

# Air Pollution Control IIoT & Remote O&M

Overview

VOC Treatment Examples

NOx Examples

Daikin Example



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# Overview



# IIoT is a \$30 billion Potential for Air Pollution Suppliers

- The elimination of operating personnel at the plant, automation revenues and expansion of services will provide an opportunity for air pollution equipment and component suppliers which will exceed \$30 billion per year by 2026.
- Fifty percent of the revenue potential is from increased purchases. The other fifty percent is from purchases that will be delivered through the IIoT route rather than through traditional routes. Filter bags, valves, fans, conveyors, continuous emissions monitoring systems and reagent delivery will be monitored and serviced through the IIoT ecosystem. In the new IIoT environment the fan and valve suppliers will be viewing health data on their products through the cloud. The APC system supplier has the opportunity to become the BOO (build, own, operate) supplier of these systems or he can abdicate and let a digital process management company such as Accenture, the plant supplier such as GE, the consulting company such as AECOM, or end user based enterprises take the lead.

# APC Remote Operation

- The air pollution system of the future will be operated and maintenance scheduled through remote monitoring and control. There will be a BOO supplier who remotely monitors all components in the system. However, this cloud based system will also supply continuous data on each major component to the supplier of that component. When a problem or opportunity arises, there will be a tier based solution. For simple problems, the BOO operator will provide the answers or defer to a generalist and the supplier company.
- For difficult or important problems and opportunities the BOO operator will bring in “subject matter specialists”. Mcilvaine believes that this domain expertise is not only the key to IIoT success but the biggest opportunity for APC system suppliers. In fact, Mcilvaine argues that the Industrial Internet of Wisdom (IIoW) will generate more revenues for suppliers than IIoT.

# Beta Site to Further IloW

- Mcilvaine has created a beta site to demonstrate this potential [4S01 Berkshire Hathaway Energy Supplier and Utility Connect](#). As part of this demonstration Mcilvaine hosted nine hours of webinars on ways to more economically solve a potential \$700 million NOx problem. Presentations by GE, Siemens, Doosan, and Emerson on optimization of boiler operations were accompanied by some presentations on novel approaches. The end result is a potential \$200 million capital investment saving accompanied by operational savings of more than \$15 million per year in energy, consumables, and repair.
- At the present time, there are pilot plant demonstrations underway to prove the value of the concepts. If successful the various aspects can be incorporated by a BOO supplier and sold to utilities around the world. The conclusion would be that IloT opens the door for faster adoption of newer and better technologies. Those suppliers who take full advantage will develop better products and generate higher sales and margins.
- Mcilvaine is identifying the opportunities for IIOT and Remote O&M relative to each APC technology including power plant FGD & NOx control, industrial scrubbing, absorption and adsorption, fabric filtration, electrostatic precipitation, thermal oxidation, and NOx control from industrial sources and engines.



# Thermal Gas Treatment and IIoT

- Thermal and catalytic oxidation system operators can benefit from IIoT in many ways. With RTO systems there is a complex system challenge. Gas must be diverted periodically among three vessels. With flaring and standard thermal oxidation with recuperation there are continuing combustion variables. With catalytic oxidation there are catalyst maintenance issues and in some cases the need to control very toxic fumes.
- Since the emissions from these systems are typically measured and data about them streamed to remote locations (government agencies) there is an IIoT base from which to expand.
- Honeywell and Aereon are collaborating on IIoT solutions. Aereon works across the complete oil and gas supply chain to provide solutions for gas and vapor handling, combustion and recovery that allow its customers to meet stringent air quality and safety regulations. It specializes in custom engineered or standard options for flares, high efficiency combustors, thermal oxidizers, and vapor recovery units.

# Thermal Gas Treatment and IIoT, cont.

- Aereon's automation services group provides turnkey automation solutions to the oil and gas industry. It uses leading HMI software like Wonderware InTouch, RSView and PLCs like Allen-Bradley, GE, Siemens and Modicon. Aereon supplies custom design control systems, including level I and level II automation, human machine interfaces (HMI) and reporting packages.
- Fugitive emissions from the oil and gas industry can also be remotely monitored. Shell is remotely monitoring these emissions as reported in the Mcilvaine IIoT Oil and Gas Webinar several weeks ago.
- Megtec (B&W) is an example of a thermal oxidizer company who is already a process advisor to chemical manufacturers. The company supplies solvent recovery systems as well as a range of oxidation systems. A plant can be switched from one solvent to another during the day. Depending on the value of the solvent the vapors can either be combusted or recovered. Instead of just providing advice Megtec can be the remote partner who helps the plant with these daily decisions. Since it can leverage knowledge of solvent value across many plants it can spend the time to provide continuous assessment.



# Fabric Filter – Control of Operations and Inventory

- Fabric filter suppliers have the opportunity to completely change the industry. Until 1980 most dust collector suppliers also provided the replacement bags. BHA revolutionized the industry with a computerized program and lots of phoning to become more knowledgeable than the suppliers about each installation. Today most bags are sold to the end user by specialized bag suppliers.
- Nearly \$3 billion is spent annually to replace bags. The system supplier can provide Sourcing as a Service (SaaS) and annual flat fee contracts for bag replacement. The system supplier will have the IloW to minimize bag failures and reduce operating costs for the owner. The bag supplier income will be reduced because of discounts to the BOO but all the continuous performance information will create an opportunity for the bag supplier to innovate and develop more cost-effective products. The bag supplier willing to invest in R&D will therefore be a winner.

# Power Plants are Largest IIoT Opportunity

- IIoT and Remote O&M is already being implemented for SO<sub>2</sub> and NO<sub>x</sub> control in power plants. System suppliers are offering IIoT services as are component and reagent suppliers. Yara has a NO<sub>x</sub> reagent monitoring and supply service, Howden offers fan operation and maintenance services. MHPS has a remote-control center in the Philippines where English speakers support emission control operations at gas turbines and other power plants throughout Asia. Another MHPS center is located in Orlando. Lhoist and Lafarge are capable of supplying world wide support for lime and limestone to capture SO<sub>2</sub>.
- Gas turbine emissions are now being remotely monitored at more than 50,000 sites around the world. Gas turbine rotating part health is remotely monitored at thousands of sites. There are a number of third party operators with remote control services. So this is an immediate opportunity for APC suppliers.
- Many absorbers are used in processes and are critical to product quality. This is common in the chemical industry but opportunities abound in many industries. Mcilvaine has unique knowledge about the ability of a two-stage scrubber used with coal combustion to provide rare earth feedstock.
- Many electrostatic precipitators are already remotely monitored by the suppliers who track precipitator characteristics and can control them to optimize performance as coal characteristics change.



# VOC Treatment Examples



# Combustion and Vapor Recovery IIoT Solution from Honeywell and Aereon Collaboration

Honeywell and Aereon are collaborating on solutions to help industrial customers boost the safety, efficiency and reliability of their operations by leveraging Honeywell's Industrial Internet of Things (IIoT) ecosystem.

"For years, manufacturers and producers have looked for ways to solve operational problems that were believed to be unsolvable – such as unplanned downtime, underperforming assets and inefficient supply chains," said Andrew Hird, vice president and general manager of Honeywell Process Solutions' Digital Transformation business. "With the capabilities of the IIoT, we can find new ways to solve those problems. A key part is the creation of an industrial ecosystem that leverages the depth of knowledge and experience of a range of equipment and service providers such as Aereon."

"Aereon's fundamental strength is its wide array of fit-for-purpose combustion and vapor recovery products supported by in-house expertise to design, manufacture and support its field-installed base," said Mark Zyskowski, senior global vice president, Aereon. "We are pleased to be able to bring our expertise to the IIoT ecosystem that Honeywell is developing to help customers around the globe maximize value from their operations by tapping into the power of the IIoT."

Honeywell and its ecosystem partners are building a simple-to-use infrastructure that gives customers secure methods to capture and aggregate data, and apply advanced analytics. This infrastructure leverages domain knowledge from a vast and unique ecosystem of leading equipment vendors and process licensors, and allows customers to use this information to determine methods to reduce or even eliminate manufacturing upsets and inefficiencies.



# Aereon Automation Services

AEREON works across the complete oil and gas supply chain to provide comprehensive solutions for gas and vapor handling, combustion and recovery that allow its customers to meet stringent air quality and safety regulations. It specializes in innovative custom engineered or standard options for flares, high efficiency combustors, thermal oxidizers, and vapor recovery units, allowing customers to come to them for both their equipment and service needs.

