BIG DATA & ANALYTICS...
THE NEXT FRONTIER FOR
ENERGY MANAGEMENT

Jack McGowan, CEM
Big data is a broad term for data sets so large or complex that traditional data processing applications are inadequate. Challenges include analysis, capture, data curation, search, sharing, storage, transfer, visualization, querying and information privacy. The term often refers simply to the use of predictive analytics or certain other advanced methods to extract value from data, and seldom to a particular size of data set. Accuracy in big data may lead to more confident decision making, and better decisions can result in greater operational efficiency, cost reduction and reduced risk.

Wikipedia

Informative graphic but woefully inadequate ➔

It is Pre-Cloud!
**Big Data**: Traditionally described as high volume, high-velocity and high-variety information

**Predictive Analytics**: Algorithms that help analyst predict behavior or events based on data

**Big Data Analytics**: Usually involves large quantities of structured and unstructured data and uses sophisticated algorithms to drive decision-making

**Open Data**: Information available to everyone to use and republish without restrictions

**Business Intelligence**: Involves gathering, storing and providing access to data through applications
Big Data... stories cross all boundaries

Big Data skills were the most sought-after by companies seeking new hires in 2015:
- Economic Times of India
- Times Jobs Job Outlook Survey 2015

Microsoft acquired Revolution Analytics, Calif.-based analytical software developer known for development of the open source analytical platform R, widely used in commerce and industry.

Goldman Sachs bets on growing $10 billion+ big data services market in Asia, invests in Singapore-based, early market leader, Antuit, providing supply chain analytical solutions to businesses.

Ford Motors plans to put big data at the center of its business, to hire 125 data-related staff, to capture freight/logistics data, compare cost of parts and services globally and to analyze supply chain.

“It’s an exciting time for the building efficiency industry. With an explosion of new, sophisticated tools and data sources for monitoring and managing energy use, owners and facility managers can see the shining destination ahead.” Buildings Magazine, December 2015
Big-Data Energy Analytics... closer to home

Exponential growth: Building /Energy Industry Analytics plays:

- Cimetrics Analytika
- Coppertree Analytics – Delta Controls
- Sky Foundry
- Connexx Energy
- Seimens Energy Monitoring
- KGS
- EchoRythm
- Abundant Power
- Splunk
- McKinney
- Optergy
- Optimum Energy

...and more plus numerous embedded products

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YOUR SEMINAR LEADERS:  JACK MCGOWAN, CEM

Jack McGowan, CEM

**Jack** is Principal of the McGowan Group. He was formerly CEO of Energy Control, Inc., an OpTerra Energy Company, and also has held management positions with Honeywell Inc., Johnson Controls Inc. and others. He’s Chairman Emeritus, U.S. DOE GridWise Architecture Council, and a Fellow with the Association of Energy Engineers (AEE), as well as a member of AEE’s International Energy Managers Hall of Fame. His experience in the energy and buildings industries spans four decades, and included leadership roles in energy management, Smart Buildings / Open Systems, Energy Services, Smart Grid and Big Data Energy Analytics. His most recent book, *Energy and Analytics: Big Data and Building Technology Integration* is published by The Fairmont Press.
Big Data Energy Analytics is important

BUT, is understanding this topic & technology an important career step

Yes

Why? This knowledge will define how we design and manage our world for the foreseeable future, …per Buildings quote:“a once in a generation change…”
INTEGRATING EFFICIENCY, MICROGRIDS, DIVERSE GENERATION & STORAGE INTO A SMART GRID

A Big-Data Energy Analytics Ecosystem

ENABLING THE FUTURE MUST = ENERGY SUPPLY & DEMAND

SMART GRID
A vision for the future – a network of efficient buildings, integrated microgrids and markets plus intelligent self-healing systems.

Energy from small generators and solar panels can reduce overall demand on the grid.

Demand Management Use can be shifted to off-peak times to save money and get paid.

Energy generated at off-peak times could be stored in batteries for later use.

Casino Hotel
Intelligence at intersection of Supply, Demand & Markets

wind power & storage as cost permits

Energy from small generators and solar panels can reduce overall demand on the grid.

