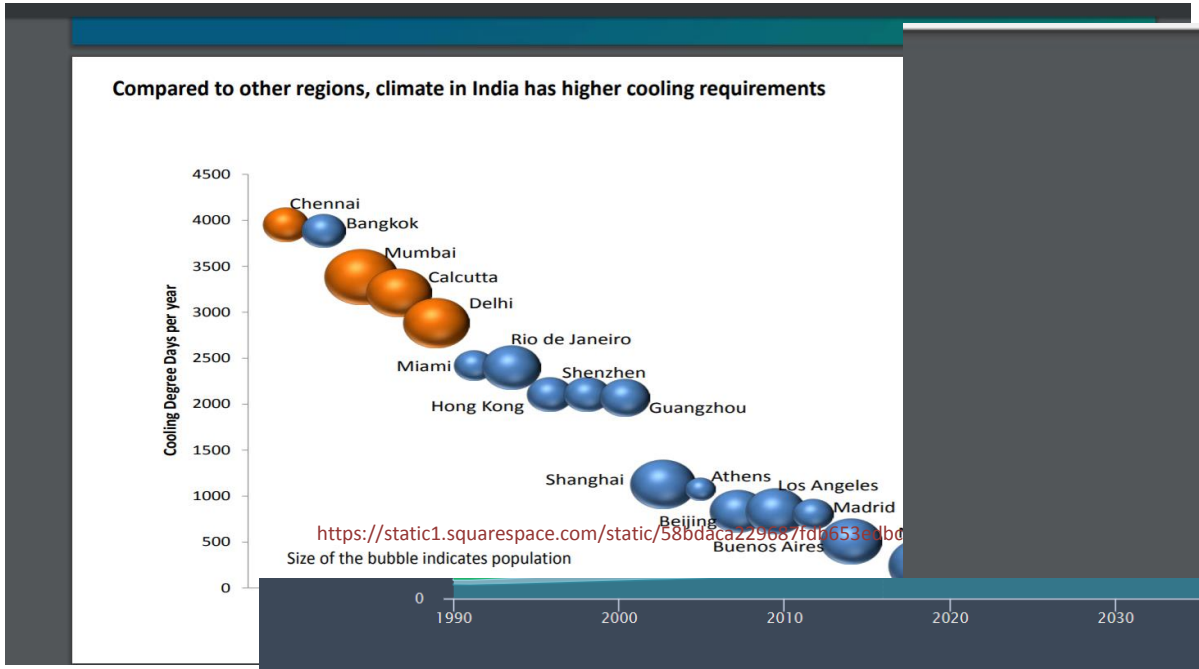


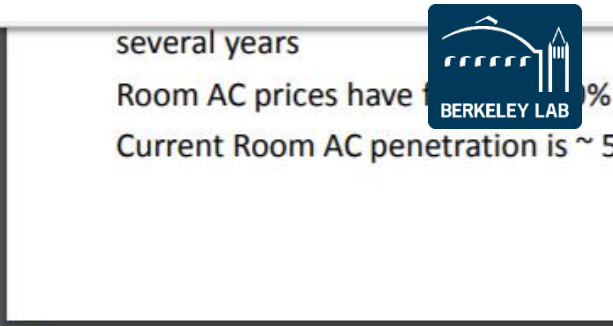
DeJoule: Cost-Effective AI + IoT to Dynamically Optimize Variable Energy Systems

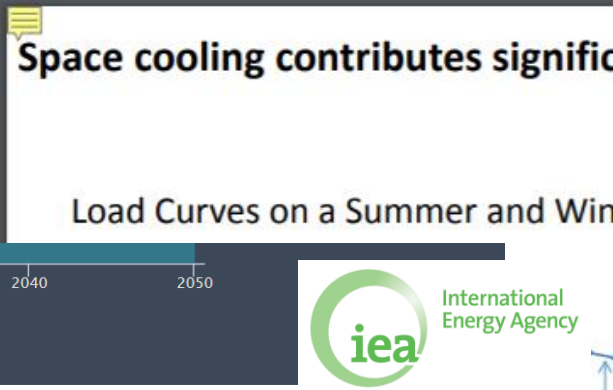
Prepared for: Asia Clean Energy Forum
Manilla, Philippines