Aereon services over 45 countries around the world with key operational centers in the United States, Canada, Italy, the United Arab Emirates and Australia. Its global presence gives customers access to a broad product line and service capabilities for the upstream, midstream and downstream markets.

AEREON's automation services group is committed to providing , turnkey automation solutions to the oil and gas industry. It uses leading HMI software like Wonderware InTouch, RSView and PLCs like Allen-Bradley, GE, Siemens and Modicon. AEREON's engineers can custom design control systems, including level I and level II automation, human machine interfaces (HMI) and reporting packages suited to your needs. Automation services include:

- PLC retrofits
- Human machine interfaces (HMIs)
- Operator interfaces
- Long range wireless systems
- Communication and SCADA control
- Startup and installation services
- Tank gauging systems
- Automated emissions monitoring and reporting systems
- Remote diagnostics



# AEREON provides Turnkey Maintenance Services

- AEREON has one of the industry's largest maintenance service teams, built to support the complete compliment of vapor management product lines. It is globally positioned in main operations centers in the USA, Italy, UAE and Australia. the service philosophy was designed with a turnkey approach for their customers. Services include installation support, equipment commissioning and the long term support of equipment with preventative maintenance, 24-hour emergency service, as well as complete inventories of aftermarket parts.
- The service team covers key locations in North America and across the globe with a 24/7 team approach, always available to support operational needs no matter what manufactured equipment the plant is operating. AEREON can provide the complete equipment maintenance, emergency services, spare parts and equipment retrofits with fully stocked service vehicles and technicians strategically located for providing the fastest response in the industry.



# Aereon Technical Services

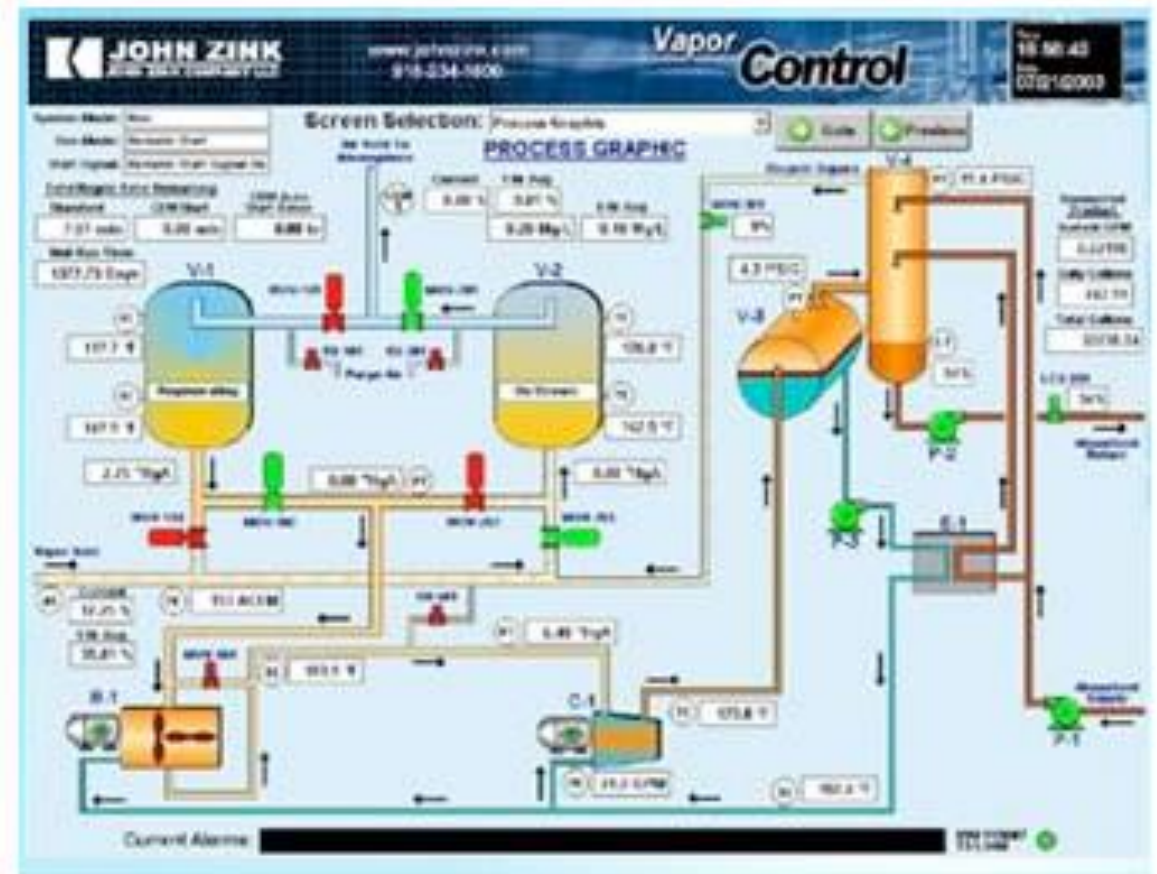
Aereon provide a vast array of technical services to help maintain and extend the useful life of equipment, upgrade and/or retrofit existing equipment to improve reliability or increase unit performance. Listed below are just some of the services provided.

- VRU, Thermal Oxidizer, Flare CEB®, VCU and preventive maintenance programs for all manufacturer's equipment types
- Flaring Services for well-testing and unit degassing (European Operational Centers only)
- Portable VCU Rentals for terminals (USA Operational Centers only)
- Flare Tip Retrofits for all manufacturer's flare systems
- Pilot system upgrades/replacements
- Energy saving equipment upgrades and retrofits for VRUs
- Equipment relocations
- Equipment demolition and removal
- New and used equipment installations: civil, mechanical and electrical
- Complete VRU carbon replacements
- Carbon performance testing
- Glycol seal fluid testing
- Air emissions testing (in select countries only)
- CGA (cylinder gas audits)
- CEM (continuous emission monitor) RATA testing
- Equipment HAZOP evaluation
- Terminal automation system installation
- Additive injection system installation
- Radio communication equipment networking
- 24-hour emergency service



# Koch Remote Vapor Control Monitoring

- John Zink Hamworthy Combustion's Vapor Control VaporWatch™ Remote Monitoring System provides the service assistance to monitor equipment performance from anywhere, 24 hours a day.
- The system monitors real-time data, then stores the data on a hard disk in a computer for long-term storage. The detailed history allows the operator or a John Zink Hamworthy Combustion service technician to log on to a secure site, review current and past performance, predict maintenance or begin troubleshooting system errors and fluctuations from a remote location. The system's advanced software makes it easy to sort and print customized reports of operating data for particular time frames – helping customers capture and analyze the data required for their reporting.





# Durr Energy Performance Contracting reduces Soliant Contract Coating Costs

- Soliant is a leader in precision coating of durable films and laminates, plus provides contract coating and laminating on a global scale. Dürr Systems Inc. EES, a VOC abatement system supplier, has been partnering with its clients for the last 10 years to reduce the energy consumption required for VOC abatement through its Energy Performance Contracting program.
- In 2007, Dürr installed a new RL60 rotary valve RTO to replace Soliant's old oxidizers. The system went online December 17, and the Energy Performance Contract began January 1, 2008. Through June 2008, the RL60 reduced the company's gas usage for VOC abatement by 85 percent.

Dürr financed the project under an Energy Performance Contract.”

“As a small company, we thought it was a good way to implement a greener solution without a large capital outlay,” says Soliant Vice President of Operations Jeff Bailey. “The performance guarantee ensured both sides have a vested interest in improvement.”

As part of the arrangement, Soliant agreed to pay Dürr a fixed monthly fee from the natural gas savings generated by the RTO replacement. Dürr guarantees the RTO's measurable thermal efficiency for the full contract term.

The contract also includes bonuses for exceeding the guaranteed thermal efficiency and penalties for falling short of the guarantee. This means that if the RTO performance falls below the guaranteed level, Dürr pays for Soliant's additional gas usage and has an incentive to address the issue immediately.

The Energy Performance Contract includes:

- Monthly performance monitoring and reporting.
- 24/7 emergency phone support.
- Remote trouble-shooting online with the system PLC via a new modem.
- An extended warranty.
- Semi-annual inspections and preventive maintenance visits.

# LumaSense Flame Measurement for Oxidizers

Optimal operation of Thermal Oxidizer furnaces require accurate process Gas (Flame) measurement to assure destruction temperatures are reached and maintained. Thermocouple measurement only provides refractory measurement not useful for confirmation of Gas (Flame) temperatures. Typical Single Channel Infrared Pyrometers do not compensate for changing flame transparencies resulting in Gas (Flame) measurement errors with lower than actual temperatures. A low error in the flame measurement will require added assist gas and this increases the operational costs to the owner.