Houses and Cars

Gas-fired CHP And Renewables

Conventional Generation With new definition

INTEGRATING EFFICIENCY, MICROGRIDS, DIVERSE GENERATION & STORAGE INTO A SMART GRID
ENERGY MANAGEMENT IS THE TOPIC AND IT HAS GOTTEN COMPLICATED

...now add Big Data, IOT, Arbitrage & business models
It is all about energy (electricity in particular) and,
Which professional are best positioned for Success in the energy and buildings market?

$279 Billion energy efficiency
Building retrofit opportunity

Electric Demand rises 30% by 2040
Buildings represent 72% of demand
CEM’s who master application of technology & Analytics

- Energy Management skill
  - Knowledge base
- Automation & DDC
  - Foundation technology
- HVAC
  - Most complex building Ap
  - Few have deep understanding
- Other building tech – i.e. Lighting
- Integration
  - BACnet™ style Tech Savvy
  - Web Services & Internet of Things
  - Big-Data Energy Analytics

How does the content of this seminar help?
BIG DATA AND ANALYTICS - MODULE 1

Introduction: Big Data and Analytics
- Big Data Technology
- Introduction to Analytics Technology and Key applications
  - Energy management
  - Fault detection and diagnostics
  - Sustainability
  - Compliances with standards (environmental, Joint Commission for Hospitals, etc.)
  - Vendor management (HVAC service, facility management, etc.)
- Underlying Technologies and Standards Critical to Effective Analytics
- New Technologies Driving Use of Analytics: Clean Energy Plan Building Standards

Overview Energy Management and Electricity
- Smart Grid and Electricity Trends
- Energy Efficiency and Demand Response
- Energy Resiliency and Its Impact on Electricity and Natural Gas
- Microgrids and Current Status of Onsite Generation
- Policy and Legislation Driving Big Data such as Performance Standards

Energy Triple Threat
- Energy Markets and Consumption Patterns
- Utility Infrastructure and Customer Impacts
- Energy Technology Upgrades and Finance Impact
- USGBC and PEER (Performance Excellence in Electricity Renewal)
Analytics and Dashboards
- Introduction to Visualization Technology Overview
- Introduction to Analytics and Approaches to Optimization

Dashboards and Visualization Tools
- Technology and Applications
- Simulation Tools
- Kiosks, Computer based Apps and Mobile Technologies

Analytics for Energy Management
- Energy Efficiency and Conservation: Baselines and Benchmarking
  - Interval data vs. utility billing analysis
  - Setting metrics and KPIs
  - Data access and analysis process
  - Targeted application evaluation and process evaluation
- Electricity Resiliency and Management in a "Triple Threat" World
  - KPI's for effective electricity management, procurement and resilience
  - Analytics for automated demand response and demand management
  - Utilizing analytics for economic and reliability strategies to manage microgrids
  - Integrating efficiency and distributed generation using analytics

Analytics for Equipment Fault Detection & Diagnostics (FD&D)
- Preventative Maintenance
- Predictive Maintenance
- Interval Data vs. Utility Billing Analysis
BIG DATA AND ANALYTICS - MODULE 3

Intelligent Buildings and Big Data
- Building Technology Architecture Optimization
- Analytics Data Determination and Integration

Key Underlying Technologies
- Technologies: Multi-Tiered Building Automation, Meter Data Management, CMMS, other
- Middleware
- Information Technology and Computer Network

BAS
- BAS Market Technology Evaluation
- BADDC Network Management, Equipment and Zone Systems
- Active Energy and Analytics

Digital Communication for Building Technology
- Protocols and Data Networking
- Internet and Web Services

Middleware
- Middleware Technology Definition and Market
- Network Systems and Data Analytics

System Integration
- BAS Architecture Integration Optimization and Data Access
- Energy Management, Sustainability and Analytics
- System Analysis and Data Evaluation for Optimization
- Understanding Data and Systems Architecture
- Legacy and Open/Standard

Control / Automation Applications
- Architecture and Data Communications
- Energy Analytics and Data Access
- Legacy System and Visualization Interface
- Integrating Legacy Systems For
BIG DATA AND ANALYTICS - MODULE 4

Analytics Tools, Internet of Things and Standards Driving the Future
- Optimization and Data Access via Multi-Disciplinary System Organization
- Data Standards and Next Generation Building and Campus Systems

Internet of Things
- Definition and Context
- Trends Driving the Internet of Things and Building Opportunities
- Internet of Everything Meeting Intranet Building Systems for Energy Management

