Thank you for signing in early

The webinar will begin promptly at
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SERDP and ESTCP Webinar Series

The webinar will begin promptly at 12:00 pm ET, 9:00 am PT

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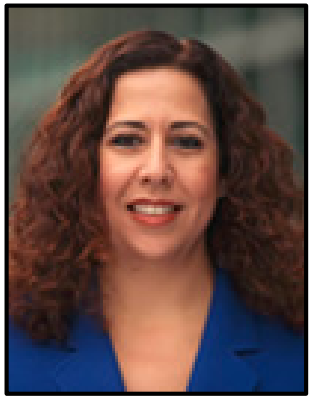
  1. Listen to the broadcast audio if your computer is equipped with speakers
  2. Call into the conference line: 303-248-0285
     Required conference ID: 6102000
- For any question or issues, please email serdp-estcp@noblis.org or call 571-372-6565

"Award Winning Projects: Energy and Water"

January 12, 2017

SERDP DOD • EPA • DOE | ESTCP

Welcome and Introductions



Rula A. Deeb, Ph.D.
Webinar Program Coordinator

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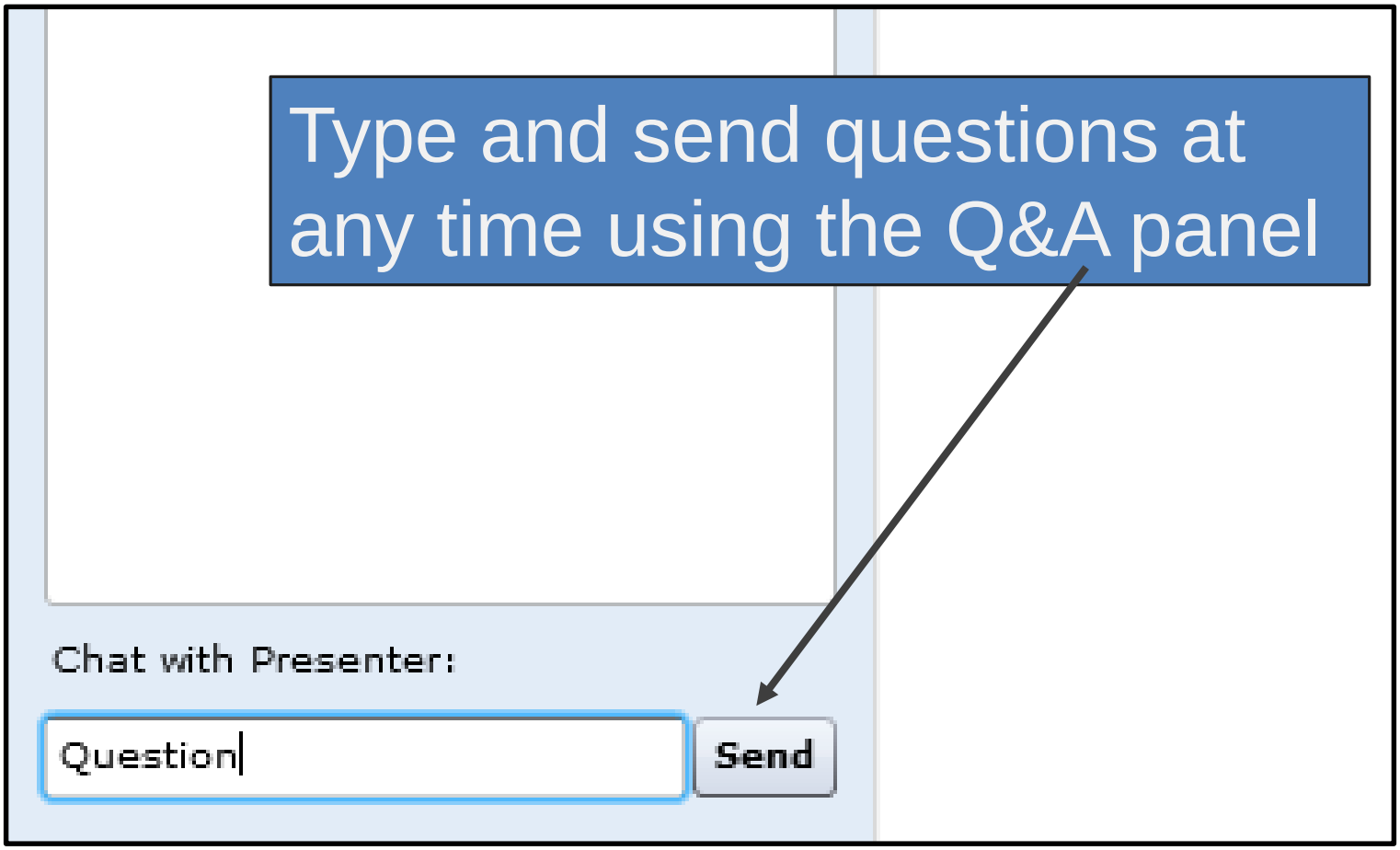
Webinar Agenda

- **Webinar Logistics** (5 minutes)
  Dr. Rula Deeb, Geosyntec Consultants
- **Overview of SERDP and ESTCP** (5 minutes)
  Mr. Timothy Tetreault, SERDP and ESTCP
- **ClimaStat® for Improved Air Conditioning Efficiency and Dehumidification** (25 minutes + Q&A)
  Dr. Michael West, AdvanTek Consulting, Inc.
- **Using Remote Audits to Achieve Energy Efficiency in the Department of Defense** (25 minutes + Q&A)
  Ms. Cara Brill, FirstFuel Software
- **Final Q&A session**

How to Ask Questions



In Case of Technical Difficulties

- Delays in the broadcast audio
  - Click the mute/connect button
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  - If delays continue, call into the conference line
    - Call into the conference line: 303-248-0285
    - Required conference ID: 6102000
- Submit a question using the chat box

SERDP and ESTCP Overview

Timothy Tetreault
Energy and Water Program Manager

SERDP DOD ▪ EPA ▪ DOE | ESTCP

SERDP

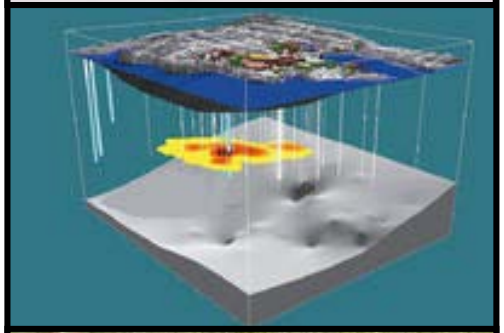
- Strategic Environmental Research and Development Program
- Established by Congress in FY 1991
  - DoD, DOE and EPA partnership
- SERDP is a requirements driven program which identifies high-priority environmental science and technology investment opportunities that address DoD requirements
  - Advanced technology development to address near term needs
  - Fundamental research to impact real world environmental management

ESTCP

- Environmental Security Technology Certification Program
- Demonstrate innovative cost-effective environmental and energy technologies
  - Capitalize on past investments
  - Transition technology out of the lab
- Promote implementation
  - Facilitate regulatory acceptance

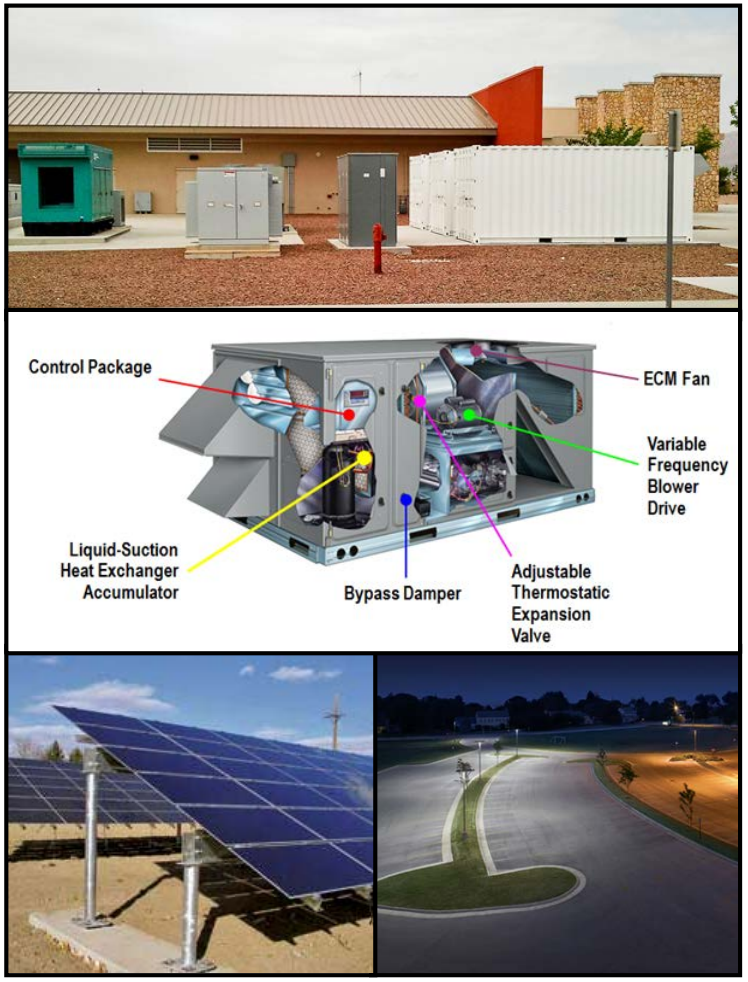
Program Areas

1. Energy and Water
2. Environmental Restoration
3. Munitions Response
4. Resource Conservation and Resiliency
5. Weapons Systems and Platforms