June 7th, 2018

Cooling Consumes a Lot of Energy, Especially in Asia







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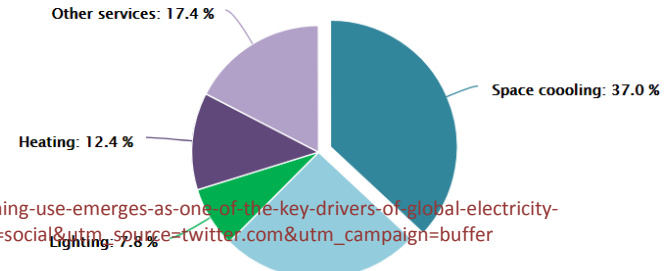
Cooling is the fastest growing use of energy in buildings

Without action to address energy efficiency, energy demand for space cooling will more than triple by 2050 – consuming as much electricity as all of China and India do today

Share of final electricity demand growth to 2050



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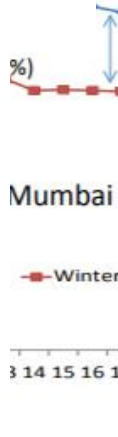
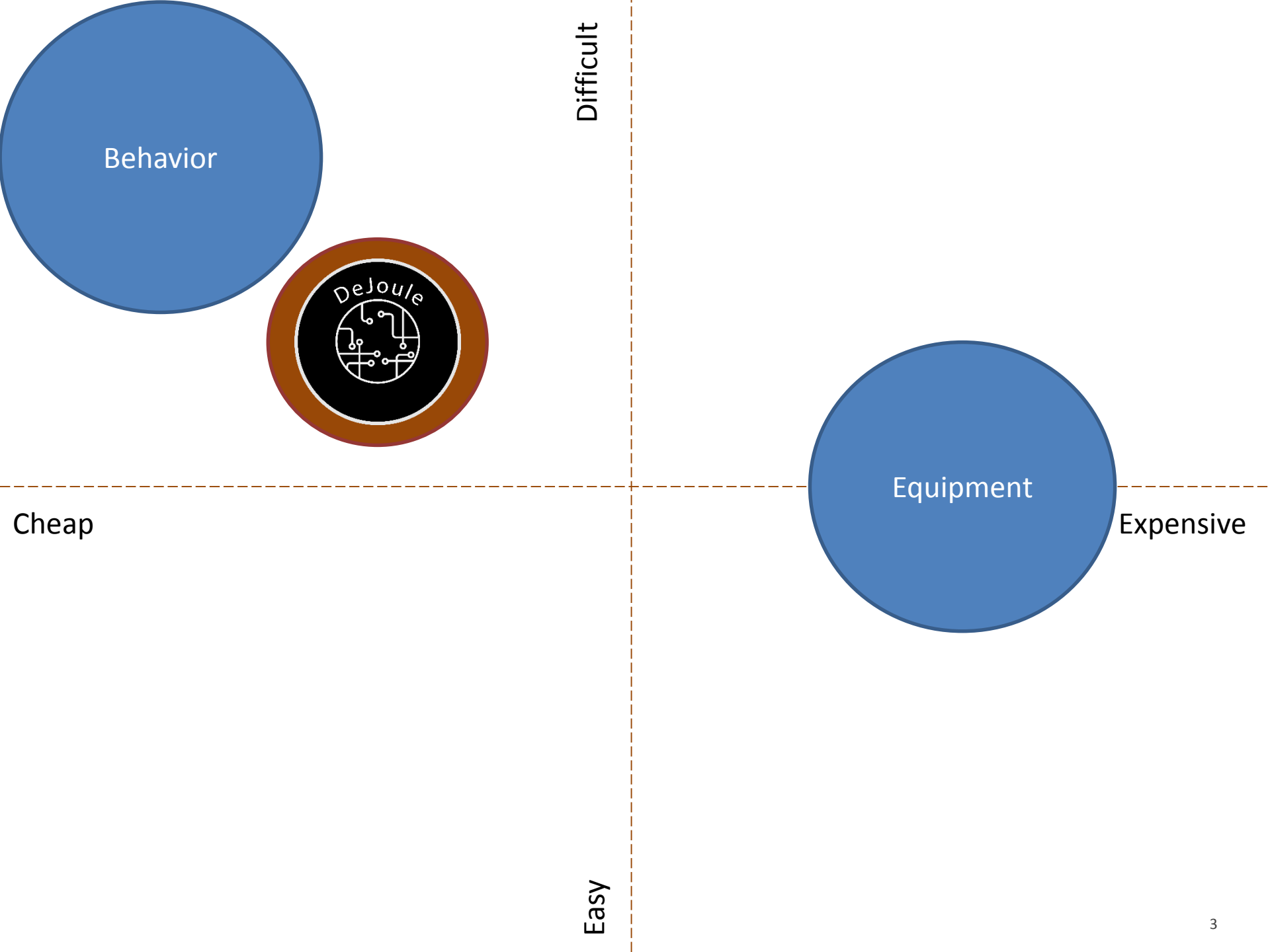
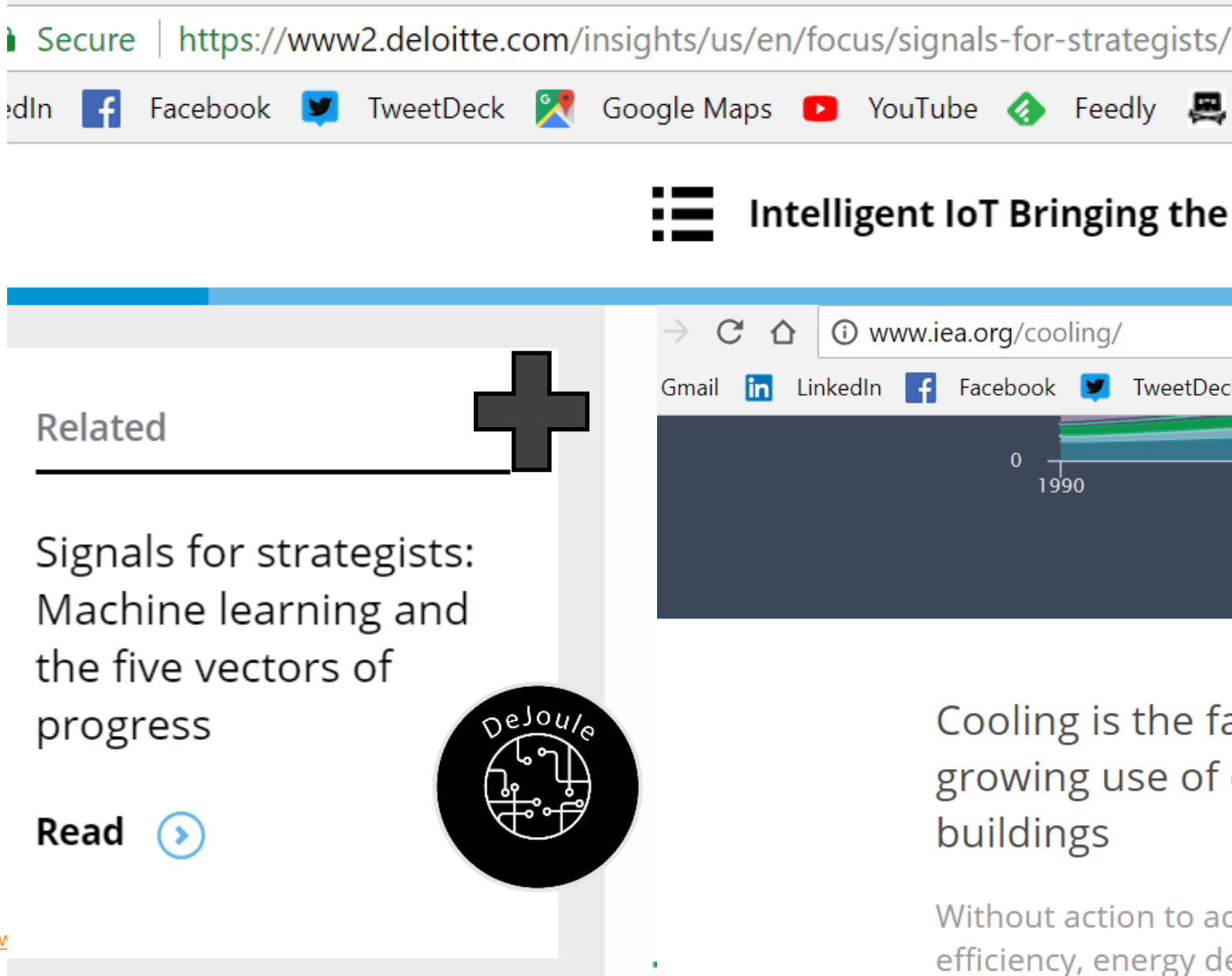