Analytics Tools
- Energy and Analytics Best Practices
- Cloud Computing and Software as a Services for Energy Management
- BAS, Middleware and HVAC-Centric Solutions
- Dashboard and API Solutions

Analytics for Measurement and Verification
- IPMVP and M&V Science Meets Analytics
- Proactive and Predictive M&V
- M&V and 21st Century Electricity Markets and Management

Case Studies
- Microgrid Campus University
- Envision Charlotte
- Microsoft - 88 Acres
I. Introduction to *Big Data Energy Analytics Applications*

Technology plus People and Process Applications

- **Energy management**
- **Sustainability**
- **Fault detection and diagnostics**
- **Vendor management (HVAC service, facility mgmt, etc.)**
- **Compliances with standards (environmental, Joint Commission for Hospitals, etc.)**

Underlying Technologies and Standards Critical to Effective Analytics

New Technologies Driving Use of Analytics: Clean Energy Plan Building Standards
II. Overview Energy Management and Electricity

- Smart Grid and Electricity Trends
- Energy Efficiency and Demand Response
- Energy Resiliency
  - Its Impact on Electricity and Natural Gas
- Microgrids
  - Current Status of Onsite Generation
- Enterprise Zones for Energy
  - Renewables, Energy Markets and Energy Management
- Policy and Legislation Driving Big Data
  - i.e. Performance Standards
II. Energy Triple Threat

- Energy Markets and Consumption Patterns
- Utility Infrastructure and Customer Impacts
- Energy Technology Upgrades and Finance Impact
- USGBC
  - PEER (Performance Excellence in Electricity Renewal)
I. Introduction to *Big Data Energy Analytics Applications*

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Technology

System Integration
- Lighting
- Fire, Life Safety, Security
- Meters Data Management
- Data Communications
- Digital Security
- Computerized Maintenance (CMMS)
- Asset Management
- Cyber Security
- Others

BAS: Equipment Control

BAS: Facility wide Control

ANALYTICS & TECHNOLOGY

The Web
- Utility Data
- Weather data
- ASP services
- Imagination is the limit
People

- Skilled Energy Managers are key to
  - Understand Technology
  - Understand Consumption Patterns
  - Understand Markets
- Utility Infrastructure Impacts
- Utility Customer Impacts
- Energy Technology Upgrades & Finance Impact
- USGBC - PEER
  - Performance Excellence in Electricity Renewal
Business Process Expertise

Technology plus People plus Process
Applications summarized here will be covered in detail throughout seminar.

**Energy management**
- 21st Century Energy Marketplace
- Value Prop for Analytics technology
- Next generation of Enterprise Energy Mgmt
- Integrated of wide-ranging Energy Services

**Fault detection & diagnostics (FD&D)**
- Often first to mind under Analytics
- FD&D excellent for Analytics particularly HVAC and complex equipment and operation
- Environmental control of buildings for comfort, indoor air quality and cost.
Standards Compliance

- Analytics for Regulatory Compliance: i.e. environmental – using FD&D, etc. is
- Joint Commission compliance requirements for hospitals required for licensing, etc.
  - accredits and certifies hospitals based on meeting certain performance standards.
- Building Performance Standards or other codes and many other reasons.

Sustainability

- Most organizations have GHG Mandates, few have Sustainability Analytics
- Performance Standards plus Measurement and Verification

Vendor management

- Measuring vendor performance against contract requirements is difficult
  - Contracts include HVAC service, facility management, security, etc.)
- Owners can now assume the drivers seat; using Analytics to track downtime, variance from required conditions, and much more, to negotiate contracts.
Underlying Tech & Standards: BAS to Big Data Integration

Building Intelligence is central to Next Gen Energy Management

Focus: Intelligence applied to energy

Optimization / Web enablement via Big-Data Energy Analytics

Big Data Analytics Turbo-charge Smart Bldgs. by starting with diligence repeatability & automating the rest

Over Building Life Cycle; First Cost is ~2%*

Single Event vs. Cathedral Thinking

Opportunities near limitless with every Analytics App

Technologies & standards addressed in this Seminar must be accessed via IoT and Integrated.

Where Energy is it Used?

27% Lighting

33% HVAC (Heat, Ventilation & Air Conditioning)

40% support / plug loads

Where can it Saved?

All Part of ACEEE $279 Billion energy opportunity

And savings with the other Big Data Applications?