**Solution:** A single pyrometer installation with two independent IR filtered detectors pyrometer system that provides both Gas (Flame) and Refractory measurements simultaneously, combined with the innovative LumaSense Smart FMA™ Flame Measurement Algorithm that will accurately do real-time flame transparency compensation and correction. Applying flame transparency calculation with FMA removes the flame transparency errors to the Gas (Flame) temperature providing the highest accuracy Gas (Flame) temperatures assuring that the destruction temperatures are reached with minimum assist gas. Benefits are

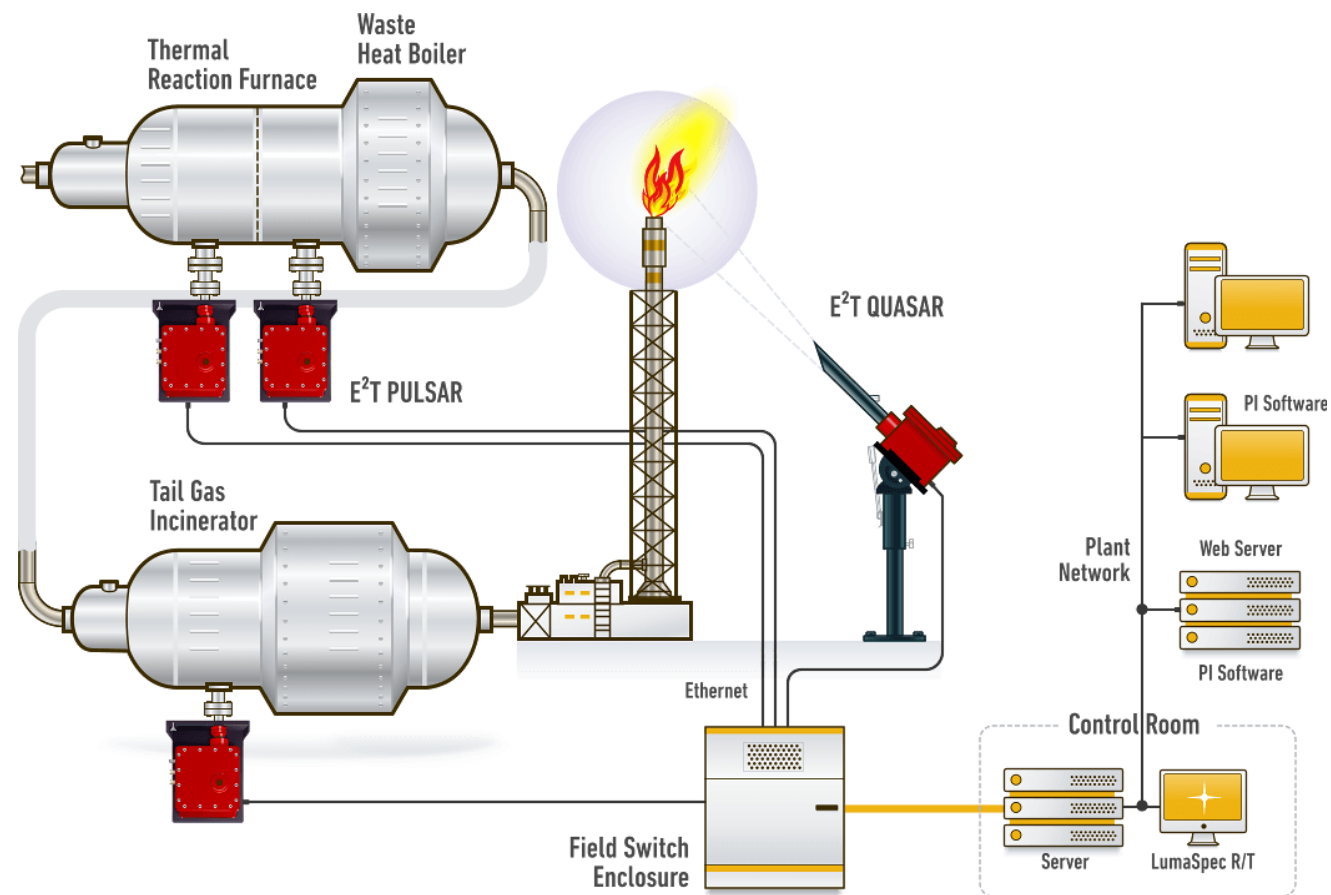
- Accurate Gas (Flame) temperature with LumaSense Flame Measurement Algorithm
- Lower cost of operation by minimizing low temperature errors due to flame transparencies



# LumaSense Flare Monitoring

LumaSense's E<sup>2</sup>T Quasar family of detection systems are built for continuous duty monitoring of pilot flame (PM), flared gases (FM) and smoke particulate (SM) from flare stacks. The sight through optical system and choices of fields of view allow the Quasar to be positioned up to ¼ mile (400 m) from the flare stack. Each of the systems includes a removable camera module, dual outputs, explosion-proof housing, internal heater and cooling.

The combination of modular features into a single remotely locatable system makes the Quasar easy to install, maintain and integrate with other systems.



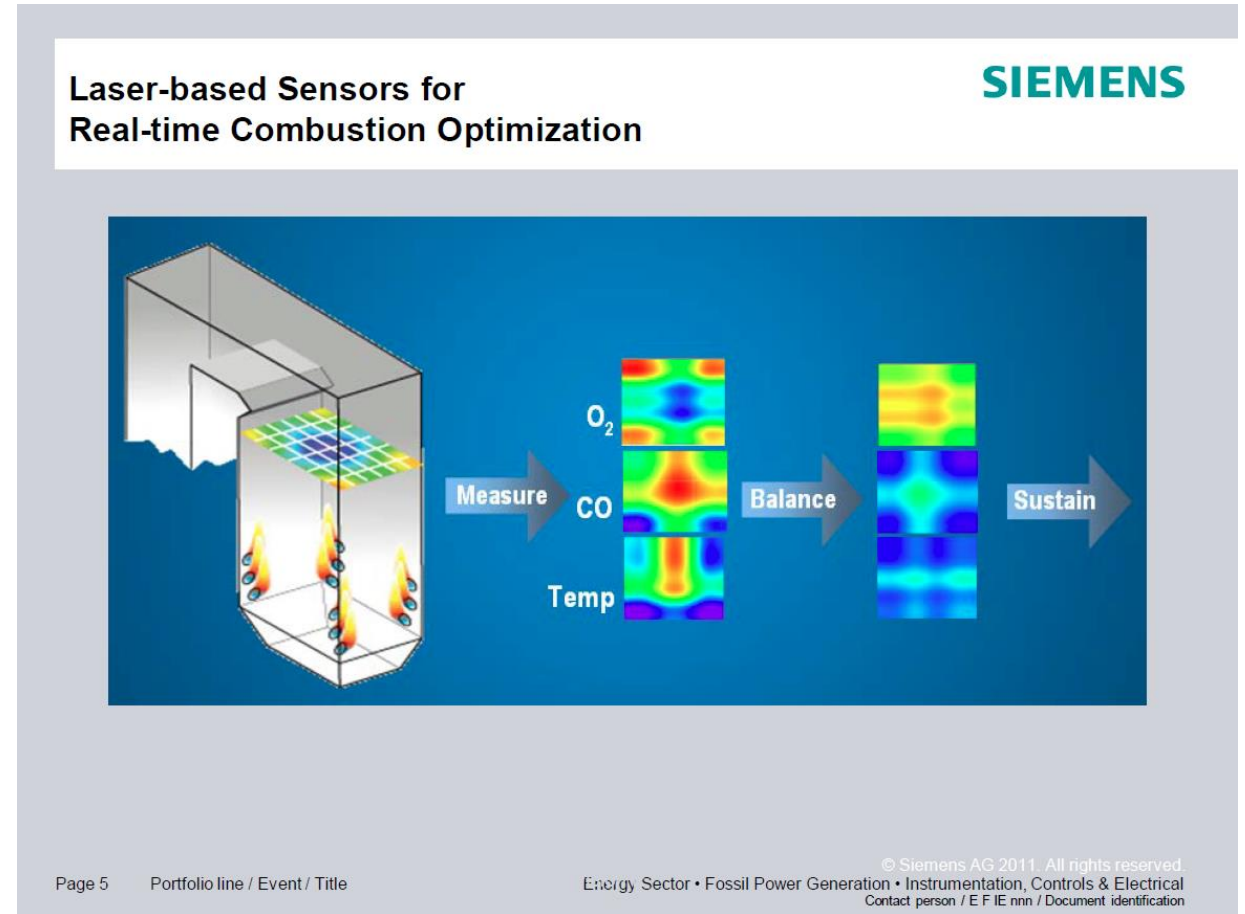
# NOx Examples

# Siemens has NOx Control Solutions based on Furnace Sensors

Siemens reduces NOx in boilers by providing a combustion optimization system which uses tunable diode laser sensors to continually monitor CO and O2 at various points throughout the furnace.