Behavior
DeJoule
Difficult
Cheap
Equipment
Expensive
Easy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Case: Sant Parmanand Hospital, Delhi

Optimizing Pre-Cooling Times

All OTs Switched on 2 hours Prior to Operations

Operation Theatre #1

Day	Set Point (C)	Time Taken To achieve setpoint
Fri	16	1 Hr 10 m
Sat	16	50 m

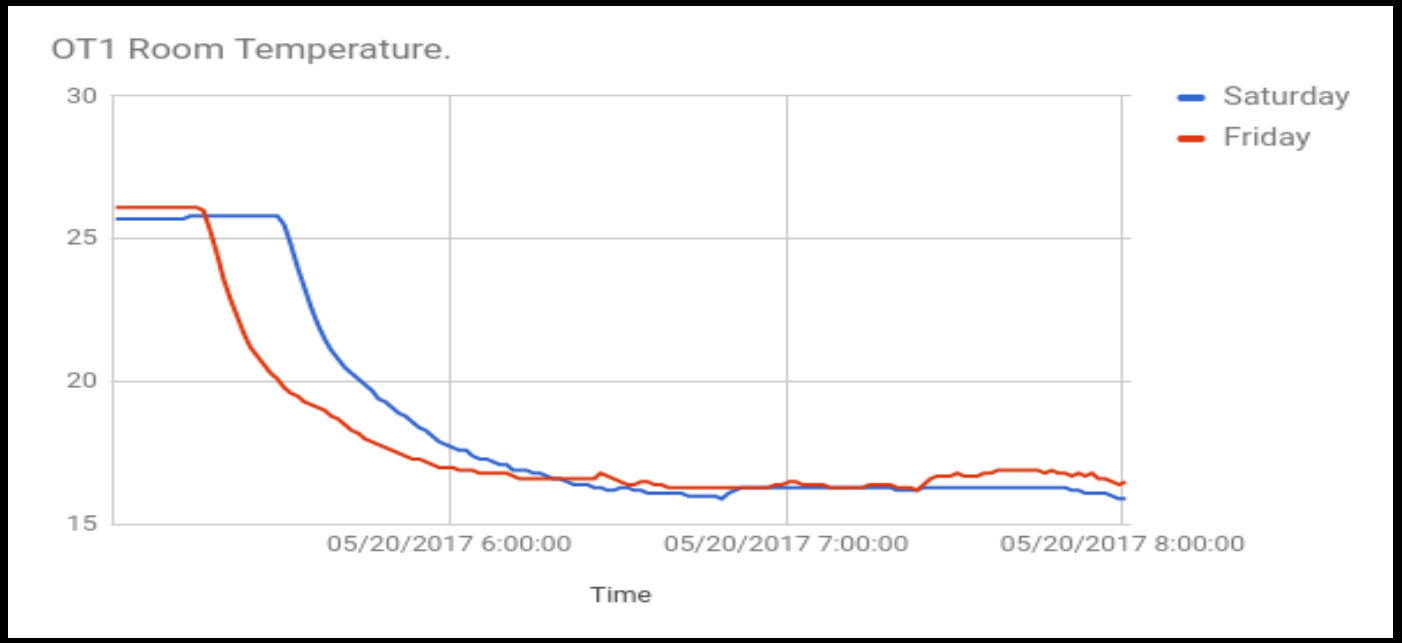
Operation Theatre #2

Day	Set Point (C)	Time Taken To achieve setpoint
Mon	19	1 Hr 57 m
Tue	19	1 Hr 30 m
Wed	19	1 Hr 30 m

Optimizing Temp. Set Points and Start Times

OT1 was pre cooled to ~16°C by 6am while use started at 7am.