- Fault detection and diagnostics
- Sustainability
- Vendor management (HVAC service, facility mgmt., etc.)
- Compliances with standards (environmental, Joint Commission for Hospitals, etc.)
New Technologies and Policy Driving Use of Analytics:

Technology is huge:
- The Cloud
- IoT
- The Big Data itself
- Analytics
- Tools & Software using above are pervasive

Policy:
- Clean Energy Plan
- Building Performance Standards
- New Energy Vision and many other Government and Utility driven programs

Drive Maximum Value by Acting on Recommendations
Enable All Big-Data Energy Analytics Apps
Energy Business Intelligence
Leverage All Systems & Software

PROGRAMMABLE
THE NETWORK / CLOUD

PV power generation
II. Overview Energy Management and Electricity

- Smart Grid and Electricity Trends
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The vast networks of electrification are the greatest engineering achievement of the 20th century

– U.S. National Academy of Engineering
Electricity: Laudable $300B market in 20\textsuperscript{st} Century…
But in the 21\textsuperscript{st} Century: Antique Grid that’s 36% Efficient

If I had asked people what they wanted, they would have said faster horses”
Henry Ford
Building Energy Efficiency Opportunity

Based on ACEE, AEE and Energy Star Data for Government / Office Buildings

DOE Secretary Chu “… Building Efficiency Potential at 20 – 30 %” ($200 B for C&I)

InterAcademy Council, European Thinktank “…most significant building efficiency opportunities involve system integration”
WHAT AUTOMATED LOAD CONTROL OFFERS?

Access to Data → Ability to Drive Decisions → Achieve Objectives & Impact Bottom-line

Today's Grid Operation is equivalent to having a Cab idling at the curb…

Not Just ADR or DR, BUT Rebirth of Demand Limiting Control

Day Trading for Energy
HOW DOES LOAD RESPONSE WORK?

Load Curtailment for Demand Response
Shut-off or reduce non-essential equipment (lighting, elevators), cycle HVAC equipment, or raise temperature set points, etc.

Load Shifting
Shift planned schedules of operation to off-peak times (typically industrials).

On-site Generation / Emergency
Switch building electric loads to backup generators.

Efficiency and Microgrids are also part of the story: Load response address current demand, Efficiency reduces ongoing demand & microgrids change the game.
DEMAND RESPONSE AND OPEN ADR

$ TA/TI Funds + DR Fees

1. Relay Output to non BAS Facility
2. UPS

DRAS

Smart Grid Cloud: Akuacom NOC (Network Op Center)

DR Program
Comm Dev

DRAS Signal Pull by Jace (Optional)

oBIX Meter Data Push from JACE

Tridium Jace

700 Other Buildings - SCE

BAS Interface & CPP Sequences

SCE Meter & Interface

Not used for Auto DR/CPP but Available for Service and Software / Driver Upgrades

Powered by Niagara AX

Constellation Energy
Akuacom
Energy Control Inc.
ENERGY RESILIENCE

✓ Electricity challenges: Antiquated grid, closing plants, growing load, etc.
✓ Efficiency = #1 untapped source but leveraging technology is key
✓ Microgrids: Distributed Generation / Combined HP = Savings/Reliability
✓ Integrate All Aspects of Smart Technology and Big-Data Energy Analytics
The MicroGrid & Its Role in Helping Meet These Challenges

- Utility Communications
- Efficient Building Systems
- Internet
- Renewables
- PV
- Dynamic Systems Control
- Consumer Portal and Building EMS
- Data Operations
- Advanced Metering
- Plug-In Hybrids
- Distributed Generation and Storage
- Control Interface
- Smart End-Use Devices
- Internet
- Distributed Systems
- Plug-In Hybrids
- Smart End-Use Devices
- Control Interface
- Distributed Generation and Storage
- Advanced Metering
- Consumer Portal and Building EMS
- Efficient Building Systems
- Internet
- Renewables
- PV
- Dynamic Systems Control
- Data Operations
- Utility Communications
KEY CHARACTERISTICS OF SMART MICROGRIDS

**Self-healing:** Grid Rapidly Detects, Analyzes, Responds and Restores.

**Empowers and Incorporates the Consumer.** Ability to Incorporate Consumer Equipment and Behavior in Grid Design and Operation.

**Provides Power Quality Needed by 21st Century Users.** Grid Provides Quality Power Consistent with Consumer and Industry Needs.

