Transforming the world's cooling systems with Axiom Cloud

(Example high-quality notes document: Afresh talk)

Let us take notes here together!
Write down what would be useful to you if you weren't able to attend this event.

Event description
Refrigeration improvements help climate via several of the most impactful angles at the same time: energy efficiency (refrigeration accounts for 10% of global CO2 emissions), leaks of HFC gases, and food waste.

Axiom Cloud's "apps for refrigeration" help retail grocery chains solve their largest energy, maintenance, operations, and sustainability challenges by applying IoT, AI and automation to this underserved market. We currently have >80 booked subscriptions with 6 major North American grocery chains and refrigerated warehouse operators. We will discuss the climate impact and market opportunity of refrigeration improvements, and will dive into Axiom Cloud's technology stack.

Goals
- Make it useful to skim for somebody who didn't attend the event and doesn't have time to watch the full recording
- Make it easier for yourselves to share 1 thing you learned

Resources
- WoCl - http://workonclimate.org/
- https://www.axiomcloud.ai/
- Therma event at bit.ly/wocl-past-events - similar domain

Notes from the talk

Cooling consumes enormous amt of energy, 8-10% of all emissions, projected 33x by 2100.
C&I (commercial/industrial) customers use 28% of electricity for cooling.
25% of refrigerants (HFC) leak per year! Orders of magnitude more powerful than CO2, #2 sol on Drawdown.
$120B/y on energy and maintenance across grocery retail, cold storage, buildings/campuses with central HVAC. Axiom addresses grocery and cold storage.
In grocery retail, refrigeration is ~55% of all energy consumption, and usually runs 24/7 - super inflexible. And an unplanned refrigeration outage is a nightmare scenario, causes tons of food waste.

Axiom vision tackles: 1) add power flexibility to cooling systems 2) provide predictive maintenance 3) identify refrigerant leaks early.

Product: “self-driving refrigeration”, software-only: attaches to existing refrig controller (there are like 3 of them across North America), integrate with sensors / status data streams, build model of the physical system. Then customers subscribe to apps: Facilities Analyzer (dashboard - already impactful), Virtual Technician (maintenance insights from data instead of calling technician), Virtual Battery (transform into flexible grid asset).

Virtual Battery under the hood:

- Forecast load (including weather and energy price forecast)
- Optimize performance for forecast - optimal load profile for saving energy/money
- Precool (“charge”) when electricity is cheaper - turn on more compressors
- Loadshed (“discharge”) - shut down compressors

Virtual Battery

- energy bill mgmt: (precools to stay below load threshold and below system capacity)
- demand response: on DR event, shuts down compressors… ⇒ 193 kW of flexible capacity.

Virtual Technician:

- Predicts failures, recognizes setpoint changes (sometimes technicians will change it when it shouldn’t be changed)
- Diagnose root causes - ML + decision trees to identify possible reason

Example: leak detection from anomaly in “receiver level” - detects slow leak that was invisible to the store’s sensors that measure it in the air. Detected leak early, sent notification to store mgr and service provider, couldn’t resolve leak remotely ⇒ sent a tech, continued monitoring.

Hiring for experienced SWE / tech lead.

Stack: Python, microservices, k8s, transitioning from custom cloud setup to native AWS,

Q&A

Q: What’s it like to work at Axiom?
Axiom Cloud founded ~1y ago, but team has been together for much longer. ~15 people, fully remote, mix of SWE + data scientists + thermal systems eng + sales/bizdev.

Q: ML methods you use?
A lot can be done with linreg. Use some other forecasting methods, have some LSTM models.

Use and pricing patterns change over time, eg now stores can have solar and energy price can go negative.

Q: Axiom’s maturity around using the algorithms for utility DR - is it in R&D stage, is it being commercially used?

Used commercially. Have successfully done DR response events, can respond to grid signals and curtail demand. However this isn't the biggest part of the value they deliver, maybe 10% - the other 90% is from reducing electricity bills, reducing peak demand.

Q: Reducing energy bills vs emissions
Currently utilities usually have fixed price structures. During times of the day like 4 or 9pm energy is more expensive. This correlates with highest grid demand.
Could extend that to markets with real-time pricing.
Analyzing emissions part of roadmap. One of the strategic OKRs is finding and sharing climate impact in every project.
In CA, carbon impact available through (SGIP?) program. But the primary impact is that they make the overall grid more flexible/intelligent, though much harder to quantify ⇒ enables connecting more intermittent solar, car charging etc. without stability issues.

Q: How do supermarkets manage produce overnight - do they keep refrigeration systems running overnight or store in a cooler?
They keep everything running overnight. Can do some things to reduce overnight refrig load, close doors, put up curtains over open-air cases, sometimes will put produce in a back cooler.

Q: Read that Trader Joe's has the worst performance on energy/efficiency vs Whole Foods - why?
Don't know about Trader Joe's - but they're a smaller store, less efficient tech. They don't have doors on cases. Whole foods has cases with doors.
TJ had headlines about refrigerant leaks.

Q: Where do HFC leaks come from?
Everywhere. Central refrig system is a 5-6ft tall rack, 10-12ft long of compressors in a back room + hundreds of pipes spidering through the supermarket. Leaks can be in interconnections, in cases, etc. Leak detection systems are mostly in the back room, really tough to have it across the store.

Q: <didn't quite get>
Load shedding more of a challenge with medium temperature and fresh produce - has to stay in narrow temp range. It's possible but have to be extra careful.
Air temp might change without product temp changing.

Q: THoughts on entering markets that don't have refrig equipment yet vs. dealing with legacy equipment?
Completely different challenges, but some similarities.
The cold chain *is* coming; maintenance challenges will be similar though - remote monitoring/analysis, root causing still relevant. The energy side of it is less applicable: grids are much weaker, don't have infra to enable profitable load shedding.

Basic tech is the same - vapor compression. Could make a different with the controller though: legacy controllers weren't built to do this stuff - with tighter integration could have faster response cycles.

Q: Differences in tackling different parts of the cold chain
Starting in groceries, but climbing up the cold chain - just deploying now to a warehouse customer (cold storage). Same technologies for the most part. From there, will go to food processing/packaging/manufacturing. And beginning to dip toes into HVAC.
Cold transportation: on roadmap but far out.