Could the temperature have been kept ~20°C until 6:45am?



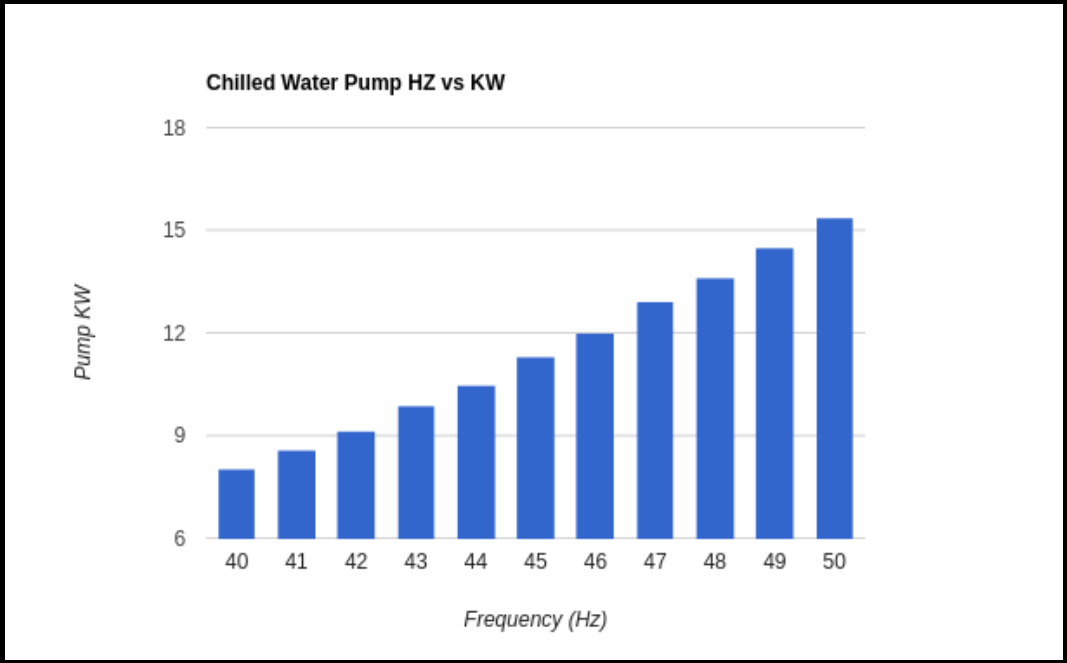
Finding Optimal Chilled Water Set Point

Chiller Setpoint (F)	AHU Water Inlet Temp. (C)	Avg. Supply Air Temp. (C)	Room Temp. Range (C)
44	7.5	11.1	18.6 - 19.6
45	8	11.7	20.0 - 23.0
46	8.3	12.6	20.0 - 23.0
47	9	12.8	21.0 - 24.0