Energy and Water

- Smart and secure installation energy management
  - Microgrids
  - Energy storage
  - Ancillary service markets
- Efficient integrated buildings and components
  - Design, retrofit, operate
  - Enterprise optimized investment
  - Advanced components
  - Intelligent building management
  - Non-invasive energy audits
- Distributed generation
  - Cost effective
  - On-site
  - Emphasis on renewables



SERDP and ESTCP Webinar Series

Date	Topic
January 26, 2017	**Award Winning Projects:** Weapons Systems and Platforms
February 9, 2017	**Award Winning Projects:** Environmental Restoration
February 23, 2017	**Award Winning Projects:** Resource Conservation and Resiliency
March 9, 2017	**Award Winning Projects:** Munitions Response
March 23, 2017	Monitoring and Risk Assessment of Environmental Risks Posed by Munitions Constituents in Aquatic Systems
April 6, 2017	1,4-Dioxane Impacts and Innovative Cleanup Technologies at DoD Contaminated Sites

For upcoming webinars, please visit

http://serdp-estcp.org/Tools-and-Training/Webinar-Series

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ClimaStat® for Improved DX Air Conditioning Efficiency

Michael West, Ph.D., PE
AdvanTek Consulting

SERDP DOD ▪ EPA ▪ DOE | ESTCP

Agenda

- Background of DX air conditioners
- Technology explanation
- Demonstrations
- Results
- Application
- Conclusions

Background

DX Air Conditioners are Ubiquitous

- 60% of US commercial space is cooled with RTUs (DOE)
- 54% of building cooling primary energy consumption (EIA)
- Total annual installations over 300,000 units
- ~1.6 million legacy units operating at low efficiency levels
- About 100,000 units at 20,000 DoD buildings

ROOFTOP UNIT (RTU)

PORTABLE ECU

PAD MOUNT PACKAGE UNIT

***RTU**: Rooftop packaged air-conditioner unit; **DOE:** U.S. Department of Energy; **EIA**: Energy Information Administration*
***DoD**: Department of Defense*

Performance Ratings

*How Much Cooling You Get for Electricity Used**

- Energy Efficiency Ratio (EER)
  - Full load @ 95F ambient
- Integrated EER (IEER)
  - Weighted full load and part load @ 95, 81.5, 68, and 65F ambient
- Seasonal EER (SEER)
  - Part load @ 82F ambient x 0.875 (cyclic performance load factor)
- Integrated Part-Load Value (IPLV) is a legacy rating
  - No longer used

*ANSI/AHRI Standard 340/360-2007; Units are Btuh per Watt (MBH per kW)

Drivers

Rising Energy Efficiency Standards

- Minimum IEER efficiency ratings
  - Up from 10.1 to 11.6 (2018) and to 13.2 (2023)
- Single-zone VAV and DDC requirements
  - ASHRAE Energy Standard 90.1-2016
  - ASHRAE Green Standard 189.1-2014
  - LEED version 4

VAV: Variable Air Volume
DDC: Direct Digital Control




Drivers

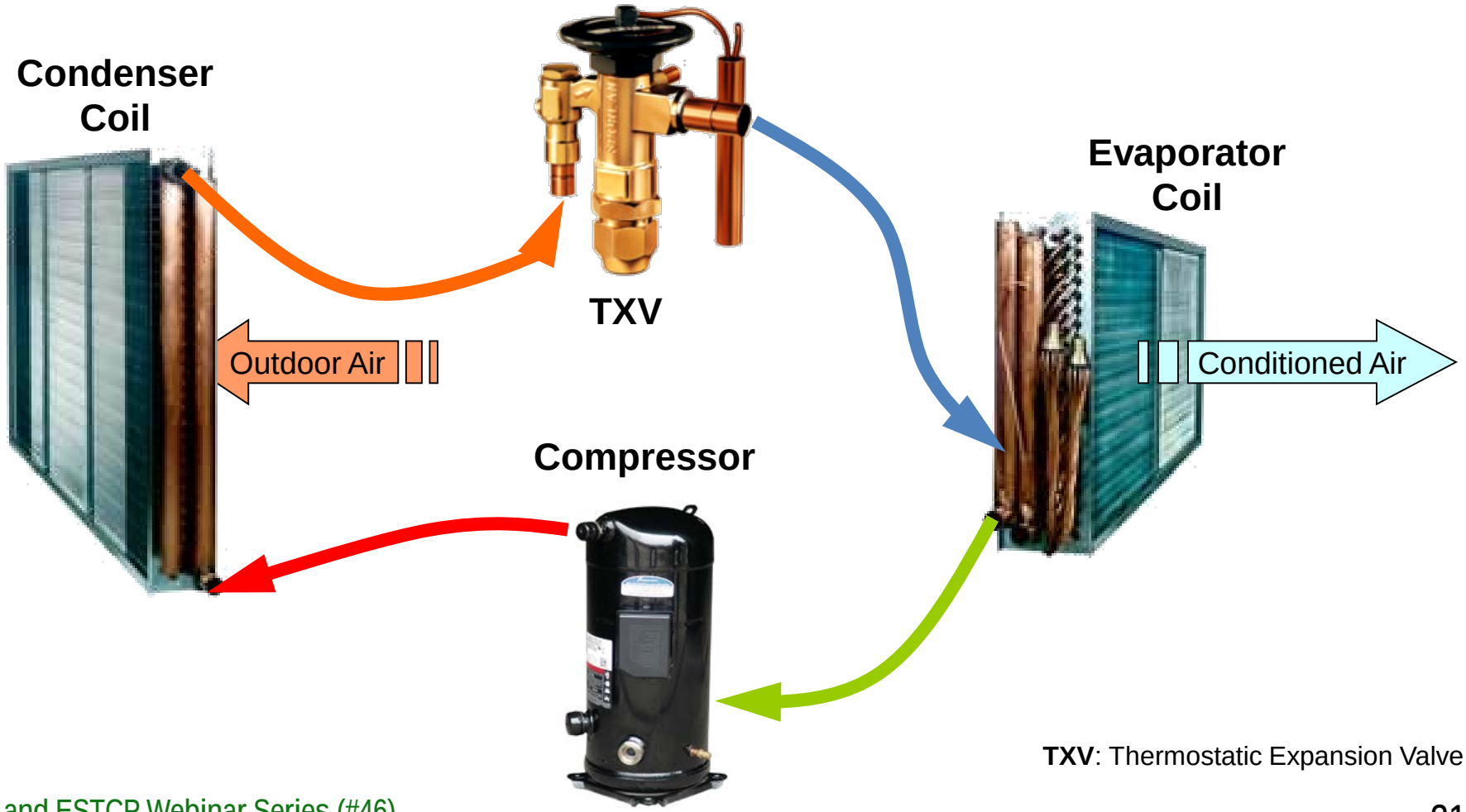
Dehumidification Needs are Increasing

- Reduced sensible loads means lower SHR
  - Lowered lighting watts per square foot
  - Higher insulation R-values
  - Heat reflective / low-e glass
- Typically addressed with energy intensive reheat
- Part-load humidity requirements
  - ASHRAE IAQ Standard 62.1-2016

