A Deep Dive into Treasure Hunts -
And Other Ways to Find Energy Savings

Dave Chamberlain & Tracy Fialli
TURI Workshop, Session E

April 13, 2021
Presentation Overview

- Raytheon Technologies (RTX) overview
- Energy program overview, benchmarking & partnerships
- Analyzing your site load shapes & kWh data
- Treasure Hunt experience & lessons learned
- Project specific assessments
- Virtual assessments

Emphasize value of roadmaps and partnerships
The future of aerospace and defense

Raytheon Technologies (NYSE: RTX) is an aerospace and defense company that provides advanced systems and services for commercial, military and government customers worldwide. The company was formed in 2020 through the combination of Raytheon Company and the United Technologies Corporation aerospace businesses, and is headquartered in Waltham, Massachusetts.

- 195,000 Employees
- 60,000 Raytheon employees combined (2019)
- 40,000 Employees
- 190+ Years of combined innovation and industry leadership
- $74B Annual company and customer-funded research and development
- $8B

Raytheon Technologies consists of four highly specialized businesses:
- Collins Aerospace, specializing in aerospace, defense, intelligence, electronic, mechanical systems, aviation, space and naval systems that customers across the commercial, defense, aerospace and military sectors.
- Pratt & Whitney, design, manufacture and market the world's most advanced aircraft engines and auxiliary power systems. Pratt & Whitney offers the support and services that allow the transformative technology in the commercial, military, and industrial markets.
- Raytheon Intelligence & Space, specializing in smartly advanced sensors, training, and digital solutions, delivering the transformative technologies to customers to access new opportunities, against any challenge.
- Raytheon Missiles & Defense, leading the industry’s most advanced precision weapon solutions to secure our nation and engage threats.

"Combining complementary portfolios with advanced technology and M&A platforms, we are delivering transformative solutions to secure the future of aerospace and defense."
- Gregory G. Johnson, CEO, Raytheon Technologies

We are defining the future of aerospace and defense with advanced technologies that push the limits of human science.

Our values shape the enterprise and influence our thoughts, behaviors and performance.

- TRUST: We earn and practice trust and do the right thing.
- RESPECT: We embrace diverse perspectives and treat others the way they want to be treated.
- ACCOUNTABILITY: We honor our commitments, expect excellence and take pride in our work.
- COLLABORATION: We share insights, learn from one another and act as a team.
- INNOVATION: We experiment, build and transform with speed and agility.

Social Impact
- We follow the core of our mission to advance science.
- We are working to inspire the next generation of great minds, engineers and business professionals.
- Our communities: Through corporate investments in organizations serving veterans, military families and an array of other worthy needs, we improve the communities where we live and work.
- Sustainability: We are committed to developing sustainable solutions that help our customers reduce their environmental impact.
- Diversity & Inclusion: A diverse company is a strong company. The people of Raytheon Technologies are different backgrounds, ages and cultures.
- Innovation: We are embracing the unique ideas to generate solutions for a world in a singular pursuit to define the future of aerospace and defense.

www.rtx.com

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Cross Company Cross Functional Team

• Collaborative Teams at Raytheon since 1998
  – Enterprise Energy Team (EET)
  – Conserving Raytheon Energy and Water (CREW)
  – April 2020: RTX Team: Conserving RTX Energy and Water (CREW)

• Key aspects
  – Policies, best practices, project identification & execution
  – Standard metrics and reporting
  – Cost reduction strategies
  – Development of roadmap with key focus areas

• Awards and Recognition
  – Raytheon Company recognized by EPA ENERGY STAR 16 times
    • 13 consecutive Partner of the Year Sustained Excellence
  – Additional recognitions by multiple regional organizations

• Benchmarking & Partnerships
  – Strong history of partnerships across government and industry
Energy and Water Program Overview

Manage Both Resources and Rates

Goals and Reporting

Understand consumption

Projects

Best Management Practices

Energy/GHG

• Energy team
• Shut-off campaign
• Utility review
• Building automation
• HVAC
• Boilers / hot water / steam systems
• Lighting
• Building envelope
• Compressed air
• Process energy management / plug load
• GHGs: Chemicals and Refrigerants

