Emerging Technologies Summit
MAKING THE CONNECTION:
From Energy Efficiency Innovation to Delivery

April 19 – 21, 2017
What Does the Future Hold? Energy Efficiency
Tech Trends to Watch the Next 5 Years

AMMI AMARNATH, COLLIN COKER, ROBERT SPEARS, SCE PIKE, SCOT DUNCAN
WHAT DOES THE FUTURE HOLD?

Collin Coker
VP of Sales and Marketing
Viking Cold Solutions, Inc.
WHAT’S DRIVING CHANGE?

- High electricity costs
- Supply and demand challenges
- Managing unstable generation resources, such as wind and solar

Energy consumption has increased at a faster rate than domestic energy production over the last fifty years in the U.S. when they were roughly equal.

In 2015, total U.S. electricity consumption was about 3863 GWh
What’s Next?

- Conservation
- Greater efficiency
- Consumer involvement

The days of traditional generation and load growth are past us now.

The U.S. Energy Information Administration's projects that world energy consumption will grow by 48% between 2012 and 2040.
• New, advanced, intelligent resources will be developed to meet supply and efficiency needs

These new resources, whether generation in nature or demand reduction technologies, all tend to have a level of improved intelligence and further enable the consumer to affect the marketplace.

From 2000–2012 renewable energy grew at a rate higher than any other point in history.
HOW MIGHT IT WORK?

We already see a revolution of efficiency and demand management focus beyond that of building supply resources.

Successful restructuring examples of the electric industry include entities that can adapt to new possibilities.

This applies to generation, delivery & distribution, and consumer choices.

The utility of the future is tasked with the reality of reliability and management of the constant barrage and implementation of new technologies - nothing new in one respect. However, these changes and associated challenges must ultimately be embraced to enable progress.
CHALLENGING THE STATUS QUO

- Refrigeration is the 2nd highest operating expense for operators
- Refrigeration is the 3rd highest usage category of load in California
- Low temperature refrigeration is the highest energy user per cubic foot of any usage category
- Current controls and equipment technology is limited when constant low temperatures are required
- Flexibility to operate for efficiency, load shift, demand reduction, or all three is very rare

The Food & Agriculture Organization of the U.N., in its 2013 Food Wastage Footprint report, estimated that 1/3 of all food produced for human consumption is lost or wasted
WHAT’S NEXT IN THE COLD CHAIN

Intelligent Thermal Energy Storage – where Phase Change Materials combined with intelligent controls can offer flexible operations to address specific regional challenges.

• Addressing the highest energy usage category
• Capable of storing Solar Energy
• Addressing the critical need of cost effectively providing safe and stable temperatures for the transportation and delivery of food across the frozen food cold chain

By leveraging thermal energy storage technology in a freezer facility, warehouse operators can save at least 25% energy, utilities can better manage their loads, and consumers ultimately benefit from safer and more cost effective access to food.
Collin Coker – Viking Cold Solutions, Inc.

Vice President, Sales & Marketing
With over two decades of experience in the energy industry, and three decades of sales and leadership experience in B2B and B2C sales, Collin brings broad experience across both wholesale and retail energy. He has a consistent record of building and leading successful sales organizations, including Sr. Vice President Sales and Marketing for StarTex Power, Vice President of Sales for Gexa Energy, and Director of Sales for Direct Energy. His early wholesale experience began in the California market while directing Reliant Energy’s mid-market wholesale origination efforts. Collin has university sales and leadership certifications from schools, including the Wharton School of Business, Villanova, Rice University, and Motorola University. He attended Texas State University.
Questions
Liquid Cooling –
Saves electricity and enables higher density computing

Robert M. Spears
Chief Executive Officer

CHILLDYNE
LIQUID COOLING SOLUTIONS
BIG DATA ... is Exploding from Disparate Sources

Volume
- Data at Rest
  - Tera- to exabytes of existing data to process

Velocity
- Data in Motion
  - Streaming data, milliseconds to seconds to respond

Variety
- Data Variety
  - Structured, unstructured, text, multimedia

Veracity*
- Data in Doubt
  - Data inconsistency ambiguities, latency, deception, approx.

* Truthfulness, accuracy or precision, correctness

Number of networked devices is 2x the population. All sensor data has uncertainty.

Data quality solutions for a fraction of the enterprise data.

Social media account # exceeds population. Highly uncertain in expression and content.

Multiple sources: IDC, Cisco

Data at Rest

Data in Motion

Data Variety

Data in Doubt

2005 2010 2015

Data Volume in Exabytes

Aggregate Uncertainty %

0 10 20 30 40 50 60 70

Bruno Michel, bmi@zurich.ibm.com
Cognitive Computing … a New Era of Computing

1900
Tabulation
Punch cards
Time card readers
Electronic computation

1950
Programmatic
Search
Deterministic
Enterprise data
Machine language
Simple outputs

2011
Cognitive
Discovery
Probabilistic
Big Data
Natural language
Intelligent options

enabling new opportunities
and outcomes

Workload Optimized Systems

Cognitive computing with learning algorithms

Jeopardy
Healthcare
Finance

Bruno Michel, bmi@zurich.ibm.com
The End of Scaling

Since 2006/07:
Circuits still become smaller and cheaper, BUT not faster and not more efficient.