SHR: Sensible Heat Ratio
IAQ: Indoor Air Quality

Technology

Basic DX Cycle Used in Virtually Every DX Air Conditioner



TXV: Thermostatic Expansion Valve

Technology

Limitations and Refrigerant Issues of the Basic DX Cycle

Pressure and temperature is reduced.
Liquid flashes to vapor

High temperature, high pressure gas is condensed and rejects heat to ambient air. Liquid is subcooled ~15F

Condenser Coil

TXV

Evaporator Coil

Remaining liquid evaporates and absorbs heat from supply air. Vapor is superheated ~15F to protect compressor

Compressor

Refrigerant pressure is increased.
Thermostat cycles compressor on/off

TXV: Thermostatic Expansion Valve

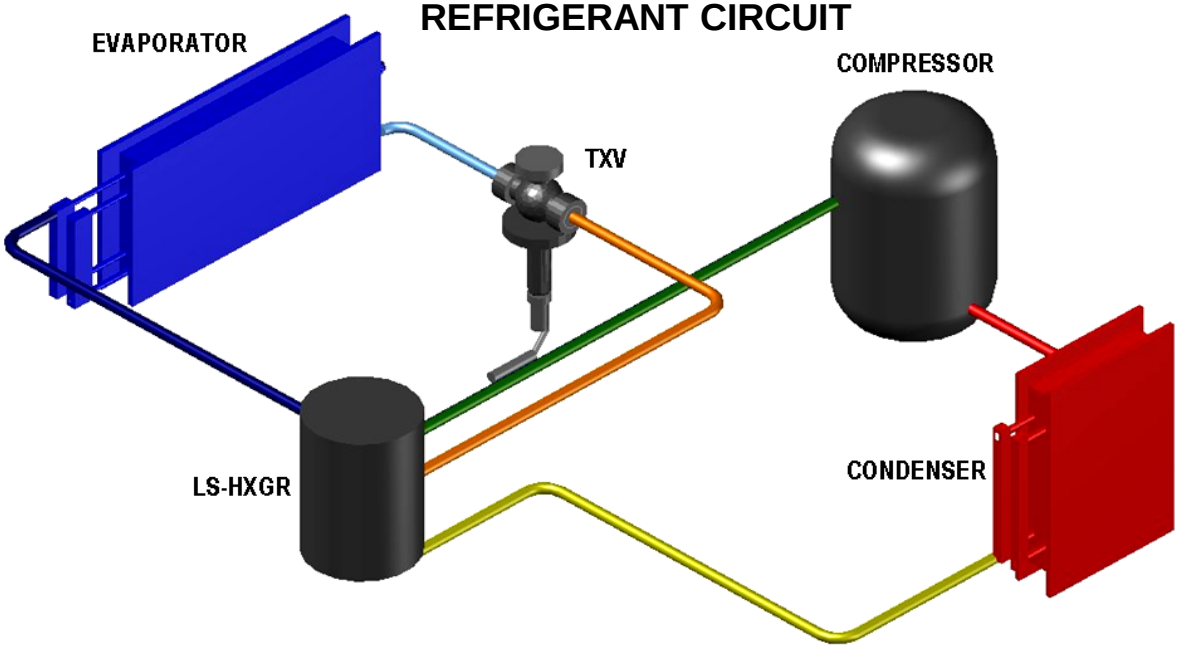
Technology

Modified DX Cycle has Higher Thermodynamic Efficiency

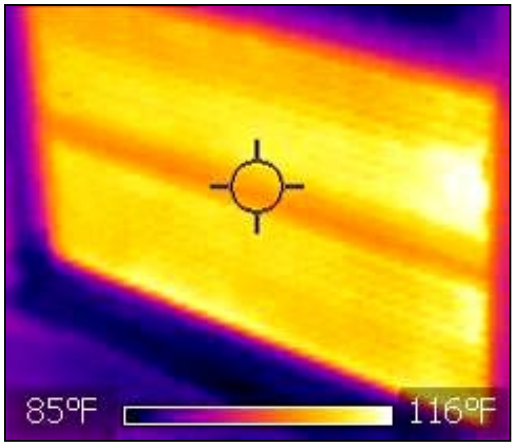
ClimaStat® revises the basic refrigeration cycle at a fundamental level

- Improvement of evaporator refrigerant / two-phase heat transfer
- Increased suction density improves compressor volumetric efficiency
- Variable sensible heat ratio optimizes airside performance

REFRIGERANT CIRCUIT



COIL HEAT TRANSFER

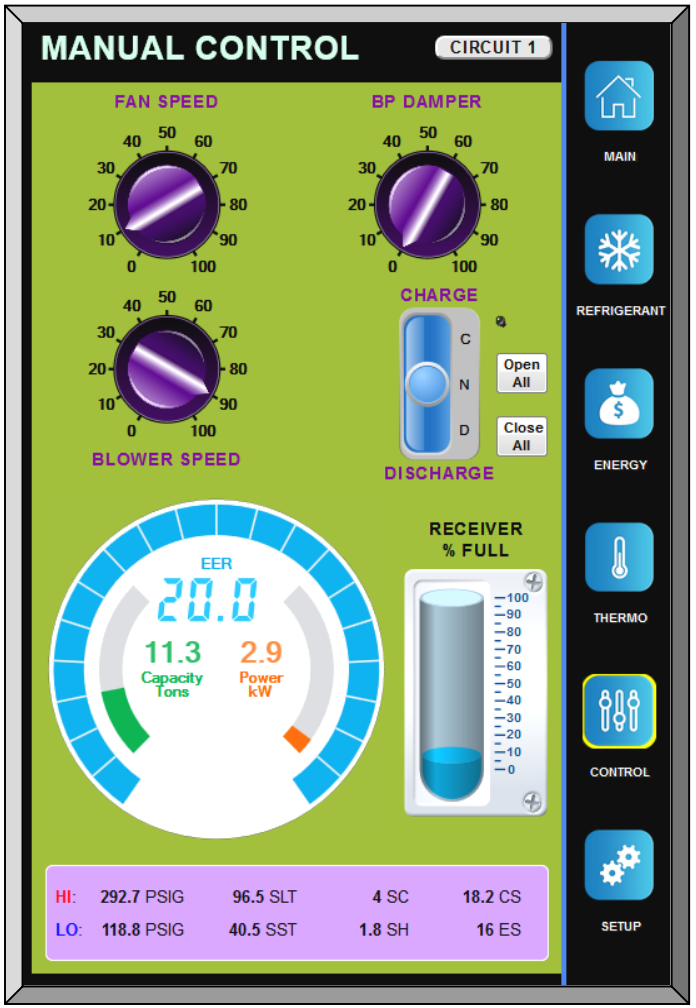


TXV: Thermostatic Expansion Valve

Technology

Optional Optimizing Control Pack

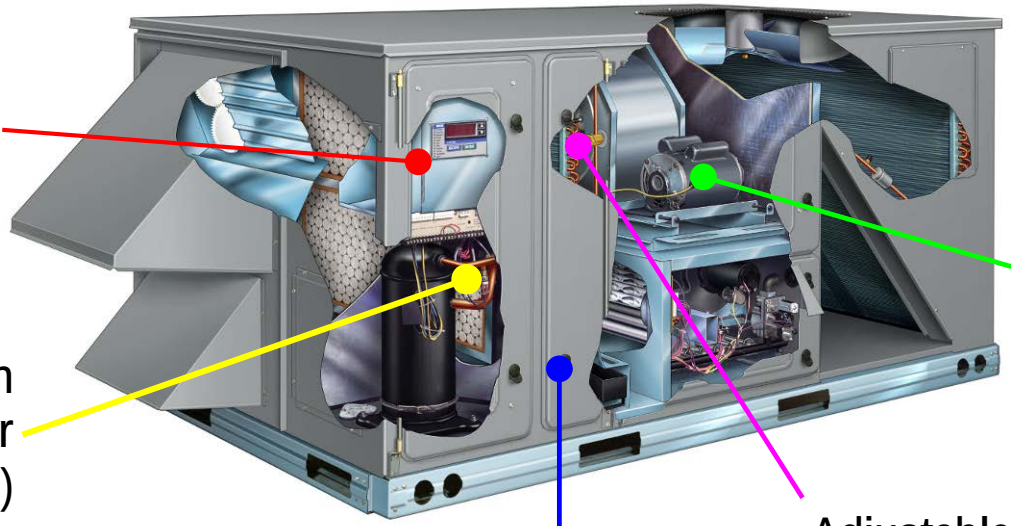
- Optimizes operating parameters
- Continuous performance tuning
  - Target is maximum EER while precisely meeting sensible and latent loads
- Web monitoring and reporting http://www.EERoptimizer.com/
- Fault detection and diagnostics
- Optional instead of standard PID temperature control