Manage cost and consumption

Energy and Water Sustainability Program

Strategy & Innovation
Benchmarking & Partnerships

• EPA ENERGY STAR
  – Industrial Partners: Owens Corning, Corning, Nissan, ArcelorMittal & Celanese
  – Aerospace Focus Group: Boeing, Lockheed Martin, Gulfstream, Northrop Grumman, BAE & General Dynamics
  – ENERGY STAR Certified Buildings

• Department of Energy Better Buildings/Better Plants
  – Industrial Partners: 3M, GE & Bristol Myer Squib
  – Tools: In-Plant trainings, technical assistance & software tools

• United States Green Buildings Council
  – Follow LEED standards, pursue building Certifications and employee credentials

• Association of Energy Engineers
  – Education, training & regional networks
  – Employee certifications: Certified Energy Manager, Energy Procurement Professional, Building Commissioning Professional

• Other
  – International Facilities Management Association, Smart Energy Decisions, REBA
Daily and Hourly kWh Analysis

~150K SF Office Building

~700K SF Mixed Use

Daily kWh

Hourly kWh

Winter Break

Baseload ~38% of Peak Load

Winter Break

Baseload ~70% of Peak Load
Reason: High Lab/Server Load (24/7)

Good pre-Treasure Hunt activity to understand where to focus
Treasure Hunt vs. Assessment vs. Energy Audit

- **Energy Audits**
  - In depth look at the entire facility
  - Focused on capital as well as low-cost expense opportunities
  - Usually costs money and requires extensive dedicated time of the site team

- **Energy Assessment**
  - Focused on specific system
  - External or internal expert or trusted supplier at no cost

- **Treasure Hunt**
  - Focused on improvements that can be made quickly and at little cost
  - Funding for implementation is generally expense related

<table>
<thead>
<tr>
<th>Focus Area</th>
<th>Energy Treasure Hunt</th>
<th>Energy Audit</th>
<th>Energy Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employee Engagement</td>
<td>Yes</td>
<td>Minimal</td>
<td>Yes</td>
</tr>
<tr>
<td>Resources External to Company or Facility</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Operational Improvements</td>
<td>Yes</td>
<td>Minimal</td>
<td>Yes</td>
</tr>
<tr>
<td>Capital Improvements</td>
<td>Minimal</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Two-way Learning</td>
<td>Yes</td>
<td>Minimal</td>
<td>Yes</td>
</tr>
<tr>
<td>Summary Report</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Cross-functional Focus</td>
<td>Yes</td>
<td>Minimal</td>
<td>Minimal</td>
</tr>
</tbody>
</table>

Apply the right process for the right need
Energy Treasure Hunt Objective

A two or three day employee engagement activity focused on:

- Low cost and no cost actions to reduce energy consumption
- Use of teams to identify, analyze, and evaluate energy savings opportunities by observing daily operations
- Cross-functional brainstorming to reduce energy use throughout the plant
- Ways to continuously improve and reduce energy consumption
- Use of standard methodology and calculations to quantify opportunities for reduction

Employees implement the Treasure Hunt process
Treasure Hunt Background & Key Elements

- Toyota concept started in 1999
  - Shared best practice with numerous organizations
  - Provide culture change for employee engagement
- Focus on operational improvements and not capital intensive
- Observing the idle facility – usually start on Sunday or periods of reduced production
- Outside experts / participants facilitate the process, generate discussion, and help quantify opportunities
- Facility employees conduct Treasure Hunts and have ownership of the ideas / opportunities
- Local personnel will have the most expertise on optimizing facility production and operational changes
- Continuous activity, can be deployed company wide
## Sample Agenda