Siemens has a comprehensive set of digital process management solutions as well as process instruments

Siemens also has VFD drives which are critical to continuous remote monitoring and control to minimize energy consumption.



# Emerson has Optimization Systems based on Disturbances

Emerson has a combustion optimization system which has been successfully employed at a number of coal plants and was discussed in several Mcilvaine webinars for PacifiCorp. It also makes valves and with the pending purchase of the Pentair valve group will be able to take advantage of the sensing of on off valve health and performance. Emerson is a major participant in digital process management

## ***SIL0 – Optimization Tasks***

### **Measured Disturbances**

Boiler Load  
Coal Mills  
Configuration

### **Non-Measured Disturbances**

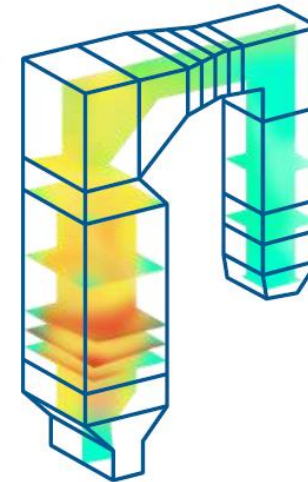
Coal Calorific Value  
Biomass Co-Firing  
Quality of Mills  
Grinding

### **Control Signals**

Secondary Air  
Dampers  
OFA, SOFA, COFA  
O<sub>2</sub>  
Coal Feeders

### **Control Signals**

RH Steam Temperature  
SH Steam Temperature  
CO, NO<sub>x</sub>, O<sub>2</sub> balance

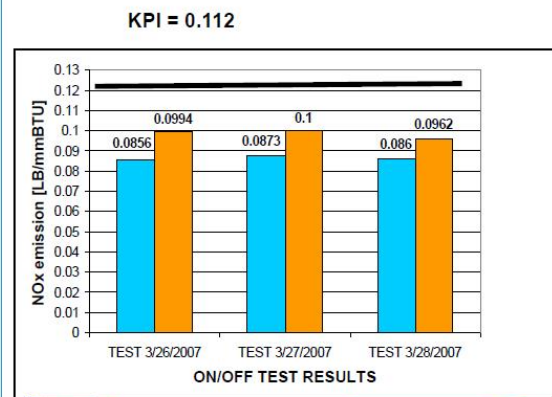


# Emerson System at Ameren provides Very Low NOx leaving the Furnace

Emerson achieved very low NOx emissions at Newton. PacifiCorp needs to achieve only 0.06 lbs/mmbtu NOx at the stack. Since SCR is expensive but 90% efficient it would be a fall back solution. A novel reductant, possibly in-duct partial SCR and ozone injection in the scrubber could provide enough safety factor to achieve the goal and save a large chunk of the \$700 million required for SCR.

This application is a good example of how IIoT and remote monitoring can greatly reduce capital and operating costs. However the necessity of all these processes working together plus the lack of a big safety margin dictate remote O&M and a robust digital process management system.

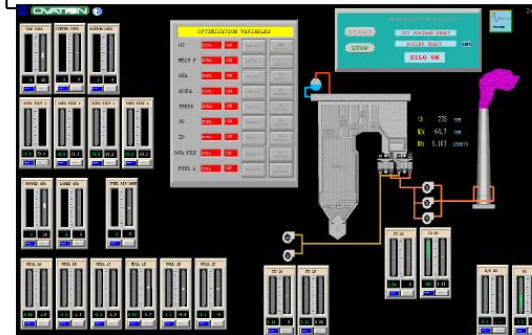
## Silo at Ameren Newton Unit 1



*NOx results are the lowest in USA today!! .085lb/mmbtu*



**Average improvement :  
12.4 %**



**EMERSON**  
Process Management

# NOx Control Inventory Management and Telemetry Services from Yara

Yara telemetry solution can help operators manage, and in some cases, optimize SNCR and SCR reagent logistics. The telemetry solution is a web-based remote monitoring system which:

- Increases security of supply of NOx reduction reagent
- Simplifies reagent ordering and stock management
- Increases data management control
- Increases security of supply

The telemetry system handles reagent stock levels, triggering a delivery when a predefined level is met. All telemetry orders are automatically delivered, securing supply, direct to you where you need it. This flexibility allows for your resources to fully focus on your other business needs. However, they can still be involved in the telemetry process, if required, so that you remain in control at all times. The telemetry solution provides an effective supply planning tool, which enables reagent to be supplied on automatic request. This gives an improved intervention capability via a fully transparent system, which also provides operators with a complete overview of stock levels and trends at all times.

Yara can provide clients with the installation of everything from tank level monitoring, to data collection and transfer, to a user friendly web-based monitoring system, which can be accessed from process computers, office computers or smart-phones and tablets. The system is flexible, and can also be used to collect and monitor other measurement data, such as temperature, pressure or chemical sensors



# Daikin and Other Examples



# Daikin Fusion Overview

- Daikin is already aggressively pursuing IIoT for HVAC.
- The company can now take the broader approach to provide its intelligent equipment platform across the air purification and environmental spectrum.