EER: Energy Efficiency Ratio
PID: Proportional Integral Derivative

Technology

ClimaStat-Equipped DX Air Conditioner Uses Much Less Energy



CLIMASTAT™

Demonstrations

Marine Corps Air Station Beaufort (MCASB)

20-ton dual-circuit
R-22 package DX unit
Gas heat
Manufactured 2/2003
Found in “poor” condition

Fresh air intake

Gas heating section

Compressors

Demonstrations

Naval Ordnance Test Unit (NOTU)

8½-ton dual-circuit
R410a package DX unit
9 kW-heat
Installed 1/2012

Demonstrations

Fort Irwin, National Training Center

Fort Irwin NTC, California

12½-ton dual-circuit
R410a package DX unit
Heat pump
Installed 2010

Performance Analysis

- Each unit was comprehensively instrumented
- Data collected for two full cooling seasons
- Results were rigorously analyzed

45 Sensors on each RTU

Compressor amps (2)
Fan and blower watts
Total unit power
Refrigerant pressures (4)
Refrigerant temperatures (12)
Refrigerant flows (2)
Air temperatures (8)
Thermostat, space, return, outdoor, cond coil, entering and leaving evap coil, unit discharge
Humidity (5)
Evap coil entering, space, unit discharge, thermostat, outdoor
Space and ambient CO_2 level
Control point status

Performance Analysis

- Site 1: MCASB 20-ton R-22
  - ClimaStat efficiency 19.6% improved from IEER 11.2 to 13.4
  - Unit varied its dehumidification capacity to match space load
  - EER at 95F 80/67 db/wb increased 10.4% from 10.6 to 11.7
- Site 2: NOTU 8-ton R-410A
  - ClimaStat efficiency 27.2% improved from IEER 12.5 to 15.9
  - Reheat only 0.5% of cooling hours at 45% space RH
  - EER at 95F 80/67 db/wb increased 29.2% from 11.3 to 14.6
- Site 3 Fort Irwin 12-ton R-410A
  - Preliminary results ClimaStat efficiency 24% improved
  - Summer 2016 data analysis underway as of 12/2/2016

Performance Analysis

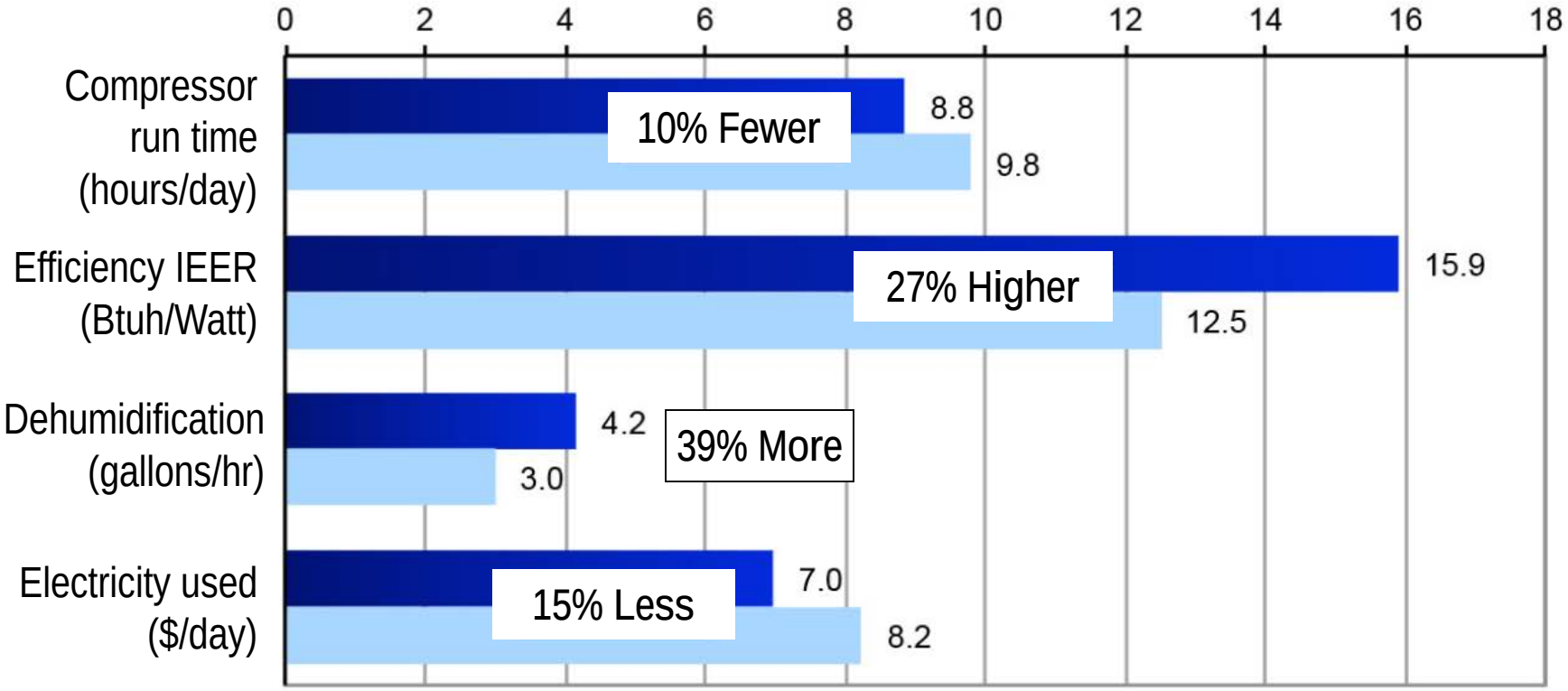
Substantial Energy Efficiency Improvements

- 10 to 20% improvement over factory rating
- 19 to 46% improvement in actual operating efficiency

ENERGY EFFICIENCY INCREASE OVER FACTORY RATING				
Site	MCASB, South Carolina		CCAFS, Florida	
Rating	IEER	EER	IEER	EER
Rating Increase	**20%**	**10%**	**17%**	**18%**
ENERGY CONSUMPTION RELATIVE TO BASELINE MEASUREMENT				
Site	MCASB, South Carolina		CCAFS, Florida	
Season	Summer	Shoulder	Humid	Dry
Energy Reduction	**46%**	**40%**	**24%**	**19%**

Results

Performance Comparison of ClimaStat vs. Standard RTU at Naval Ordnance Test Unit



Field test data from 8.5-ton dual compressor package unit. Run hours to satisfy thermostat at 50 ton-hr sensible cooling load.

Results

MCASB 20-ton R-22 RTU, installed 2003

- After refurbishment, baseline IEER = 9.5
- With ClimaStat, IEER = 13.4
- BLCC payback for ClimaStat is 4.0 years

NOTU 8-ton R-410A RTU, installed 2012

- Baseline IEER of new equipment = 12.5
- With ClimaStat, IEER = 15.9
- Increased dehumidification capability by 70%
- BLCC payback for ClimaStat is 2.6 years

Implications for DoD Facilities

- Field retrofits suitable for large RTUs with at least 5 years service life
- Factory installations are cost-justified for most new RTUs
- Potential total $110 million annual energy savings

BLCC: Building Life Cycle Cost analysis software

Application

Study Shows ClimaStat is 36% More Cost Effective

12½-ton Package Units	IEER	Cost	$ / IEER
Flagship Model *	18.5	$ 25,666	1,387
Midline Model	11.4	$ 11,857	1,040
Base Model with ClimaStat	15.9	$ 14,166	890

*Flagship model with variable speed inverter scroll compressors, plenum airfoil fans, electronic expansion valves, proprietary digital controls

Application

Typical Project Economics

- Current cost for installation of ClimaStat on a new 20-ton unit is $4,964
- Customer benefits are energy savings of $1,900 per year* and improved dehumidification (savings will be more if system uses reheat)
- Payback period: 2.6 years
- Maintenance needs are not increased

Mr. Neil Tisdale, Utilities Director/Energy Manager at MCASB, gave this feedback on the ClimaStat demonstration in January 2013: "The MCCS Maintenance Director is happy with the performance of the unit due to the fact that he has had no complaints. In the maintenance world no complaints is considered a job well done!"

