Advanced RTU Campaign: Tompkins County’s Usage of the ARC RTU Inventory Spreadsheet

April 15, 2014
Advanced RTU Campaign (ARC) Overview

- National campaign for promotion and support of high-efficiency RTU replacements and retrofits
- Partnership between DOE, ASHRAE, RILA, and several supporting organizations
- Launched May 30, 2013 and runs through November 2014

Eligible Technologies

- **High-Efficiency Replacements**
  - For units > 10 years old
  - CEE Tier 2 and above

- **Advanced Control Retrofits**
  - For units < 10 years old and > 7 tons
  - Primarily add variable speed fan control

What is the Advanced RTU Campaign?

Older, inefficient commercial rooftop unit (RTU) air conditioning systems are common and can waste from $1,000 to $5,000 per unit annually, depending on the building size and type. By replacing or retrofitting them, you can save money, improve your energy efficiency, make your building more comfortable, and help the environment. The Advanced RTU Campaign (ARC) encourages commercial building owners and operators to replace their old RTUs with more efficient units or to retrofit their RTUs with advanced controls in order to take advantage of these benefits.

What are the benefits of joining?

ARC provides building owners and operators with access to information and expertise to lower facility operating costs while maintaining or improving building occupant comfort. Joining the campaign allows you to:

- QUALIFY FOR TAX DEDUCTIONS QUICKLY AND EASILY
  
- EVALUATE YOUR BUILDING ELIGIBILITY
  
- DETERMINE ELIGIBILITY TO USE 179D DOE CALCULATOR
Decision Tree for Evaluating RTUs

Advanced RTU Campaign: Decision Tree for RTU Replacements or Retrofits

Preliminary Screening
- What is the general condition, age, and size of each RTU?
- Is the RTU a candidate for retrofit or replacement?

Initial Inventory
- Building name
- Space type
- Age
- Size
- Manufacturer
- Model
- General condition
- Maintenance history

RTU Inventory Spreadsheet

Evaluation and Analysis
- What is the result of the field evaluation?
- Can a replacement be combined with other energy efficiency measures?
- Is the RTU properly sized?
- What is the predicted energy savings and ROI for retrofit or replacement and does it meet your requirements?

Detailed Inventory
- Controls, Usage, Features

Field Evaluation

Replacement Analysis

Retrofit Analysis

Planning and Procurement
- Do you need to hire engineering support or a service company?
- Which are the best RTUs for your applications?
- What is the predicted energy savings and payback?
- Do you need to include measurement and verification?

Spec Retrofit

Spec Replacement

Project Planning

Resources
- RTU Inventory Spreadsheet
- RTU Field Evaluation Checklist
- RTU Comparison Calculator
- 179D DOE Calculator
- RTU Incentives Database
- RTU Sizing Guidance
- Case Studies

Learn more at betterbuildings.energy.gov

Prepared by the National Renewable Energy Laboratory
RTU Evaluation Process

Gather Information
- Initial RTU Inventory: RTU Inventory Spreadsheet
- Preliminary Screening: Bin RTUs for retrofit, replacement, or no action
- Detailed Inventory: RTU Inventory Spreadsheet
- Visual-Based Field Evaluation: RTU Field Evaluation Checklist

Analyze
- Analysis: make the business case and prioritize actions. RTU Incentives Database, RTU Comparison Calculator, 179D DOE Calculator, RTU Sizing Guidance, and ARC Case Studies

Plan
- Project Planning: See the list of ARC Supporting Partners

Take Action
- Procurement: Procurement Specifications for guidance
- Measurement and Verification (M&V): Use the M&V Guidance
RTU Inventory Spreadsheet

- Starting point – modify to fit your needs
- Combines
  - Preliminary Screening
  - Detailed Inventory
  - Field Evaluation results
# Preliminary Screening Example

## Rooftop Unit Inventory Spreadsheet

<table>
<thead>
<tr>
<th>Building ID</th>
<th>RTU #1</th>
<th>RTU #2</th>
<th>RTU #3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Space type</td>
<td>lobby</td>
<td>Retail/Service</td>
<td>Office</td>
</tr>
<tr>
<td>Age or installation date</td>
<td>1 year</td>
<td>10 years</td>
<td>13 years</td>
</tr>
<tr>
<td>Cooling capacity (ton, Btu/h, W)</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Manufacturer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model number</td>
<td>50TC-A12A1A5A0A0A0</td>
<td>50HJ-012-C561</td>
<td>TCH240B300JB</td>
</tr>
<tr>
<td>Serial number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Original nominal efficiency (EER, SEER, IEER)</td>
<td>11.2 EER</td>
<td>10.4</td>
<td>10</td>
</tr>
<tr>
<td>Maintenance history</td>
<td>Regular</td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
<tr>
<td>Major repairs</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>General condition (good, fair, poor)</td>
<td>Good</td>
<td>Poor</td>
<td>Poor</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Initial Screening Recommendation</th>
<th>Retrofit</th>
<th>Needs Further Analysis</th>
<th>Replace</th>
</tr>
</thead>
</table>