Comfortable Room Temperature With 5-6% Less Energy

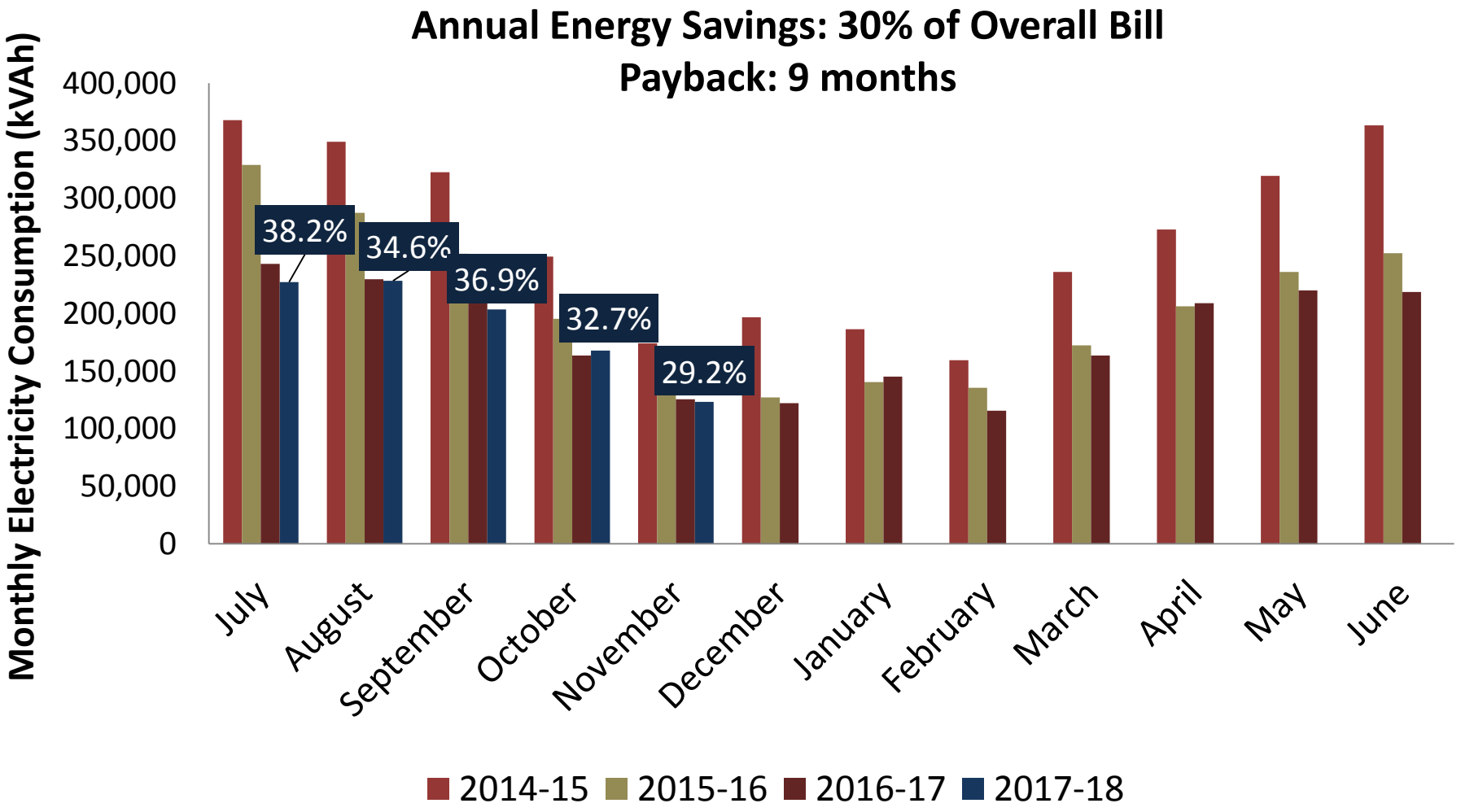
Finding the Right Pumping Combination

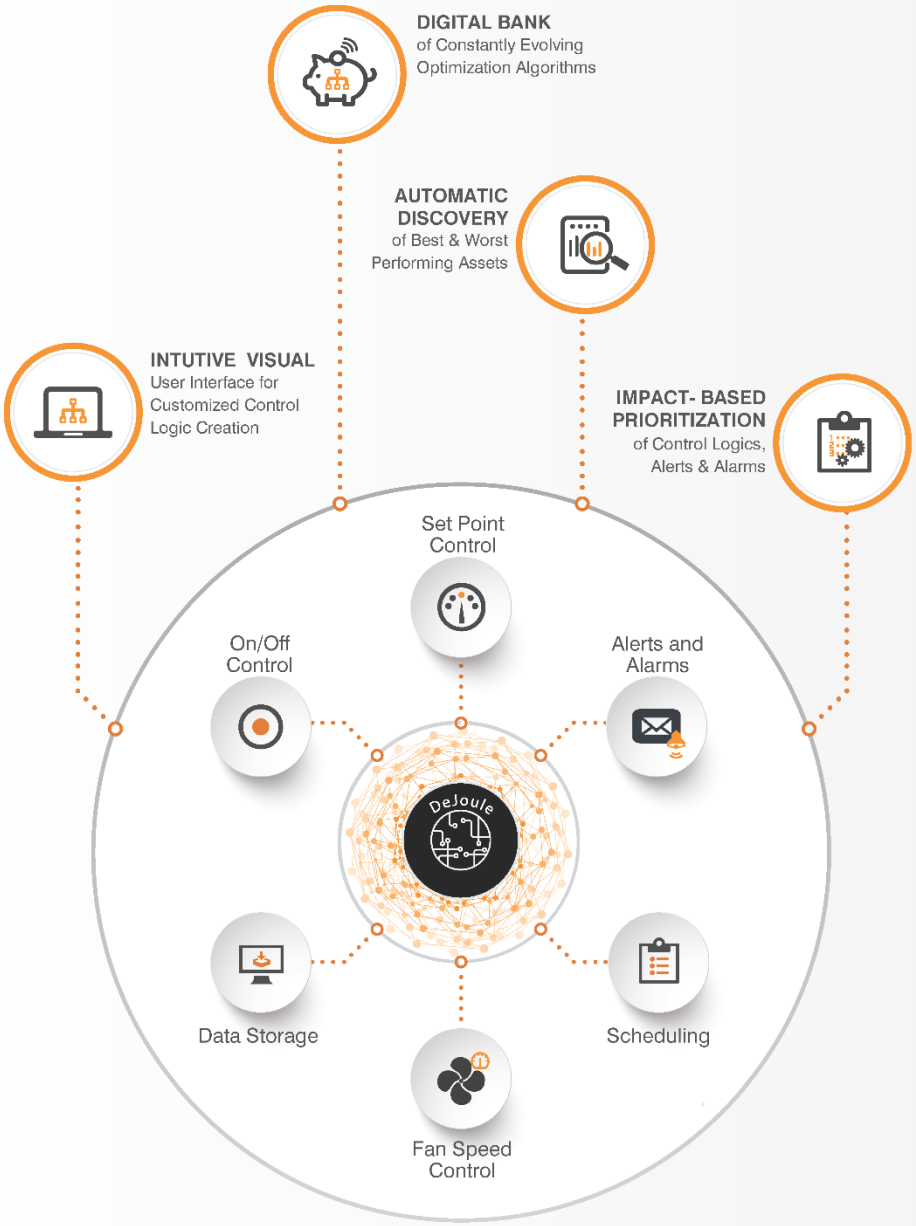
Chilled Water Pump Operations	Frequency	Flow	Total KW
Single Pump	42	454	11
Both Pumps	30 and 33	450	8.6 (4 + 4.6)



6% increase in kW consumption per 1 Hz (2%) rise in VFD frequency

Energy Savings Results





Generic BMS Features + DeJoule's Novelty

ENABLING I

Smart Joules designs, engineers and tests every single hardware that we utilize for DeJoule in-house. With complete control over the hardware and software, we are able to create a precisely engineered system to tackle the unique operational challenges encountered in field conditions that otherwise complicate delivery of the novel features described above. Our unique mesh topology for deployment of the hardware nodes, and the decentralized communication and computing platform

Distributed

Artificially Intelligent Network

enabled by it, prevent single point failure and enable extremely high fault tolerance to DDOS attacks, malware and even operational failures in facilities where they are deployed. Encrypted message passing between nodes safeguard against man in the middle attacks on the network.

Each hardware module serves a specific actuation & sensory purpose, and has the necessary computational capability to run a distributed artificial intelligence and advanced

Summary

The Question: What is the best combination of Chillers, Pumps, Cooling Towers, Chilled Water Set Points, Valve Positions and Motor Running Speeds to achieve desired comfort?

At any given point of time.

The Solution: **Continuously Find** and **Automatically Deploy** best operating points.

Reliably and Affordably.

Let’s Partner to Revolutionize Cooling.

Arjun P. Gupta, *Founder & CEO*
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