** 0.11 $/kWh, 2,505 Full Load Equivalent Operating Hours, 2,590 Cooling Degree-Days*

Application

Unit Selection by Size and Age

BEST: RTUs with dehumidification or a humidistat

BETTER: Large DX systems 25 to 60 tons and up

GOOD: Midsize RTUs 10 to 25 tons

- Perform RTUCC economic analysis
- Not usually cost effective for units under 10 tons
- Existing units with 5+ years remaining service life

Application
Procurement Options

- New equipment
  - Guide specifications for bidding to include ClimaStat technology
  - Sole-source justification and approval (FAR Subpart 6.3)
    - Defense Contingency Contracting Handbook http://www.acq.osd.mil/dpap/ccap/cc/jcchb/HTML/Topical/sole_source.html
  - New RTU ships from factory to ClimaTek HVAC LLC for installation of ClimaStat, then shipped to project site
- Existing equipment
  - Economic analysis for selection of RTUs based on savings to investment ratio (SIR) and payback period.
  - Contract task order to ClimaTek HVAC LLC for retrofit of existing RTUs onsite, and briefing of local service technicians

Conclusions

- ClimaStat improves energy and dehumidification performance of DX air conditioners
  - Average 21% reduction in energy costs while nearly doubling dehumidification capability and improving air quality via lower humidity
  - Cost effective with payback in 3 to 5 years
  - Increased energy efficiency by 17 to 46%
  - Equal or improved comfort and reliability
  - No additional maintenance concerns

For additional information, please visit

https://serdp-estcp.org/index.php/Program-Areas/Energy-and-Water/Energy/Conservation-and-Efficiency/EW-201144

Speaker Contact Information

mwest@advantekinc.com; 321-733-1426 x3

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Q&A Session 1

Rapid Building Assessment for Energy Efficiency in the Department of Defense (DoD)

Cara Brill

FirstFuel Software

SERDP DOD • EPA • DOE | ESTCP

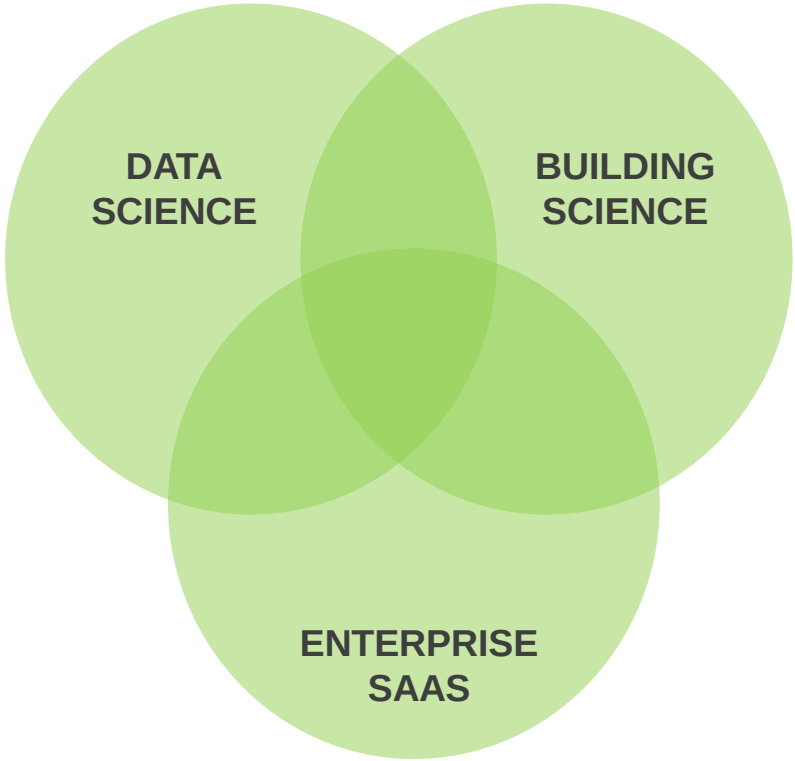
Agenda

- What is FirstFuel Software?
- Analytics-enabled energy efficiency
- Project overview
- Audit findings and outcomes
- Fort Bliss: A case study
- Lessons learned
- Conclusion

FirstFuel

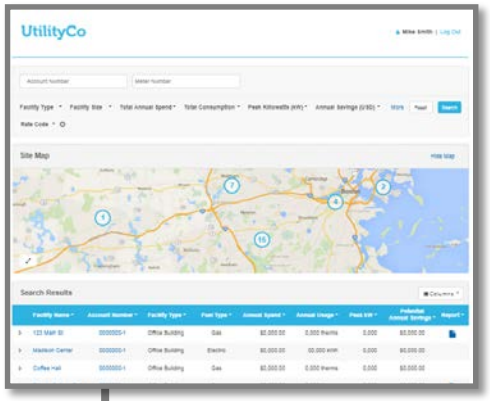
An Energy Intelligence Company

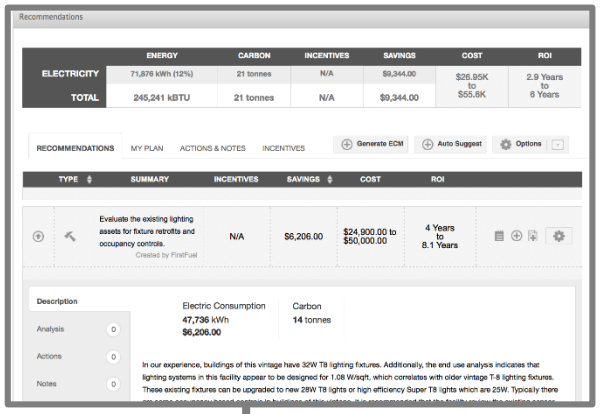
- Meet compliance requirements and achieve energy efficiency and sustainability goals while managing and monitoring large building portfolios



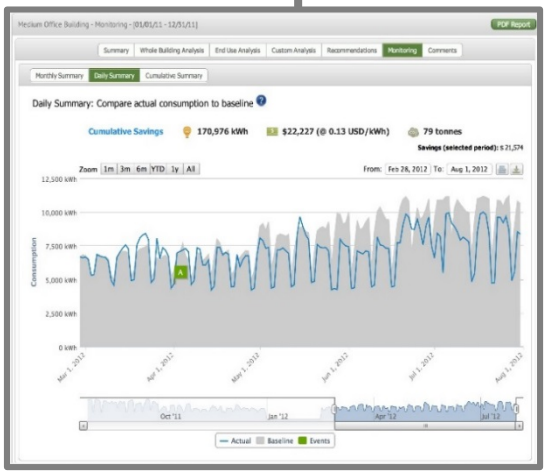
- Deployed at over 30 large utilities and government agencies
- Simple, scalable, affordable Portfolio Energy Management tools which help our customers efficiently identify and realize energy savings goals

Analytics Across the Lifecycle of Efficiency





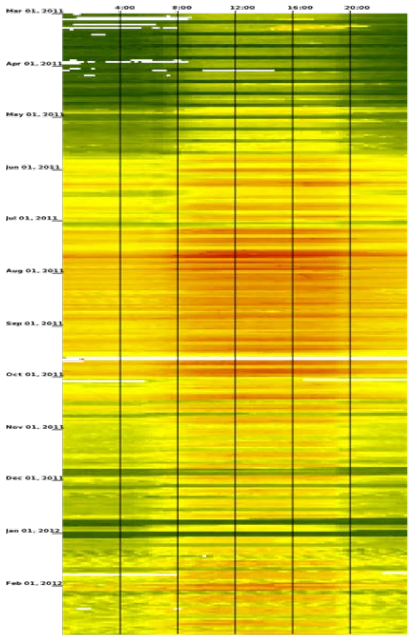
SCREEN PORTFOLIO → **CONDUCT REMOTE AUDITS** → **ENGAGE AND IMPLEMENT** → **MONITOR SAVINGS**



Key to Accelerating kWh/kW Savings

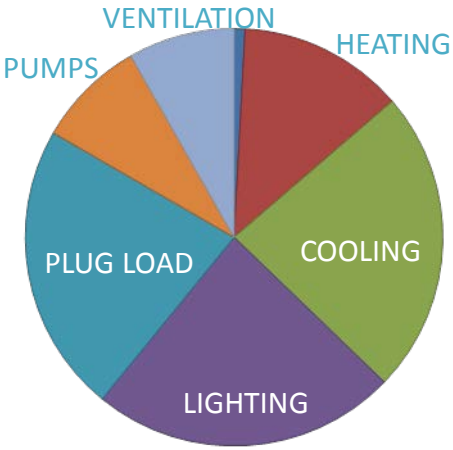
Understanding the Unique Story of Every Building