<table>
<thead>
<tr>
<th>Day</th>
<th>Activity</th>
<th>Function</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thursday</td>
<td>Kick Off Meeting</td>
<td>Review Event Details &amp; Team Assignments Treasure Hunt Introduction</td>
<td>Webex &amp; Teleconference</td>
</tr>
<tr>
<td>Sunday</td>
<td>Observe Sleeping Facility Create Detail Sheets</td>
<td>Identify opportunities during weekend non production Enter plant and kaizen details into savings estimation tool (Kaizen Detail Sheet).</td>
<td>Host Facility</td>
</tr>
<tr>
<td>Monday AM</td>
<td>Observe Startup Observe Production Create Detail Sheets Observe Lunch Break</td>
<td>Identify kaizen equipment starting too early Identify operational energy opportunities Enter plant and kaizen details into savings estimation tool (Kaizen Detail Sheet). Identify equipment to turn off during lunch (between shift if applicable)</td>
<td>Host Facility</td>
</tr>
<tr>
<td>Monday PM</td>
<td>Finish detail sheets Prepare Summary</td>
<td>Fill out opportunity sheets for remaining items, Refine sheets of Top opportunities Summarize total opportunity Highlight Top 3-5</td>
<td>Host Facility</td>
</tr>
<tr>
<td>Tuesday</td>
<td>Local Presentation</td>
<td>Senior management buy-in &amp; support</td>
<td>Host Facility</td>
</tr>
<tr>
<td>Future</td>
<td>Follow up</td>
<td>Implementation update</td>
<td>Host discretion</td>
</tr>
</tbody>
</table>
Treasure Hunt Process Flow

**Preparation:**
- **Kick Off with site**
  - Intro to TH
  - Collect Preliminary Data
  - Finalize Agenda
- **Data Gathering**
  - Identify: significant energy users
  - annual cost / consumption
  - plant operating parameters
- **Create TH Teams**
  - (5-10 Members)
  - Maintenance T/M’s
  - Production T/M’s
  - Engineering T/M’s
- **Hold Pre-Training**
  - (Webinar)
  - Review Objective
  - Review Agenda
  - Introduce Tools

**Execution:**
- **Go & See:**
  - ID Opportunities
  - Collect Data
  - Grasp Hurdles
- **Create Detail Sheets:**
  - Estimate Savings
  - Describe Opportunity
- **Summarize Opportunities:**
  - Individual Savings
  - Individual Payback Totals
- **Management Presentation:**
  - Highlight Top Opportunities
  - Implementation Support

**Outcomes & Follow-up:**
- **Action Plan:**
  - Prioritize List
  - Work for funding
  - Keep All Ideas
- **Implementation:**
  - Measure Energy Before Install
  - Measure Energy After Finalize Detail Sheet
- **Communicate:**
  - Share Company Wide
  - Share with site employees
- **Follow-Up:**
  - Meet regularly
  - Review action plan
  - Provide help if needed

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Data Gathering

- Done before the Treasure Hunt so teams can focus on “floor time” identifying opportunities during the event
- Identify significant energy users, annual cost / consumption, and plant operating parameters
- Additional information such as project lists and major upgrades that will affect the plant energy profile should be included
  - Plant energy profile – meter or utility data
  - Lighting count
  - Proposals for upgrades / projects
  - Existing projects / upgrades
  - Previous energy assessments
  - Utility rate structure / contracts

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Assemble Teams

• Made up of
  – Host
  – Facilitator
  – Team Leaders
  – General participants
• Number of teams varies by site
• Focus of each team varies by site
• No more than 5 participants per team
• Assemble from different locations with different perspectives and skills

• Site Expert(s) - Knows where to get information and who makes decisions in their area of focus
• Maintenance – shift mechanic / electrician
• Production – operators, supervisors, leads
• Engineering – area engineer, process engineer
• Plant Subject Matter Expert / Owner – HVAC, Compressed Air, Electrical, etc.
Assemble Teams (continued)

• General Team Participants (continued)
  – Internal (fresh set of eyes)
    • Other organizations: Supply Chain, IT, EHS, Process Engineers, Communications, Planners, Project Management, Test engineers, continuous improvement
    • Trades: mechanics, electricians, hourly, salary
    • Anybody enthusiastic to participate
  – External
    • Consultants – compressed air, process heat, energy specialist, etc.
    • Nearby facilities, similar facilities, BU participants, internal experts, future Treasure Hunt hosts
    • Suppliers, vendors

Outside perspective for learning / sharing & items overlooked

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Responsibilities

Host

- Provide data to facilitator
- Work to identify focus areas
- Identify any site people or local resources to participate
- Get buy-in from management
- Arrange event logistics
  - Team meeting space
  - One site person per team to coordinate access to plant resources
- Close-out participants & logistics
- Assemble closeout presentation with facilitator