Since 2015:
Circuits still become smaller but not cheaper → Moore's economic “law” is dead

Wiring “Crisis” since 2007
The Big Data and Cognitive Challenge

- Big Data in 2030 to 2040 means: \(~1000\times\) as much data as now
- End of Transistor Scaling means: We will not get more efficient chips
- Cognitive Compute Era means: Work \(~100\times\) more intensive with the data
- Currently ICT industry consumes \(~3\%\) ww energy and \(~10\%\) ww electricity

- \(~1000\times\) more data times \(~100\times\) more intense compute (at constant efficiency)
- Results in \(~100,000\times\) more compute and thus \(~100,000\) times more energy!

- Current computers are operated at \(~1\%\) of maximal efficiency since they run at \(<10\%\) load and power is not proportional to load
- Cloud compute delivery and workload optimization allows an efficiency improvement of \(~100\times\)

- But we still need \(~1,000\times\) more energy; we need \(~100\times\) more electrical power stations to fully enable world wide use of big data and cognitive computing! (in a worst case scenario)

- We clearly need major breakthrough innovations!
Chilldyne set out to solve cooling problems

Problem #1 – Economic
- HVAC 50% of datacenter electricity. Inefficient.
- Liquid cooling cheaper up front and cheaper to operate (16 month payback in a sample case study).

Problem #2 – Business need
- Servers once had 2 x 120w chips. Now 200-300w chips and up to 32 of them in a server!
- 42U server rack used to have 5kW of power. Can now have 60kW or more.
- Rack densities of 30+ kW cannot be cooled with air.
Technology behind Chilldyne’s solution

**Negative Pressure Prevents Leaks**
- Retains air cooling
- Uses existing rack layout
- No changes to server chassis or rack

**Cost Effective Server Side Parts**
- Cooling kit for server OEMs to install
- Simple connectors & heat sinks
- Cools other components
- Inexpensive parts get refreshed

**High Reliability/Performance**
- Automatic fail over to backup air
- Works regardless of leaks
- CDU redundancy with 2+1 backup

5 patents issued, 1 pending

- Hybrid air-liquid heat sink
- Server cooling kit
- Patented connector fits in PCI slot
Go ahead cut the line….It won’t leak

https://www.youtube.com/watch?v=552tzND2Xx0

Warning: Don’t try this with your positive pressure system!
Customer building new 300kW\(^{(1)}\) data center:

- Can spend $1.8M\(^{(2)}\), including $490k for air HVAC for a data center with a 1.5 PUE\(^{(3)}\) (vs industry avg 1.8-2.0), OR
- Can spend $1.6 M, including $300k for liquid cooling for a data center with a 1.1 PUE, saving $190k now.

Payback on $300k liquid cooling?:

- Day 1 CapEx savings of $190k
- Electricity savings 33.7% or $87K per year @7¢/kW hr (National average)\(^{(4)}\)
- Less server refresh costs @ year 4 and 8
- Total PV benefit of $874,300 (291% ROI)
- $300k spend recovered in month 16

Footnotes: (1) Containing approx. 1000 servers, (2) and (3) Source: Schneider Electric, (4) U.S. EIA
Robert M. Spears  
Chief Executive Officer  
rspears@chilldyne.com  
Tel: 858-735-7579  

5900 Sea Lion Place  
Carlsbad, CA 92010
Questions
Smart Apartments made easy.
20 Billion devices will be connected by 2020.
Access to value is more important than ownership.
Apartments can choose to remain dumb...
or be smart and ready for techies at move-in.
With IOTAS, a premier Smart Apartment technology, you will generate more revenue.
Entire Home Solution

• All lights & outlets
• Thermostats
• Multi-sensors
• Smart Hub
• Optional (Fans, Voice, Garage, Locks and more)
IOTAS automatically pairs and sets up 30 devices per apartment and places them into mobile apps.

Automatic Setup is funded by the National Science Foundation.
Leave the rest to us!
There is nothing left for YOU to do.

And we made it easy for residents with 10 default automation.
Control everything with a click.

- Prepare your vacant units for showing
- Make your new buildings look occupied
- Show resident gym occupancy
- See when’s best for Happy Hour
- See activity in the Lounge
IOTAS CONFIDENTIAL. ALL RIGHTS RESERVED. ©

App for Residents

Property Dashboard for Owners & Managers

More prospects
Faster to rent
Lower costs
Premium rent
Social impact when an apartment autosaves energy

Potential energy savings of an IOTAS installed apartment = 6.74 kWh/sq.ft-yr

18M apartments = 17.7B sq.ft

17.7B sq.ft x 6.74kWh = \(119,136\) GWh/yr or \(\sim\)$7.3B in Potential Savings

Which is equivalent to:

- 2,967,957,822 incandescent lamps switched to LEDs
- 79,255,473 acres of U.S. forests in one year
- 3,795,855 garbage trucks of waste recycled instead of landfilled
- Power NYC
  - Provide power to New York for 1 year
WE ARE LIVE AND COMING TO:

WE ARE ACTIVELY WORKING WITH:

Google

Schneider Electric

SDGE

Honeywell

NIST

Working on super secret product with Schneider

Piloting Demand Response in Single Family Homes

IOTAS is currently the only Smart Apartment partner

NEWS:

WIRED

npr

The Washington Post

8 KGW News

KATU 2

OPB

DIGITAL TRENDS

Chicago Tribune

FORTUNE

PORTLAND BUSINESS JOURNAL

GIGAOM
People want to live where they feel valued.
Show them you value what they value

Environmentally friendly
Sense of community
Socially conscious
Tech friendly
Thanks!

For more information, contact:
Matt Greene, VP Sales & Marketing
matt@iotashome.com
619-251-4575
Questions
Smarter Energy Management

DoD ESTCP Competition Winner 2014
DOE FEMP “Call For Innovation” Award Winner 2016

Prepared for: Emerging Technologies Summit
Dehumidification Overview & Strategies

• Dehumidification and reheat energy waste drive energy and utility load shapes for most of the Country, for the entire summer

• Properly performed strategies can reduce chiller plant and boiler plant energy consumption for dehumidification 60% to over 80% while reducing or eliminating biological growth

• Contributes to healthier IAQ which leads to increased health, wellness and productivity

• Original intent - to solve massive energy waste and mold growth problems for our Military!

*Current HVAC designs actually promote mold growth at many facilities!*
Unseen Mold is Almost Everywhere
Typical AHU Design vs. HEDS
Reheat is Critical to Proper RH Control

Traditional AHU Designed for Dehumidification Duty

1. 10,000 CFM Airflow
2. 78°F dry bulb temp, 65°F wet bulb temp
3. 55°F dry bulb, 55°F dewpoint, essentially 100% relative humidity
4. 65.3°F dry bulb, 55°F dewpoint, 55% RH (Relative Humidity)
5. 45°F water enters the reheat coil at 70 GPM (5A) and leaves the cooling coil at 55°F
6. New source of 140°F water enters the reheat coil at 4GPM (6A) and leaves the reheat coil at 87°F

High Efficiency Dehumidification System (HEDS)

1. 10,000 CFM Airflow
2. 78°F dry bulb temp, 65°F wet bulb temp
3. 55°F dry bulb, 55°F dewpoint, essentially 100% relative humidity
4. 65.3°F dry bulb, 55°F dewpoint, 55% RH (Relative Humidity)
5. 45°F CHW enters the cooling coil at 27 GPM and leaves the coil at 70°F
6. 70°F water enters the CRC coil at 27 GPM and leaves the CRC coil at 62°F while heating the air to 65°F
### Dehumidification Field Performance Results

<table>
<thead>
<tr>
<th>Application</th>
<th>Tested Supply Dewpoint Temperature Range (lower equals drier)</th>
<th>AHU Cooling Load % Reduction</th>
<th>AHU Dehumidification Heating Load % Reduction</th>
<th>Estimated Total Dehumidification-Related Cooling + Heating Plant Energy Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Rooms, Industrial Clean Rooms – Hot / Humid Climates</td>
<td>Less than 50°F</td>
<td>20%</td>
<td>100%</td>
<td>57-81%</td>
</tr>
<tr>
<td>Dining Facilities (DFACs), barracks, Dedicated Outdoor Air Systems, (DOAS), general hospital areas, laboratories, industrial clean rooms, equipment coating facilities, and Corrosion Control Facilities</td>
<td>Between 50°F and 52°F</td>
<td>31%</td>
<td>100%</td>
<td>63-85%</td>
</tr>
<tr>
<td>Less Humid Environments</td>
<td>Between 52°F and 56°F</td>
<td>37%</td>
<td>100%</td>
<td>67-87%</td>
</tr>
<tr>
<td>Office and Administrative</td>
<td>Between 50°F and 56°F</td>
<td>27% to 29%</td>
<td>100%</td>
<td>79-91%</td>
</tr>
</tbody>
</table>
DoD Field Test Results

Fort Bragg Cooling Load W/O HEDS (blue line)
Cooling Load Sent to Plant with HEDS (orange Line)
Savings % (grey Line)
Chilled Water System Temperature Differentials

HEDS Eliminates “Low Delta T Syndrome”
Cooling Coil CHW TD above 14F, even at 30% load

- HEDS TD @ 30% to 50% load is 14F to 21F
- Base case ran around 3F to 7F with “Low Delta T Syndrome”
- Eliminating “Low Delta T Syndrome” can increase savings by over 30% at many sites.

From a CHW Flow Perspective, the system sees a 14F to 21F TD. From a CHW Load Perspective, the CHW System sees a 10F to 15F TD. The Difference is the Load and Reheat Savings.
Questions?

Presenter:
Scot M. Duncan, P.E.
President
Conservant Systems Inc.

sduncan@conservantsystems.com
(949) 370-8582
Questions