1 MINIMAL DATA INPUTS



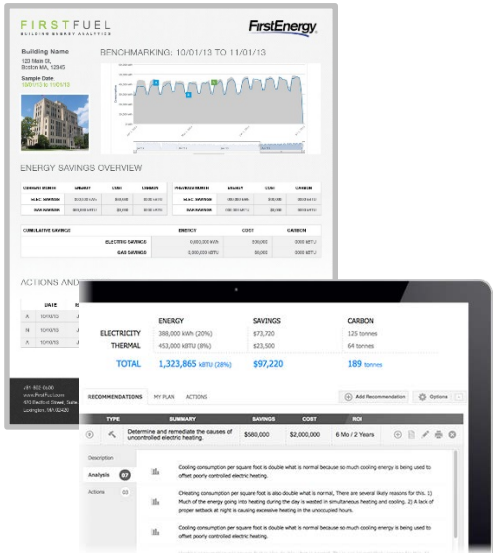
No onsite visits or devices

2 ENERGY INTELLIGENCE



No building simulations or buildings "like" this one

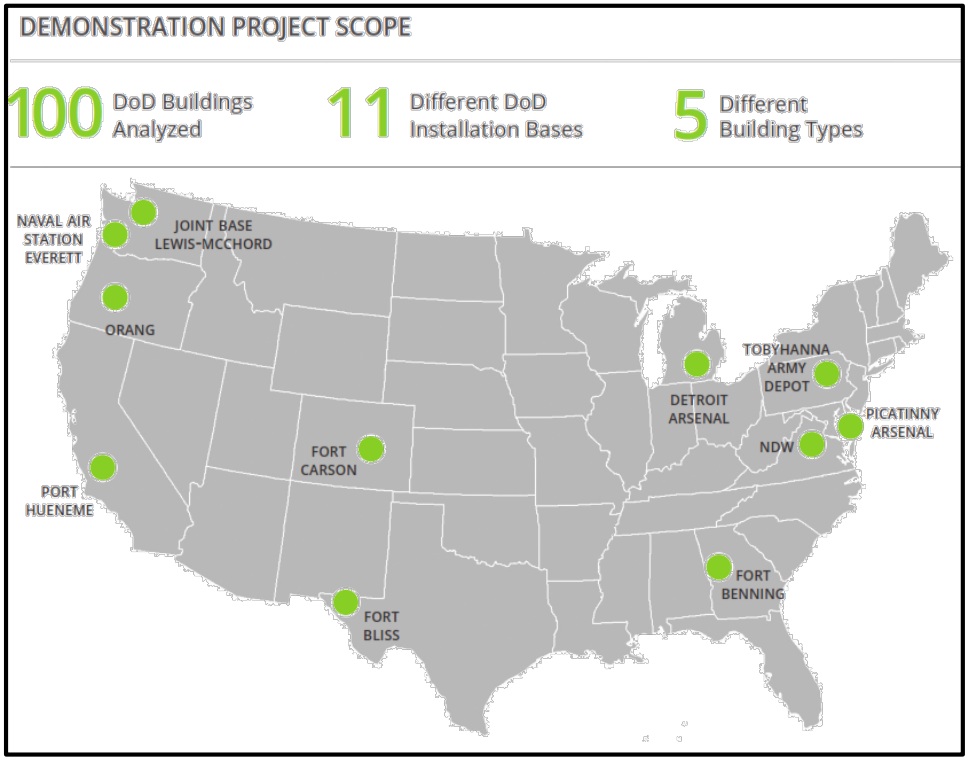
3 CUSTOMER SPECIFIC COMMUNICATION



Unique, verified analysis and messages for each building

Assess Energy Analytics Across Diverse Portfolio

- DoD was challenged with identifying and profiling energy savings opportunities across their large and diverse portfolio
- 5 building types unique to DoD were analyzed
  - Type 1 - Headquarters, classroom buildings
  - Type 2 - Barracks, dining facilities
  - Type 3 - Warehouses, commissaries
  - Type 4 - Rec centers, auditoriums
  - Type 5 - Facilities with lighter process loads



Program Performance Objectives

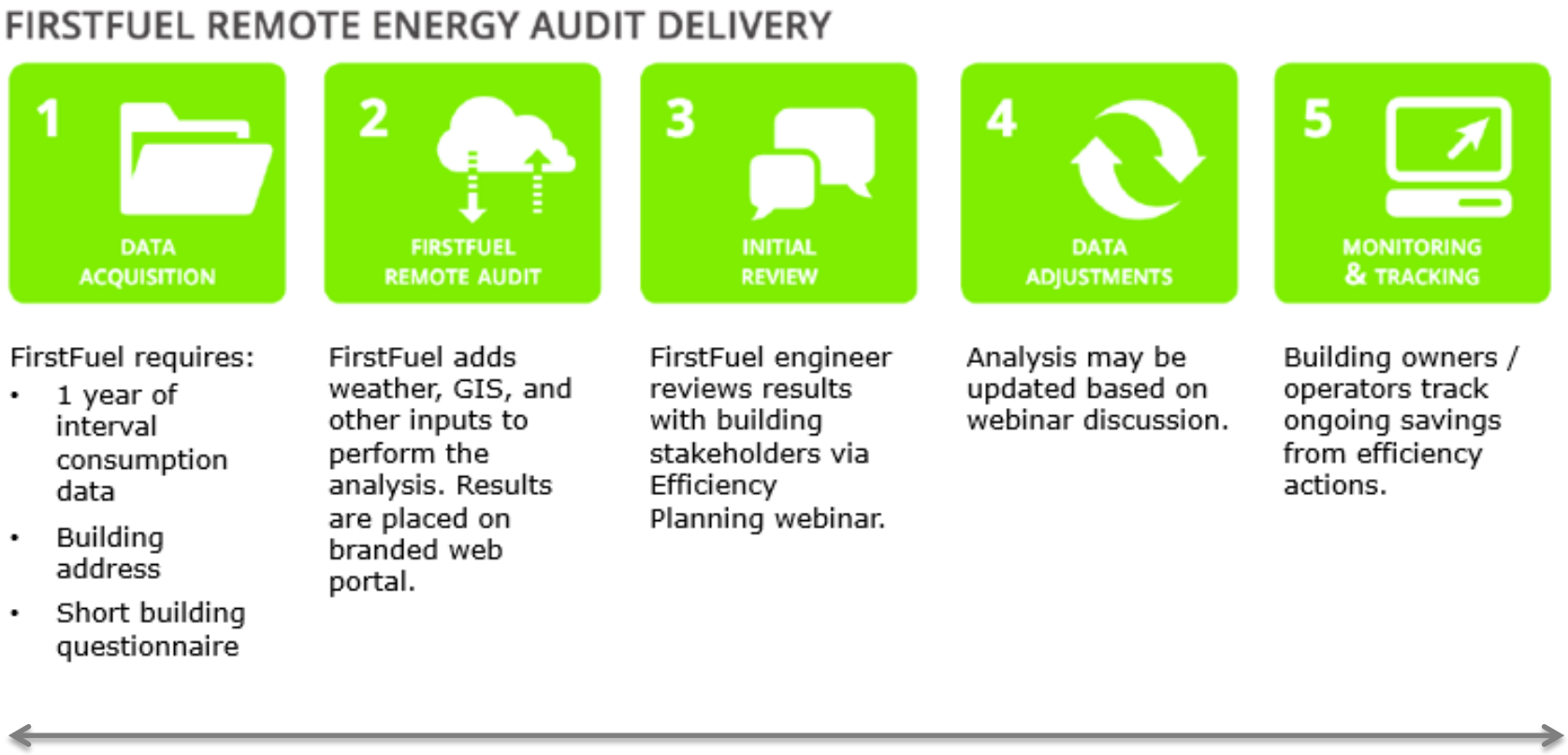
Testing FirstFuel's Analytics Platform

Performance Objective	Metric	Success Criteria
Cost	FirstFuel remote audit price per building and per square foot	▪ The average cost for the FirstFuel Audits performed on the 16 ASHRAE[1] Level II audited buildings (Types 1-5) will be less than or equal to $3,000/building, or $0.12/square foot (whichever is higher)
Scalability	Hours per engineer per FirstFuel remote audit	▪ FirstFuel Audits for Type 1 buildings completed in 75% of the time of onsite ASHRAE LII Audits ▪ FirstFuel Audits for Type 2-5 completed in 50% of the time of onsite ASHRAE LII Audits
Accuracy	# of recommendations identified and # of ASHRAE Level II recommendations	▪ RBA finds 80% of the recommendations found in Building Type 1 ASHRAE LII audits. ▪ RBA finds 60% of the recommendations found in Building Types 2-5 ▪ RBA finds recommendations NOT found in Type 1 Building ASHRAE LII onsite audits