**Tolerant of Attack.** Grid Mitigates and Resilient to Physical and Cyber Attacks.

**Accommodates Wide Variety of Supply and Demand.** Grid Accommodates Variety of Resources (Including DR, CHP, Wind, PV).

**Fully Enables Maturing Electricity Markets.** Allows for and is Supported by Competitive Markets.
Enterprise Zones (EZ) Electricity

- Efficient Building Systems
- Utility Communications
- Dynamic Systems Control
- Data Management
- DR, CPP Dynamic PRICE
- Distribution Operations
- Consumer Portal and Building EMS
- Advanced Metering
- Plug-In Hybrids
- Distributed Generation and Storage
- Interoperable Self-Healing
- Green DG
- Smart End-Use Devices
- Renewable
- Control Interface
- Internet
- PV
- Apps
- Micro-Grids
- Enterprise Zones (EZ) Electricity
II. Energy Triple Threat

Energy Markets and Consumption Patterns
Utility Infrastructure and Customer Impacts
Energy Technology Upgrades and Finance Impact
USGBC and PEER (Performance Excellence Electricity Renewal)
Energy Markets and Consumption Patterns

Projections are a moving target, but consumption is again on the rise and resilience complicates the story.

Between 2003 and 2030, the US and Canada will need to add 758,000 MW of additional capacity at the cost of $1.6 trillion (IEA).
Energy from small generators and solar panels can reduce overall demand on the grid. Energy generated at off-peak times could be stored in batteries for later use.

Casino Hotel Intelligence at intersection of Supply, Demand & Markets Solar Panels Gas-fired CHP And Renewables Wind Power & Storage as Cost Permits Houses and Cars Demand Management Use can be shifted to off-peak times to save money and get paid. Conventional Generation With new definition

Big Data Energy Analytics are pervasive
Utility Infrastructure and Customer Impacts

CAPACITY SAVINGS: TYPICAL LOAD CURVE

1. Reduce kWH via efficiency projects, control system upgrade and retro-commissioning

2. Reduce kW via ADR with advanced BAS Load limiting and peak shaving applications

3. Smooth bandwidth via optimizing control strategies
   Improve Bandwidth to 10% or Better +/- 5
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BIG-DATA ENERGY ANALYTICS
AN ECO-SYSTEM THAT PRESENTS HUGE POTENTIAL

- Next Generation BAS, Metering, Big Data Energy Analytics and much much more
- Energy and Optimization
  - Visualization can bring operation value when coupled with Energy/Building Analytics
- Awareness and Mission Optimization
  - Engaging tenants and occupants has value as well
  - Performance and on Cost, Carbon, Comfort & More
- The Real Upside
  - Leveraging Information to Increase Value thru Markets
  - Resilience to Sustain Mission in spite of Grid
  - Getting paid more than one way
  - Driving dollars from programs, savings & other sources
  - Leverage power of analytics and other tools that accompany visualization
Energy Technology Impact and Financing:

Drive Maximum Value by Acting on Recommendations

Enable All Big-Data Energy Analytics Apps

Energy Business Intelligence

Leverage All Systems & Software

PROGRAMMABLE

THE NETWORK / CLOUD

Technology is huge:
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Financing:
- ESCO
- PACE
- QECB, etc
USGBC GREENBUILD 2014: PEER & ZERO NET ENERGY ZONE

Performance Excellence in Electricity Renewal
✓ Supply & Demand Lines blurring
✓ Goal is interconnecting buildings & power to transform Electricity via cross-sector collaboration to leverage emerging tech, policies and consumer understanding
✓ 1st certified: UT Austin, Naperville
✓ Can PEER do for Electricity what LEED did for buildings?

Zero Net Energy Zone
✓ Greenbuild exhibitors takes part of Center Off Grid with PV & Tech
✓ Zone = Solar PV, Batteries Switch Tech & Intelligence to allow for Islanded Power in New Orleans
✓ Energy Islands Technology is now
✓ New Mexico Sustainable Energy Community Act for Earthships
✓ Is this proof that the time is now?
Performance Excellence in Electricity Renewal
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Four Criteria Categories
ENERGY EFFICIENCY AND ENVIRONMENT
RELATABLE POWER QUALITY AND SAFETY
OPERATIONAL EFFECTIVENESS
CUSTOMER ACTION
Q & A

Next Module Preview

ESCO 2.0
BIG DATA AND ANALYTICS - MODULE 2

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