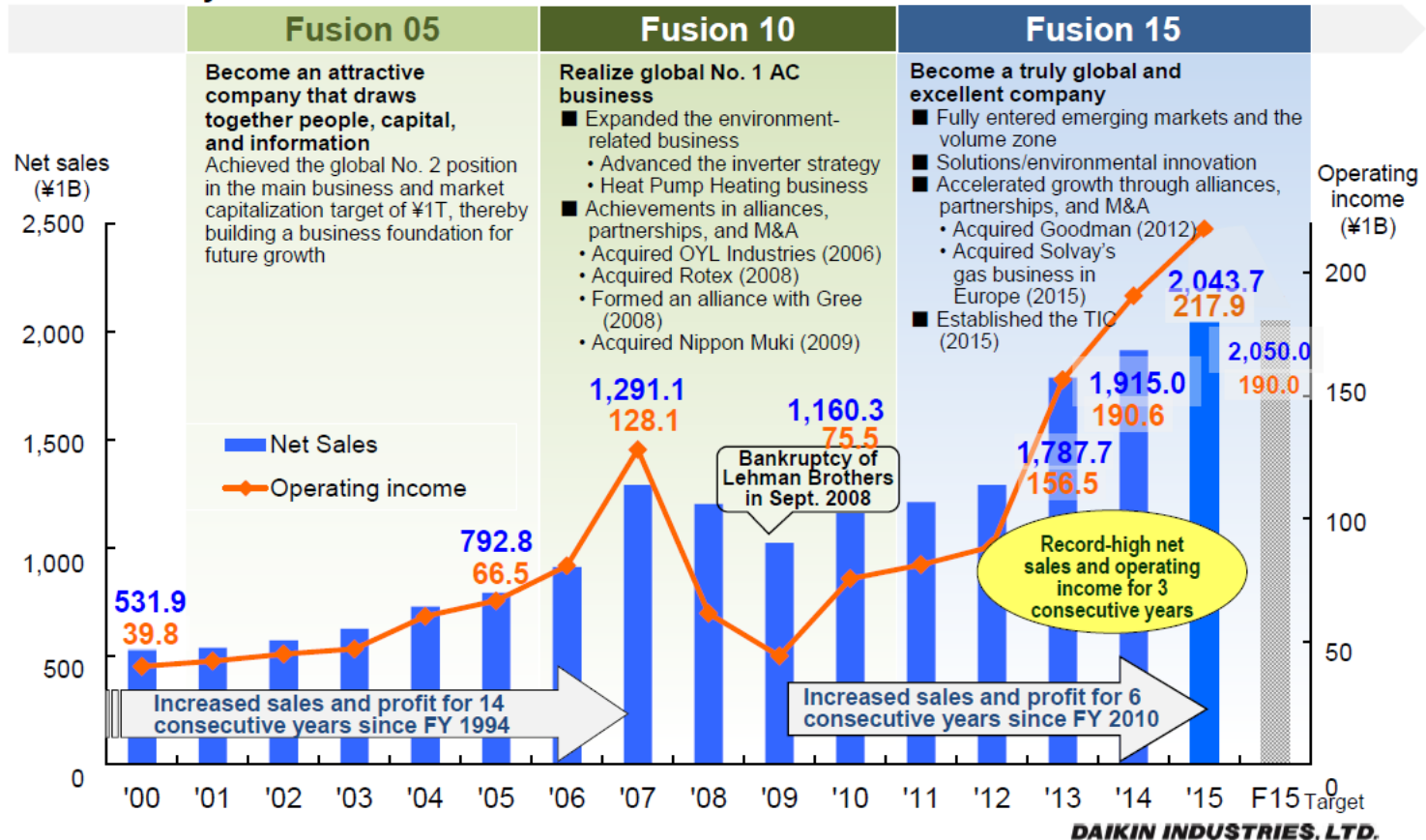
Here is an example

- A Daikin HVAC audit resulted in a change to a new HVAC filter design to handle sugary dust and savings for a sugar manufacturer. However, an IIoT comprehensive approach would have likely incorporated better sugar dust capture at generation points for even greater savings.
- HVAC, dust control, exhaust air, heat recovery, recirculated air and make up air all are inter-related.
- Daikin can expand from HVAC IIoT to environmental IIoT
- The company has a “fusion” program. So this is just an embellishment.

# Daikin Fusion to create New Value in the Air and Environmental Fields with Wisdom and Passion

## (Reference) Performance

Despite drastic changes in the economic environment, Daikin has achieved tremendous growth and development over the past 10 years. We achieved a V-shaped recovery after the bankruptcy of Lehman Brothers and increased sales and profit for 6 consecutive years since FY 2010. Net sales and operating income have hit record highs for 3 consecutive years since FY 2013.



# Daikin is aggressively pursuing IIoT for HVAC

- With Intel's systems and end-to-end analytics, Daikin Applied is able to efficiently connect its Rebel\* units to the cloud and securely aggregate, filter, and share data. Accessing the data of embedded systems is simplified by using Intel's intelligent gateways to connect to next-generation intelligent infrastructures. This IoT application allows Daikin Applied to assist proactive management of a building's performance and awareness of heating, ventilation, and air conditioning (HVAC) issues before they happen.
- Intel, along with Wind River and McAfee, is enabling this advancement in service and development of energy management systems with end-to-end IoT application solutions that are efficient and secure. These solutions are also affordable because they are constructed on an existing infrastructure and common architecture. At every stage of IoT development, Intel has the pre-integrated, pre-validated hardware and software building blocks necessary to compile "things" into an intelligent system and unlock the value of data.
- Connecting existing units through intelligent devices allows for a future focused on rapid deployment of value-added services, such as real-time HVAC unit performance, remote diagnostics, monitoring and control, advanced energy management, and third party content integration. Intelligent gateways are critical to extending and connecting legacy systems to a smart grid. With the next generation of intelligent infrastructure, Intel enables businesses to be empowered by the IoT.

# Daikin Intelligent Equipment for HVAC can be integrated with APC IIoT

With 40% of a building's energy expenses tied to HVAC operations, building owners and managers need better visibility to their HVAC unit performance. Daikin's Intelligent Equipment connects directly to HVAC unit to monitor energy consumption at the equipment level for deeper, more accurate performance measurement. For less than it costs to run a smart phone, Intelligent Equipment provides direct access to 150 data points. Intelligent Equipment can trend a unit's health and performance from commissioning throughout the life of the asset. It provides timely notifications for maintenance without requiring additional programming. And because all unit data is stored in the cloud, storage is unlimited.



# Daikin Applied already incorporates Filter and Fan Health Analysis

- Daikin Applied plans to incorporate the Intelligent Equipment platform across its entire product line beginning with packaged rooftop systems, specifically Daikin Rebel and Daikin Maverick II. The technology easily interfaces with new or legacy equipment, and the units will intuitively know when to adjust for occupant comfort and energy efficiency. Daikin Intelligent Equipment is powered by an Intel IoT Gateway along with Intel Decision Solutions: Trend Analytics Module that offers users the confidence of predictive maintenance. The solution also includes a Wind River IoT platform based on its Linux operating system and overall security is provided by Intel McAfee.
- At the maintenance level, the solution will predict faults such as fan or motor failures and will alert users when filters need to be changed based on usage, not time. At the operations level, the system can sync with the weather forecast to adjust for changing conditions before they happen. It can provide access and insights into a building's Energy Star Ratings as well as comparable buildings in its area. It will provide users with financial summaries of their energy savings and equipment payback, measure and automatically adjust for building comfort based on building users profiles, and give users direct access to its level of power usage as well as its CO2 use to provide a more accurate view of the carbon footprint.

# APC and Applied AC serve the Same Market

The service solutions for AC and internet connectivity can be integrated with the air filtration and air pollution control IIoT including Sourcing as a Service (SaaS) Daikin could supply replacement filters and A/C repair parts as needed with remote monitoring and control.

## 1) AC Business in North America

Join the top group in the world's largest market of North America by leveraging Daikin's core environmental technologies and reinforcing development of unique local products, localized production, and our sales network

### <Policy by market>

Residential	<ul style="list-style-type: none"><li>● Further expand sales and improve profitability of residential ducted unitary products</li><li>● Fully enter the premium unitary market</li><li>● Instill a new AC culture using ductless products and controls</li></ul>
Light commercial	<ul style="list-style-type: none"><li>● Obtain the No. 1 share in the VRV market by winning design-build projects</li><li>● Expand rooftop product lineup to fully enter the market</li></ul>
Applied	<ul style="list-style-type: none"><li>● Expand sales in the mid-size market by introducing differentiated products such as integrated control systems for VRV and Applied</li><li>● Develop business in the replacement market by reinforcing owner-direct sales</li></ul>

### <Common themes>

- Localize production in North America with the new Houston Plant and Mexico Plant at the core
- Establish the North America R&D Center to reinforce development of unique local products
- Provide high-quality service solutions utilizing Internet connectivity

# Some of the Biggest Synergies are in China

China represents the biggest market. It is spending more than the U.S. and Europe combined for air pollution control equipment and also more for HVAC filters due to the poor air quality throughout the country.

## Other Regions: AC Business in China

Constantly create new markets and develop unique product and sales strategies to accelerate business expansion. Positioning VRV (commercial market), residential multi-split (residential market), and Applied (building market) as strategic products, maintain overwhelming influence in all the markets and continue growing as the top foreign brand

### <Policy by market>

Residential

- Propose new lifestyle for 1.3B Chinese people with the New Life Multi Series, which adds new functions to AC, to expand the multi-split market
- Develop PROSHOP strategy throughout China and establish our own user-direct proposal-type specialty store network centered on direct sales
- Expand sales/profit with strategy combining residential multi-split and RA

Commercial

- Capture all markets from large buildings to stores by launching new VRV models
- Evolve heat pump heating technologies to capture cold regions with opportunities sparked by environmental issues
- Expand sales with priority on replacement, stores, and offices, for which demand is stable

Applied

- Reinforce the large-sized heat source/refrigeration fields to become the No. 1 Applied manufacturer
- Establish a cyclical business centering on the After Sales Service business

### <Common themes>

- Provide high-quality service and solutions based on advanced IoT
- Reinforce the Shanghai R&D Center as a global development base in addition to product development for the Chinese market
- Expand in-house production of core parts and supply devices from China to the world with the Shanghai and Suzhou factories at the core



# The Pharmaceutical and Power Industries present Major Opportunities

Feedback from remotely monitoring all the filters in the plant can be used by the PTFE media group to design better media for specific applications. The monitoring of cleanrooms opens the door for insights on PTFE clothing and other cleanroom products.

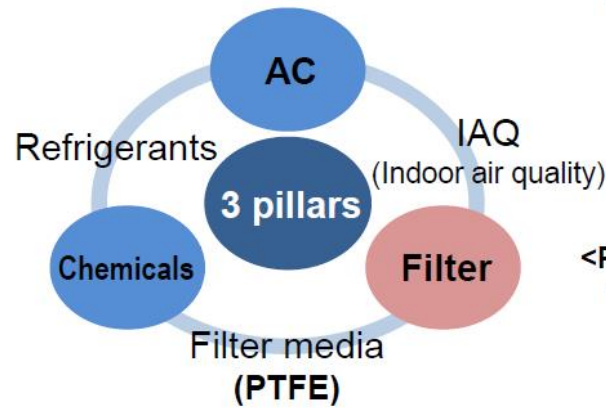
Indoor air quality monitoring will provide the data to design better hoods to capture fumes and better ways to recover heat.