[1] ASHRAE is an organization that develops standards for the design and maintenance of indoor environments

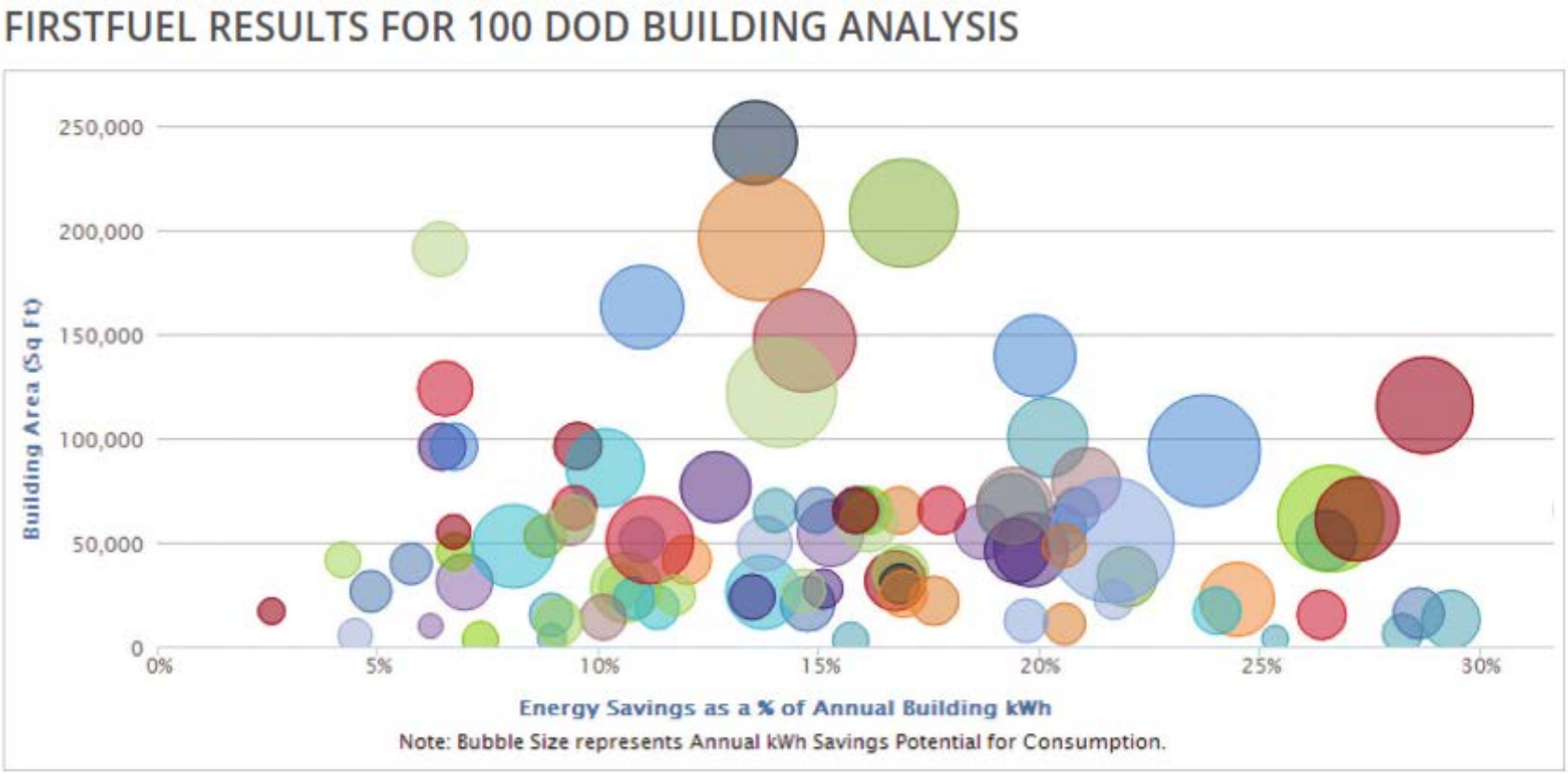
RBA: Rapid Building Assessment

Remote Energy Audit Delivery Process



- Elapsed time of ~2 weeks compared to ~2-4 months with onsite audits
- Building manager time commitment of <2 hours compared to >8 hours for onsite audits

Portfolio-Level Outputs and Analysis

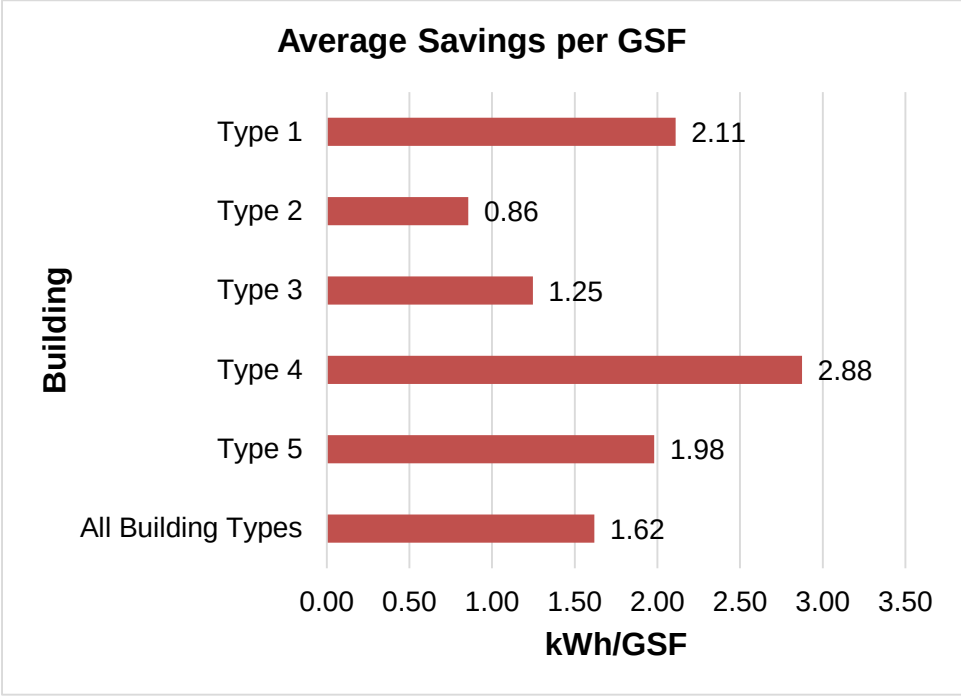


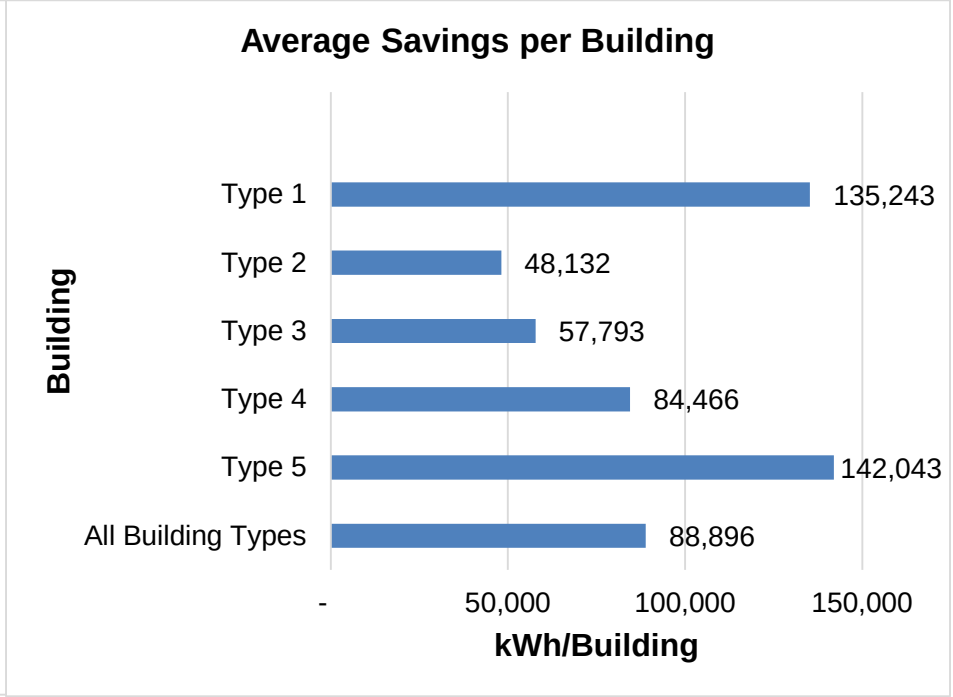
Total Buildings	Total GSF	Annual Consumption (kWh)	Operational Savings (kWh)	Retrofit Savings (kWh)	Total Savings Identified (kWh)	Total $ Savings Identified
100	5,547,931	61,467,053	4,856,584	9,528,619	14,385,203	$1,157,876