![Image of outdoor units](image1.jpg)

![Image of dirty filter](image2.jpg)

![Image of wall damage](image3.jpg)
### RTU Evaluation Checklist

<table>
<thead>
<tr>
<th>Component</th>
<th>Rating</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condenser Coil.</td>
<td>Good</td>
<td>No</td>
</tr>
<tr>
<td>Refrigerant Piping.</td>
<td>Good</td>
<td>No</td>
</tr>
<tr>
<td>Cabinet.</td>
<td>Good</td>
<td>No</td>
</tr>
<tr>
<td>Evaporator Coil.</td>
<td>Good</td>
<td>No</td>
</tr>
<tr>
<td>Burner Section.</td>
<td>Good</td>
<td>NA</td>
</tr>
<tr>
<td>Compressor.</td>
<td>Good</td>
<td>NA</td>
</tr>
<tr>
<td>Air Dampers (OA, economizer, and return air).</td>
<td>Good</td>
<td>No</td>
</tr>
<tr>
<td>Fan Motors (supply and condenser).</td>
<td>Good</td>
<td>No</td>
</tr>
</tbody>
</table>

**Overall rating (determined by individual component ratings) and service requirement**

- **Good**: No

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- **Document advanced functionality not inherent to unit make and model**
  - **(Y/N)**: No
- **Energy Recovery**: No
- **Evaporative Cooling**: No
- **Variable Speed Fan Operation**: No
- **Economizing**: No
# Detailed Inventory and Field Evaluation

<table>
<thead>
<tr>
<th>Initial Screening Recommendation</th>
<th>Retrofit</th>
<th>Needs Further Analysis</th>
<th>Replace</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area served (ft²)</td>
<td>4,000</td>
<td>3000</td>
<td>12000</td>
</tr>
<tr>
<td>Capacity-normalized area served (e.g., ft²/ton)</td>
<td>400</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Operational hours</td>
<td>24/7</td>
<td>7 am to 10 pm, cycles at 7 am to 10 pm, cycles</td>
<td></td>
</tr>
<tr>
<td>RTU control</td>
<td>room Tstat</td>
<td>Duct Tstat</td>
<td>room Tstat</td>
</tr>
<tr>
<td>Evaporator fan control</td>
<td>CAV</td>
<td>CAV</td>
<td>CAV</td>
</tr>
<tr>
<td>Evaporator fan size (hp)</td>
<td>2.4</td>
<td>2.4</td>
<td>7.5</td>
</tr>
<tr>
<td>Evaporator fan voltage and phases</td>
<td>208-3ph</td>
<td>208-3ph</td>
<td>208-3ph</td>
</tr>
<tr>
<td>Economizer control (none for no economizer)</td>
<td>enthapy</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Refrigerant type</td>
<td>410A</td>
<td>R22</td>
<td>R22</td>
</tr>
<tr>
<td>Refrigerant quantity (lb, kg)</td>
<td>20 lb</td>
<td>20.2 lb</td>
<td></td>
</tr>
<tr>
<td>Heating type</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Additional features (ERV, DCV, …)</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Results from Field Evaluations</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Condenser coil condition</td>
<td>Good</td>
<td>Fair</td>
<td>Poor</td>
</tr>
<tr>
<td>Refrigerant piping condition</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Cabinet condition</td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>Evaporator coil condition</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Burner section condition</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Compressor condition</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Air dampers condition (OA, economizer, and return air)</td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>Fan motors condition</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Recommendation</td>
<td>Retrofit</td>
<td>Replace</td>
<td>Replace</td>
</tr>
<tr>
<td>Priority</td>
<td>3</td>
<td>2</td>
<td>1</td>
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</tbody>
</table>

# Notes
Using and Managing the RTU Inventory Form: A Case Study in Progress

April 15, 2014
Purpose of this presentation

- Describe how the DOE RTU Inventory Form is used to support Tompkins County in their approach towards optimizing their RTU portfolio and identify needed replacements

- Show how an inspection and maintenance path can backfill inventory details
Tompkins County

Situation

- Approximately 40 units on their county facility roofs
- County facilities consist primarily of county offices, service garage, library, and courthouse
- Staff recognizes value for optimizing their RTUs
Condition

- Facility staff maintains own systems
- Core inventory currently maintained: make, model, tonnage, year
- Staff introduced to NYSEERDA HVAC Business Partners and Advanced RTU Campaign this past fall
- Initial conversations and meetings held this spring

Question

How can Tompkins County establish a best practice for RTU optimization while maintaining current budget and staffing levels?
Establish and pursue a logical stepwise approach:

1. Complete the initial data for the **RTU Inventory Form**
2. Start up the annual **spring inspection and tuneup process**, following now the ASHRAE/ACCA Quality Maintenance checklists and diagnostic testing
3. **Backfill inventory details** as inspection and tuneup process is done
4. **Prioritize RTUs and economizers** for repairs and planned replacements
### Rooftop Unit Inventory Spreadsheet

**Version 2.0, 10/28/2013**

<table>
<thead>
<tr>
<th>Sample</th>
<th>RTU #1</th>
<th>RTU #2</th>
<th>RTU #3</th>
<th>RTU #4</th>
<th>RTU #5</th>
<th>RTU #6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building ID</td>
<td>MCH</td>
<td>MCH</td>
<td>MCH</td>
<td>MCH</td>
<td>MCH</td>
<td>MCH</td>
</tr>
<tr>
<td>Space type</td>
<td>Office</td>
<td>Office</td>
<td>Office</td>
<td>Office</td>
<td>Office</td>
<td>Office</td>
</tr>
<tr>
<td>Age or installation date</td>
<td>1999</td>
<td>1999</td>
<td>1999</td>
<td>1999</td>
<td>1999</td>
<td>1999</td>
</tr>
<tr>
<td>Cooling capacity (ton, Btu/h, W)</td>
<td>6 tons</td>
<td>7 tons</td>
<td>5 tons</td>
<td>15 tons</td>
<td>13 tons</td>
<td>16 tons</td>
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<tr>
<td>Manufacturer</td>
<td>Trane</td>
<td>Trane</td>
<td>Ason</td>
<td>Ason</td>
<td>Ason</td>
<td>York</td>
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<tr>
<td>Model number</td>
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<td>R0K</td>
<td>5001022174-H</td>
<td>5001022174-H</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Maintenance history</td>
<td>Minimum</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Major repairs</td>
<td>Typical replacement</td>
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<td></td>
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<td>General condition (good, fair, poor)</td>
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<tr>
<td>Initial Screening Recommendation</td>
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<tr>
<td>Area served (ft²)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Capacity-normalized area served (e.g., ft²/ton)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational hours</td>
<td>65/week</td>
<td></td>
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</tr>
<tr>
<td>RTU control</td>
<td></td>
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<td></td>
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<tr>
<td>Evaporator type</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Condenser fan size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaporator fan voltage and phases</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economizer control (none, fan, economizer)</td>
<td>None</td>
<td>Economizer</td>
<td>Economizer</td>
<td>Economizer</td>
<td>Economizer</td>
<td>Economizer</td>
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<tr>
<td>Refrigerant type</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Refrigerant quantity (lb, kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heating type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional features (FRW, DOV, etc.)</td>
<td></td>
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</tr>
</tbody>
</table>

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**Advanced RTU Campaign**

Prepared by the National Renewable Energy Laboratory
Actions to Date

Meetings and presentations:
Jan 14

Inventory form core data completed:
Feb 14

Diagnostic tool purchased:
Apr 14
Next Steps

- Inspection and maintenance cycle:
  - *Inventory form details backfilled*
  - *Immediate repairs for RTUs and economizers*

- RTUs reviewed and tiered for further actions:
  - *Good working order*
  - *Important repairs needed: compressor motor, heat exchanger, etc.*
  - *Unrepairable OR uneconomical to repair*
Tiered action items

- **Good working order**
  - Continue maintenance plan using ASHRAE/ACCA Quality Maintenance Standard and annual diagnostic testing
  - Record ongoing inspection conditions and repairs

- **Important Repairs**
  - Repair and restore; test to ensure restoration complete
  - Record conditions, repairs, and estimate lifespan left

- **Unrepairable OR uneconomic to repair**
  - Determine time to replace based on property budget
  - Assess and plan for replacement: EER, size, timing
Tools and support for replacement plan

- **Load Calculation**
  - Building loads change over time
  - Evaluation can include an air flow/duct work evaluation

- **RTU Calculator**
  - Assess total lifecycle cost of standard vs. high efficiency for replacement
  - Assess energy use difference and ROI

- **NYSERDA Incentives for High Efficiency Replacement**
  - Prequalified high efficiency systems
  - Prequalified enthalpy controls
Learned Lessons to Date

1. No need to get hung up on capturing all details up front on RTU Inventory; better to capture initial details, and then move ahead.

2. Backfilling inventory details during maintenance allows staff to develop the best practice path incrementally without taking them away from the daily “fires”.

3. Recording inspection conditions and repairs during the QM process will allow staff and budget decision makers to proactively work towards planned repairs and replacements instead of emergency breakdowns.
Follow up presentation – June 2014

- Completed inventory and assessment
- Inspection and maintenance outcomes
- Planned replacement strategy
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