With fan filter units supplied by Daikin it is possible to precisely control air flow through the filters and turn off some fan filter units when cleanroom cleanliness warrants. Flexibility is the big advantage of large numbers of fan filter units as opposed to ballroom cleanroom fans.

## 4) Filter Business

**Leveraging the Flanders (U.S.) acquisition, capture the pharmaceutical and other high-end markets and strengthen our cost competitiveness to accelerate growth of the Filter business as the third pillar of revenue following AC and Chemicals**  
**<Net sales: FY 2015: ¥80.0B → FY 2018: ¥140.0B>**

<3 main businesses and affinity>



<Air Filter business>

- Create synergy with Flanders (U.S.)
  - Reinforce the U.S. high-end market with our expertise in PTFE (Chemicals business) and equipment for pharmaceuticals
  - Deploy the know-how acquired in the U.S. globally utilizing AAF's sales network and brand power
  - Develop cost competitiveness with wide-ranging product lineup and mass-production efficiencies

<Power and Industry business>

- Backed by the rise of IAQ needs to remove PM2.5, etc., contribute to the resolution of environmental problems such as control of air pollution  
 Strengthen the Aftermarket business and improve profitability

<Ref.: Air filter equipment, etc.>

Clean room filters for semiconductors and LCD



Fan filter units for pharmaceutical and medical clean room equipment



<Ref.: Power and Industry equipment, etc.>

Dust collection for gas turbines



Dust collection for large plants



DAIKIN INDUSTRIES, LTD.

# New APC Technologies recover Exhaust Heat and can leverage Daikin Heating/Water Business

## 5)-1 Heating/Water Heater Business

While maintaining our advantageous position in the heat pump heating market, expand the Combustion Heating business  
With Europe as our first priority due to its market size and business opportunities, develop the Heating/Water Heater business  
<Net sales: FY 2015: ¥120.0B → FY 2018: ¥160.0B>

Recovering the energy from hot dust collector exhausts is a big money saving potential. Using that energy for heating and cooling is a practical option in many industrial plants. New air pollution technologies such as catalytic filtration at 850F provide a clean hot gas stream.

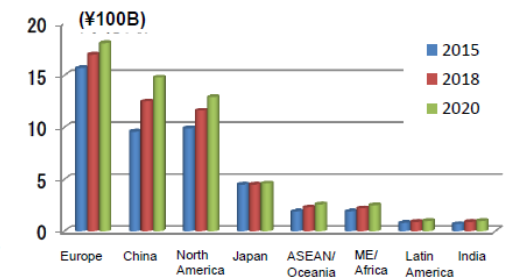
### <Europe>

- Expand the Heat Pump + Combustion Heating/Water Heater business  
Top priority: France, UK, Germany, Italy, Turkey
- Obtain combustion products and technologies and heating sales channels/service networks through alliances and M&A
- Prompt market changes with hybrid heating/water heaters

### <Other regions>

- NA: Horizontally develop tankless (gas) hot water heaters
- China: Create a heat pump heating/water heater market (provide solutions to environmental problems)

### <Global heating/water heater demand>



Source: Estimates by Daikin  
(not including district heating)

# Daikin already expanding into Air Environment Engineering

Daikin is already programmed to combine sales of AC, ventilation, and filtration to meet air quality needs. In addition to conventional needs there is the bioclean environment for biopharmaceuticals where remote monitoring and preventive maintenance guidance can be critical to product quality and safety.

## 6)-2 Next-generation Refrigerant/Gas business

**Achieve both environmental contributions and business growth by developing low-GWP refrigerants to help mitigate global warming and increasing penetration of equipment using these refrigerants**

**<Net sales: FY 2015: ¥16.0B → FY 2018: ¥20.0B>**

- Select the most suitable refrigerant for each application and promote its market penetration  
Promote penetration of R32 for AC (split-type air conditioners, etc.)
- R&D for next-generation refrigerants and equipment
- Globally expand the Gas business in the Chemicals Division (for automotive, AC, cold chain, and other applications)

Comprehensive evaluation items to research, develop, and select refrigerants



## 6)-3 IAQ/Air Environment (AE) Engineering business

**Expand the business domain from air conditioning to AE engineering, create spaces that meet the diverse air quality needs of customers, and initiate the IAQ/AE Engineering business development with earnings from equipment, systems, and services/engineering, moving away from stand-alone equipment sales**

**<Net sales: FY 2015: ¥5.0B → FY 2018: ¥20.0B>**

- Combined equipment sales (AC, ventilation, filter, etc.) meeting existing air quality needs
- Engineering business that realizes air environment promising safety/security
  - Realize bioclean environments needed for the advanced biopharmaceutical market, etc.
- Create spatial value related to health/comfort

# The Present Pursuit of Differentiated Products will be expanded by focusing on Smart Products and Integration

The introduction of IoT and big data already underway opens the door for Dakin to be remotely monitoring and controlling the environment in industrial plants. With the local production of filters and other components, Daikin can provide sourcing for all HVAC and air pollution control products. Marketing and product development will be shaped by IIoT more than the other way around.

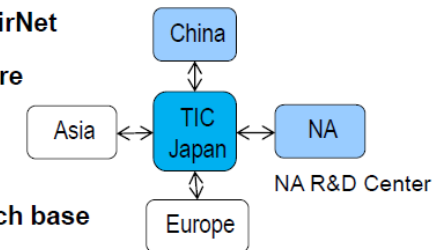
This sourcing will be global and accommodate customers such as Arcelor Mittal who has 200 plants scattered throughout the world.



## 7) Differentiated Technologies/Products with the TIC

Strengthen collaboration inside and outside the company and create technologies and differentiated products to drive expansion of existing and new businesses. Deploy technologies developed at the TIC globally and quickly create differentiated products at local bases close to the customer to meet regional needs

- Develop differentiated products such as next-generation VRV. Explore energy-saving, reliable, and low-cost basic technologies
- Acquire technologies and resources we lack from outside the company in the environment/energy, IAQ/AE engineering, and hybrid/non-fluorine fields
  - AC system for zero energy buildings (ZEB)
  - Energy management and failure prediction with next-generation AirNet that utilizes IoT and Artificial Intelligence (AI)
  - Establish sensing technologies and evaluation methods to measure correlations between air environment and human physiology
- Strengthen the global AC development system
  - Focus on strengthening development bases in China and NA where engineering HR is abundant
  - Strengthen marketing and product development capabilities at each base



## 8) Enhanced *Monozukuri* in the AC Business

Introduce IoT, Big Data analysis, and other advanced technologies to increase productivity

- Establish highly efficient manufacturing that enables profitable small-scale production to meet diverse needs
- With a base of localized production, establish a division of production operations to ensure global total optimization

# Daikin solves HVAC Problem when a Better Solution may have been Available with a Holistic Approach

A food manufacturer in Michigan was experiencing short life on his HVAC filters due to sugar dust. Daikin conducted an HVAC audit and recommended an HVAC filter change. Switching to a deeper pocket filter from AAF increased the filter life from 2 weeks to 5 weeks and saved \$ 24,000 per year.

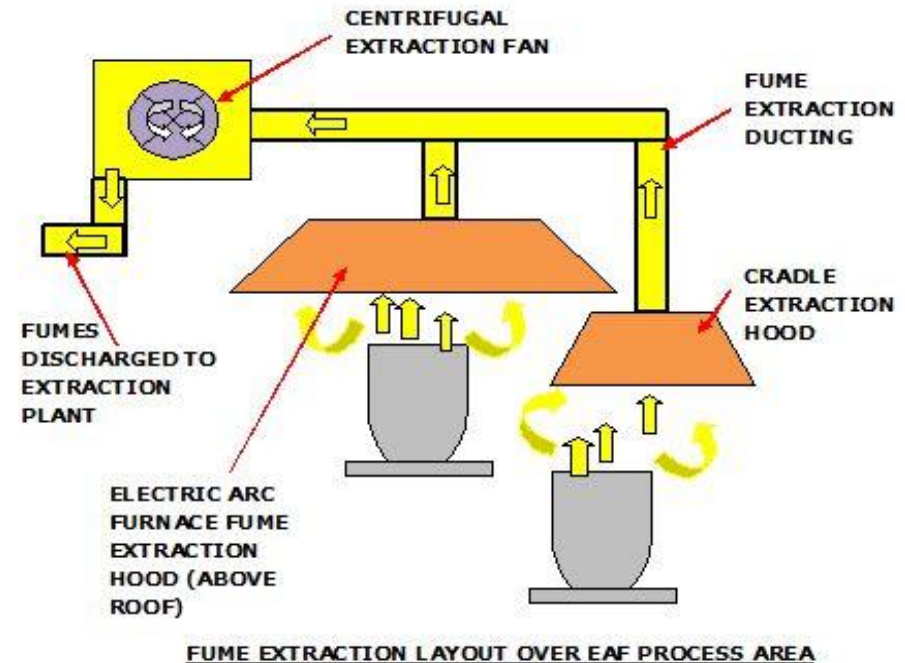
With the Fusion strategy the sugar dust would not be in the atmosphere causing problems with equipment as well as HVAC filters. With better local dust control at points emitting sugar dust there could be hundreds of thousands of dollars saved.