Facilitator

- Identify participants & team leaders
- Prepare detail sheets with host supplied data
- Conduct training with host / focus area leaders
- Present opening presentation, process, and agenda to participants during Energy Kaizen event
- Help teams use detail sheets to quantify opportunities
- Assist with closeout presentation with input from focus teams and site host

Team Leader

- Bring laptop
- Lead team to:
  - Identify energy reduction opportunities
  - Evaluate project viability and quantify with detail sheets
- Facilitate energy measurements
- Summarize focus area opportunities
- Oversee closing summary presentation content
- Present opportunities to management at closing summary

Identify the Right Person for Each Role

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Observing The Idle (Sleeping) Facility

• Most important day for generating ideas
• Rarely is production activity 24 hrs / 7 days a week
• Take note of maintenance downtime / shift changes / off shifts
• Use your eyes and ears to find wasted energy!
Tools

Data Gathering

<table>
<thead>
<tr>
<th>Tool</th>
<th>Manufacturer</th>
<th>Voltage</th>
<th>City</th>
<th>Online</th>
<th>Remarks</th>
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<td>HOBO</td>
<td>30V DC</td>
<td>1</td>
<td>Yes</td>
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<td>Laser Dots Maker 514X Pro Dots, 4x10</td>
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<tr>
<td>Emissary</td>
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<td>WISIOTT</td>
<td>PLU</td>
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<td>RAYTECH</td>
<td>220V DC</td>
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<td>Transferable Laser/Reader SD-10</td>
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<td>Ultrasonic Diagnostics Test</td>
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</table>

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Checklists

Offices

Labs

Manufacturing

Server Rooms
Documentation and Calculation

• An “Opportunity sheet” is the excel calculator used to document and quantify an opportunity during an Energy Treasure Hunt

• Create an “Opportunity sheet” for each opportunity

• Each opportunity sheets quantifies a “before” and “after” state for the equipment
  – Consider equipment operating profiles
  – Note nameplate energy consumption or take a measurement

Generate: walk through facility
Assess: feasibility, gather data, quantify
Consolidate: top opportunities

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Site Treasure Hunts – 2019 & 2020

Onsite
• 2019 Performed at 4 sites
• 17 employees from 10 different locations
• Train the trainer to create a larger pool for future Treasure Hunts.
• ~$470K savings identified
  • Compressed air leaks & pressure reduction
  • Lighting upgrades
  • Central chiller plant controls upgrade
  • Exhaust system upgrades

Virtual
• 2020 converted using technology
• Focus on Chiller Plants
  – Assess plant’s performance against KPI of 0.65kW/tR – 0.85kW/tR
  – Provide recommendations to improve performance
• Optimize utilization of SMEs & exchange of knowledge
• Performed at 3 sites and 2 more planned
• Includes members from all 4 Businesses

Modified the Process for Current State
Treasure Hunt Suggestions & Links

- **ENERGY STAR Treasure Hunts web page**
- **Treasure Hunt process** established by Toyota (Bruce Bremer, 2005)
- Seeing is believing: Watch videos to learn from others
  - “Four steps to hosting a successful energy treasure hunt”
  - “Uncover hidden energy savings with an ENERGY STAR Treasure Hunt”
- Get familiar with **detail sheets** (i.e. data collection)
  - Instruction tab explains how to use
  - Tabs for plant information, opportunity summary & project details
  - Project details feed automatically to opportunity summary & analysis tabs
- **US DOE Better Building program has additional tools & resources**
Project specific assessments (Hint: utilities can help)

- You and your colleagues may already know some opportunities
  - Add details to TH project tabs
  - Keep calculations simple if possible
  - Submit multiple project savings to Find The Treasure campaign
  - Use this data for MassSave incentive applications
  - Utility reps can help guide you or call 1-866-527-SAVE (7283)

- Technical assistance may be available for some projects

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Virtual Assessments

- Develop a virtualized energy efficiency offering for large commercial & industrial customers;
- First step on continuum of options;
- Use available utility data to review customer operations; look for patterns and anomalies, such as equipment running during unoccupied hours;
- Identify a pipeline of opportunities, which can be further assessed and verified with future studies and site visits;
- Enhanced data analysis offers customers a low-touch option.

**Goal: Engage Customers & Identify Opportunities**
Thank you.