Targeting Savings

- Significant savings across the different building types, but some are better savings targets than others
- Remote audits tell us where we should go first – Admin buildings and process load facilities have the highest potential

Targeting Savings (Cont'd)





Fort Bliss: A Case Study

Profile	
Goal	Net zero by 2020 for water, energy and waste
Location	El Paso, Texas
Size	1.12 million acres (10% Texas, 90% New Mexico)
Population	29,000+ active duty
Buildings	2,000 +

Fort Bliss: A Case Study

Physical Fitness Center

- Size
  - 22,648 square feet
- Consumption
  - 633,770 kWh
- Total potential electric savings
  - 24% of annual consumption
- Top recommendations
  - HVAC scheduling control
  - Lighting retrofit
  - Plug load management

Recommendations

	ENERGY	C
ELECTRICITY	155,129 kWh (24%)	84
TOTAL	529,300 kBTU	84

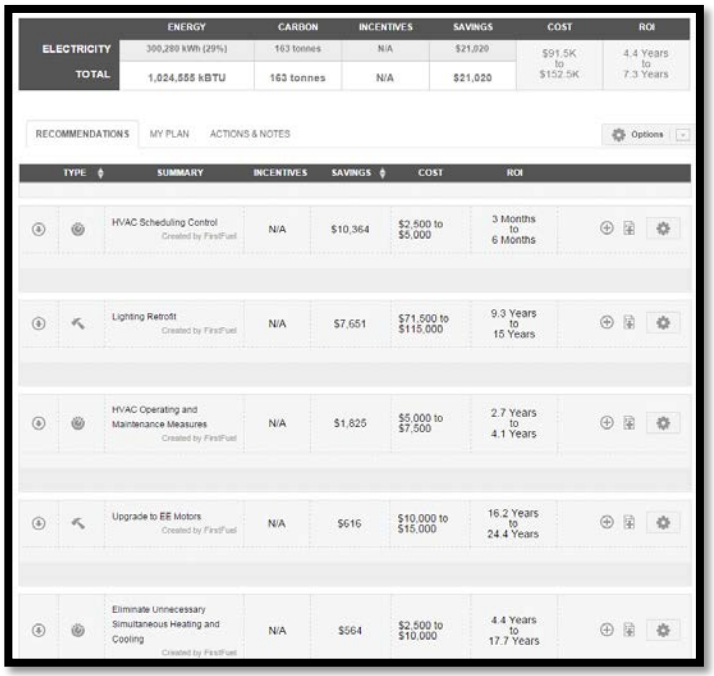
RECOMMENDATIONS | MY PLAN | ACTIONS & NOTES | Options

TYPE	SUMMARY	INCENTIVES	SAVINGS	COST	ROI
	HVAC Scheduling Control Created by FirstFuel	N/A	$7,238	$1,800 to $3,200	3 Months to 5 Months
	Lighting Retrofit Created by FirstFuel	N/A	$2,560	$13,314 to $19,971	5.2 Years to 7.8 Years
	Plug Load Management Created by FirstFuel	N/A	$735	$6,415 to $7,507	8.7 Years to 10.2 Years
	Demand Controlled Ventilation Created by FirstFuel	N/A	$211	$2,600 to $3,400	12.3 Years to 16.1 Years

Fort Bliss: A Case Study

Vehicle Maintenance Shop

- Size
  - 115,742 square feet
- Consumption
  - 1,044,840 kWh
- Total potential electric savings
  - 29% of annual consumption
  - 60/40 split between low-cost and capital measures
- Top recommendations
  - HVAC scheduling control
  - HVAC operations and maintenance measures
  - Eliminate unnecessary simultaneous heating and cooling



	ENERGY	CARBON	INCENTIVES	SAVINGS	COST	ROI
ELECTRICITY	300,280 kWh (29%)	163 tonnes	N/A	$21,020	$91.5K to $152.5K	4.4 Years to 7.3 Years
TOTAL	1,024,555 kBTU	163 tonnes	N/A	$21,020		

RECOMMENDATIONS | MY PLAN | ACTIONS & NOTES | Options

TYPE	SUMMARY	INCENTIVES	SAVINGS	COST	ROI
	HVAC Scheduling Control	N/A	$10,364	$2,500 to $5,000	3 Months to 6 Months
	Lighting Retrofit	N/A	$7,651	$71,500 to $115,000	9.3 Years to 15 Years
	HVAC Operating and Maintenance Measures	N/A	$1,825	$5,000 to $7,500	2.7 Years to 4.1 Years
	Upgrade to EE Motors	N/A	$616	$10,000 to $15,000	16.2 Years to 24.4 Years
	Eliminate Unnecessary Simultaneous Heating and Cooling	N/A	$564	$2,500 to $10,000	4.4 Years to 17.7 Years

Fort Bliss: A Case Study

- Summary of benefits
  - Analysis provided actionable items
  - Operational measures were low cost
  - Brought Fort Bliss closer to net zero goals
- Going forward
  - Securing funding to expand, implement and continue with program
  - Address issues of scale as program grows, such as data collection and integration

Program Performance Objectives and Results

Performance Objective	Metric	Results
Cost	FirstFuel Audit price per building and per square foot	▪ The average cost for the FirstFuel Audits was equal to $3,000/building
Scalability	Hours per engineer per FirstFuel Audit	▪ FirstFuel Audits for Type 1 buildings completed in 16% of the time of onsite ASHRAE LII audits ▪ FirstFuel Audits for Type 2-5 buildings completed in 15% of the time of onsite ASHRAE LII Audits
Accuracy	# of FirstFuel audits recommendations identified and # of ASHRAE Level II recommendations	▪ FirstFuel Audits found 61% of the recommendations found in Building Type 1 ASHRAE LII audits (1) ▪ FirstFuel Audits found 65% of the recommendations found in Building Type 2-5 ASHRAE LII audits ▪ FirstFuel Audits found 18 recommendations NOT found in Type 1 building ASHRAE LII onsite audits

Lessons Learned and Outcomes

- Meter data collection hurdles→ Big opportunity to increase value from Advance Metering Infrastructure (AMI) deployments
- Technology has been validated → shift in focus to measure implementation

1 Accuracy + Depth	2 Analysis 'Coverage'	3 Cost + Speed	4 Deployment Ease
Identifies **more energy conservation measures** than traditional methods through meter data analysis	Performs remote audits on **wide variety of DoD building** types	**5x faster** than traditional on-site methods **6x less** expensive than on-site methods	Simple, scalable, affordable **Portfolio Energy Management**

Conclusions

- Analytics-enabled energy efficiency
  - Provides valuable information at both the building and portfolio levels
  - Builds on existing efforts and is easy to deploy
  - Audits buildings quicker and cheaper than traditional methods
  - Delivers solid, actionable results, many at no-to-low cost
  - Helps achieve aggressive savings targets department-wide

For additional information, please visit:
https://www.serdp-estcp.org/Program-Areas/Energy-and-Water/Energy/Conservation-and-Efficiency/EW-201261

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Q&A Session 2

The next webinar is on
January 26, 2017

Award Winning Projects
Weapons Systems and Platforms

Survey Reminder

Please take a moment to complete the survey that will pop up on your screen when the webinar ends

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