Instead of just a Daikin HVAC audit the plant could be operating with advice and preventive maintenance schedules from a Daikin remote control center which would be manipulating intake air, recirculating air through the HVAC, recirculating air through in plant dust collectors and exhaust air through dust collectors.

There is a huge energy savings available by varying the capture air in dust collector hoods based on the dust generation at various times during the day. Fugitive particulate monitors can signal the air purity in the area and be used to remotely control capture volumes.

# Big Potential to control Dust Hood Capture Air

AAF provides dust control systems with hoods which capture dusty air. The dust is conveyed to filters and the clean air then discharged. The amount of dust generated varies with the process changes. Fugitive emission monitors can be providing intelligence to a remote operator who can vary the flow to maintain optimum air quality and energy efficiency. However when the extraction air varies so must the intake air from outside the plant. Temperature and humidity inside and outside the plant are additional variables. There is also the option to discharge clean air from dust collectors back into the plant (very common for certain types of applications with large particles and low toxic potential). So this is another variable which can be controlled with sophisticated analytics available in an IIoT program.



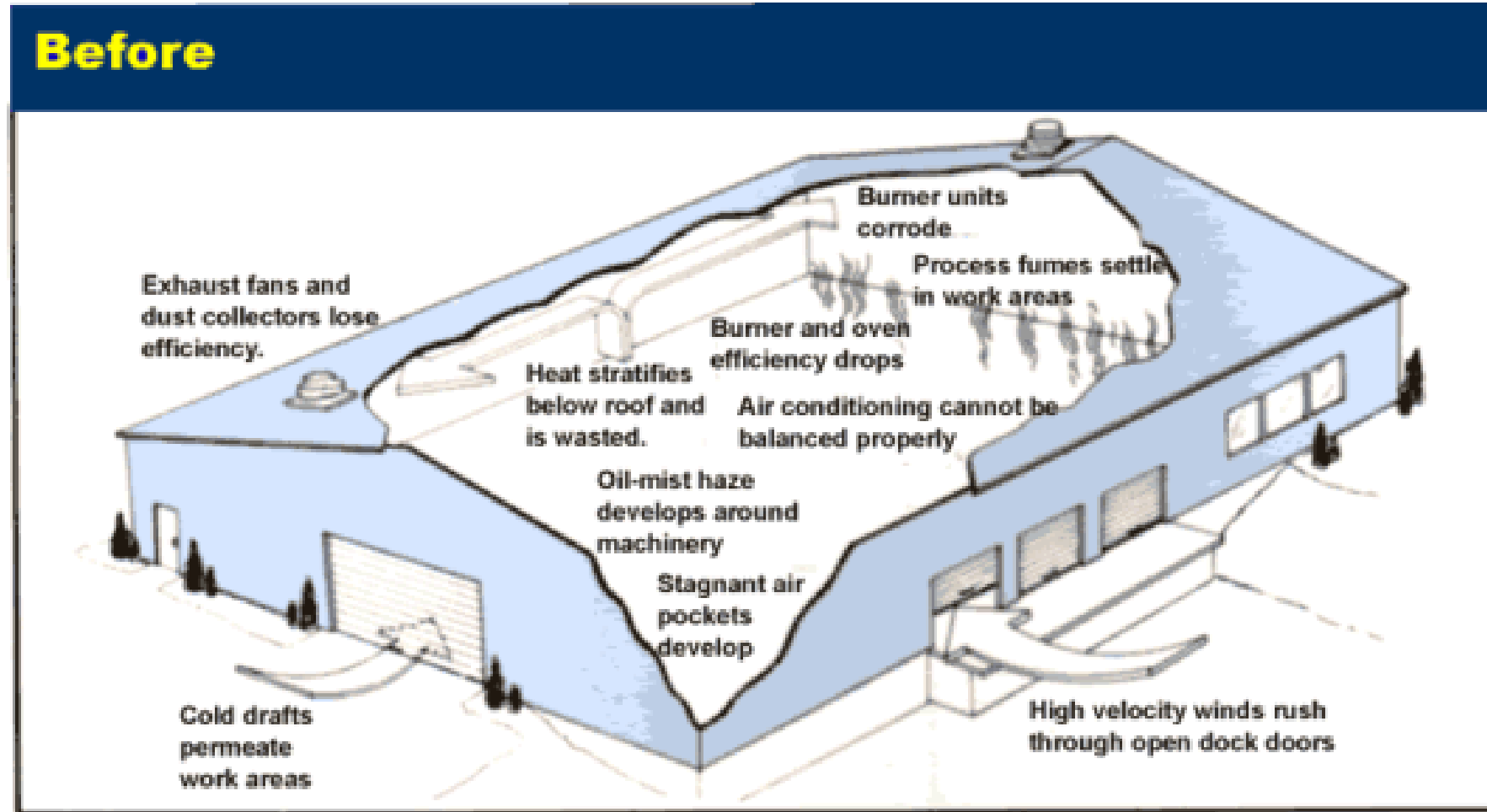
*Drawn by Willie Scott 27/7/2010*

# Holistic Approach incorporates Make Up Air and Exhaust

Insufficient make up air creates a negative pressure in the building with drafts and reduction of dust collector flow.

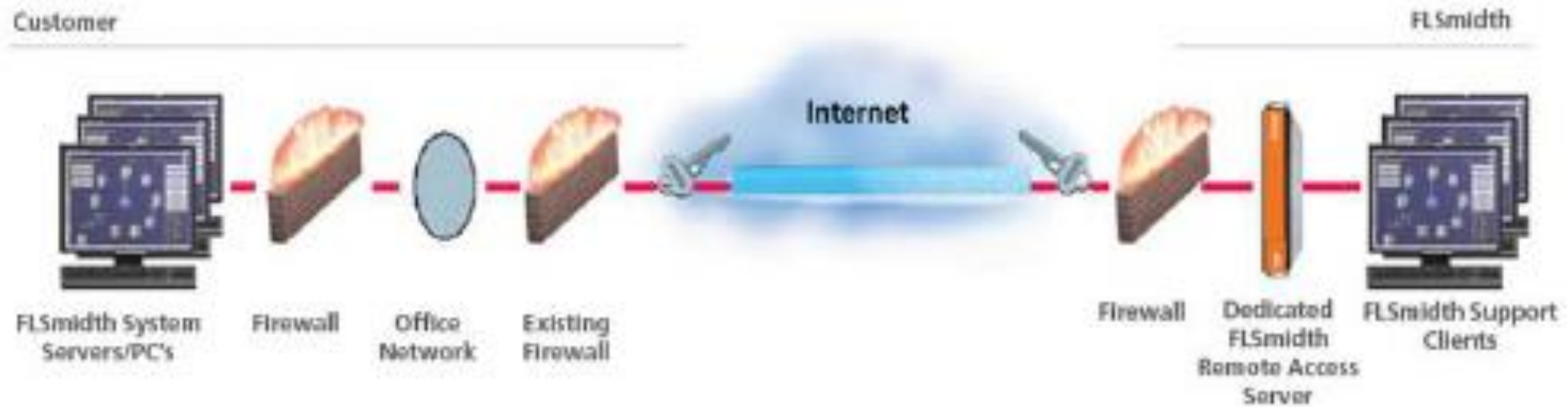
The oil mist haze around the machinery can be eliminated with oil mist collectors which can recirculate the air back into the plant.

There is significant energy savings with the holistic approach which also assures that OSHA and EPA regulations are met.



# FLSmidth has the Plant Systems and APC

The portfolio of FLSmidth Automation Services includes five Remote Services available worldwide via online computer communication. Remote Service offers the customer faster response time and access to a wide range of specialists, while saving travel time and costs. For the customer this means higher system performance and shorter downtime in case of system failure.



24/7 Front-end Global Support  
Advanced Troubleshooting  
Engineering Services  
Remote Software Maintenance  
Remote Optimization

The company supplies replacement bags, precipitator control as well as complete particulate and acid gas removal systems and is well positioned for holistic delivery of products with IIoT.



# B&W is in an Ideal Position to deliver IIoT and Remote O&M for a Range of Products and Industries

- B&W and its Megtec subsidiary have a complete range of air pollution control equipment and spare parts programs.
- B&W is a leading supplier of boilers for power and other industries including waste to energy plants.
- It has a problem in that its human experts are centered in the U.S whereas its growing markets are in Asia and developing countries.
- With remote monitoring and control B&W can take advantage of all the expertise in Barberton Ohio, Depere WI and other locations in the U.S.

# B&W All<sup>®</sup> Acoustic Leak Detector System

- Alabama Power Company's B.C. Gaston Plant is located in Wilsonville, Alabama and has five units totaling 1,880 MW. Unit 5 is a Combustion Engineering (CE) supercritical, combined circulation, radiant reheat boiler. Due to leaks the plant installed a B&W ALL leak detector system
- The amount of unit downtime to repair damage from a leak is affected by the number of tubes to be repaired and the type of repair needed. In most cases, early leak detection can minimize the number of tubes to be repaired, the type of tube repairs needed, and also the outage hours the unit would be off-line and unavailable. The cost savings generated by an early leak detection system is dependent on the frequency of leaks occurring and the cost of replacement power at the time the leaks occurred. Given the historical data on Unit 5 leaks, together with an average replacement power cost of approximately \$90,000 a day, an early leak detection system was found to be cost justified on Unit 5. In fact, only three leaks on the unit would cost justify the purchase of a detection system using the vendors' approximate budget numbers. After all factors were evaluated, Alabama Power chose the Babcock & Wilcox Acoustic Leak Locator (ALL<sup>®</sup>) to provide early leak detection.

# B&W already supplies CEM Systems with Continuous Reporting of Emissions

- Through the B&W KVB-Enertec™ product suite of integrated Continuous Emissions Monitoring Systems (CEMS) and Data Acquisition and Handling Systems (DAHS) solutions, B&W can deliver a total system, individual components and/or expert service to help you monitor, control, collect and evaluate your plant's emissions data. We understand your emissions systems have to be reliable 24/7. We have a 100-percent on-time track record for delivery, provide proprietary software that ensures accurate data is measured against the most current emissions standards, and offer around-the-clock support to help ensure your CEMS stays up and running.

Our CEMS can be found in diverse industries – including utility, petrochemical, cement, biogas, refinery, pulp and paper, and many others – regardless of fuel and across a broad range of operating conditions.

We are uniquely qualified to provide you with:

- Two supply options for CEMS hardware and shelters
  - A completely customized CEMS designed to your space and operational requirements
  - Our standardized CEMSCAN® system – a unique, modular, low-maintenance, low fixed price design available for next-day delivery
- Expert CEMS management and operations support as well as regulatory experts who work closely with environmental agencies and can provide guidance from air permitting to reporting.
- A full range of life-cycle support services including system design, installation, startup, certification, training, testing, and spare parts inventory.
- Software tools that provide data reports and system condition alerts from across your fleet directly to your mobile device.
- An active user community for sharing best practices and directing product development



# B&W working with Yokogawa for Recording performance of RTO's supplied by Megtec

- MEGTEC Systems, a major manufacturer of Regenerative Thermal Oxidizers in DePere, Wisconsin is now specifying DAQSTATION for use with their equipment. These oxidizers, commonly known as RTOs, are found in Paint Finishing Operations, Chemical, Petrochemical and Ethanol Production, Ink Coating and Odor Abatement, and many other applications on a global basis.
- Many RTOs are similar to large furnaces that eliminate manufacturing and production byproducts such as vaporized solvents or airborne pollutants.
- **Application**
- The EPA requires data acquisition devices to be incorporated into an RTO for the purpose of long-term data retention. These devices provide a record of temperatures maintained inside the RTO as proof that all pollutants were eliminated before venting factory air back into the atmosphere. DAQSTATIONS retain this data in a secure format for review upon request. End users also periodically file formal reports with state inspectors to satisfy local reporting requirements. PLCs and HMIs are often found in the RTO for control and logic functions with respect to firing rates and damper positions. An important part of basic instrumentation of an RTO is interconnectivity between the different instruments

# B&W can also Remotely Operate and Control Waste to Energy Plants

- Metso has signed an agreement with Babcock & Wilcox Vølund to supply automation for a greenfield energy-from-waste plant in Peterborough, UK. With advanced automation solutions, the operators will be able to efficiently control the process of transforming waste into green energy and manage operations at the plant.
- The new plant will be operated and maintained by Viridor, one of Europe's major waste management companies. Once completed in 2015, it will have a capacity to treat approximately 85,000 tons of waste per year. The plant's electrical power generation capacity will be 7.25 MW. Babcock & Wilcox Vølund is responsible for the engineering, procurement and construction of the plant.
- Metso's delivery scope consists of a Metso DNA automation system, a Metso DNA information management system and a fully integrated Metso DNA Machine Monitoring solution to predict mechanical faults in critical machinery. Taking the right actions at the right time guarantees maximum process availability and an efficient maintenance process. The order is included in the second quarter orders received by Metso's Automation segment. Project handover is scheduled to take place in December 2015. The value of the order will not be disclosed.
- "We have wide experience in supplying automation technology to energy-from-waste plants in Europe, and especially in the UK. In fact, our Metso DNA automation system is installed in 60 to 70% of UK's energy-from-waste plants," informs Neil Buckland, Sales Director, UK, Automation, Metso. "To support our customers and provide them with professional services throughout the plant life cycle, we have a strong local service organization in the UK."
- Babcock & Wilcox Vølund is among the world's leading suppliers of knowledge, technologies and equipment for combustion of waste and biomass. It is based in Denmark and employs about 440 employees. The company is 100% owned by The Babcock & Wilcox Company. [www.volund.dk](http://www.volund.dk)

# B&W provides training in a Number of Related Technologies

- Individuals and groups can register to attend scheduled technical training seminars on subjects such as boiler operation and maintenance, pulverizers, and electrostatic precipitator controls and maintenance. Seminar participants hear from recognized experts in the subject area, and receive written material to reinforce the lessons learned in presentations.
- B&W continually strives to provide seminars and training programs to meet the needs of our customers. Seminar participants will hear from recognized experts in the subject area, and will receive written material to reinforce the lessons learned in presentations. Participants also will receive a complimentary copy of Steam, its generation and use (42nd Edition), the complete reference guide to steam generation.
- B&W offers each seminar attendee the opportunity to earn Continuing Education Units (CEUs) through The University of Akron's UA Solutions Program. One contact/training hour equals 0.1 CEU. Upon course completion and verification, attendees will receive a certificate of completion from The University of Akron's UA Solutions Program.



# B&W now has Acoustic Emission Control and Filtration Systems for Engines

- BW) has acquired Universal Acoustic & Emission Technologies, Inc. (UniversalAET), a Wisconsin-based provider of custom-engineered acoustic, emission and filtration solutions
- UniversalAET is a bolt-on acquisition for B&W MEGTEC and will be included in B&W's Industrial operating segment. The new company will be named Babcock & Wilcox Universal and operate under the trade name B&W Universal.
- UniversalAET provides custom-engineered acoustic, emission and filtration solutions to the natural gas power generation, mid-stream natural gas pipeline, locomotive and general industrial end-markets. UniversalAET employs approximately 460 people, mainly in the U.S. and Mexico. UniversalAET's product offering includes gas turbine inlet and exhaust systems, custom silencers, filters and custom enclosures.
- "UniversalAET expands our industrial environmental portfolio into noise abatement, introduces us to new end markets and customers, and gives us another avenue to serve natural gas power generation customers," said B&W Chairman and Chief Executive Officer E. James Ferland. "This acquisition aligns with our strategy to grow our industrial market exposure and continue to increase our non-coal revenue base."
- The deal is based on an enterprise value of \$55 million, subject to certain adjustments. UniversalAET is expected to generate approximately \$80 million of annual revenue and to be accretive in 2017.