U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Walk-in Coolers and Freezers (WICFs)

Presentation to Minnesota ASHRAE Chapter

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Agenda

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DOE's Appliance and Equipment Standards Program

Per the Energy Conservation and Policy Act, as amended, DOE's Appliance and Equipment Standards Program:

- Conserves energy and water resources by improving the efficiency of consumer products and commercial/industrial equipment.
- Establishes test procedures for measuring the energy efficiency or energy use of covered products and equipment.
- Establishes the mandatory standards for the energy efficiency of covered products and equipment.
- Establishes labeling requirements for certain covered equipment, including walk-in coolers and freezers.
- Monitors compliance with standards and labeling requirements to maintain a level playing field.

WICF Regulatory History

1978

The National Energy and Conservation Policy Act (Public Law 95-619) amended the Energy Policy and Conservation Act (Public Law 94-163; EPCA) to establish the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of provisions designed to improve energy efficiency. (42 U.S.C. 6311-6317, as codified)

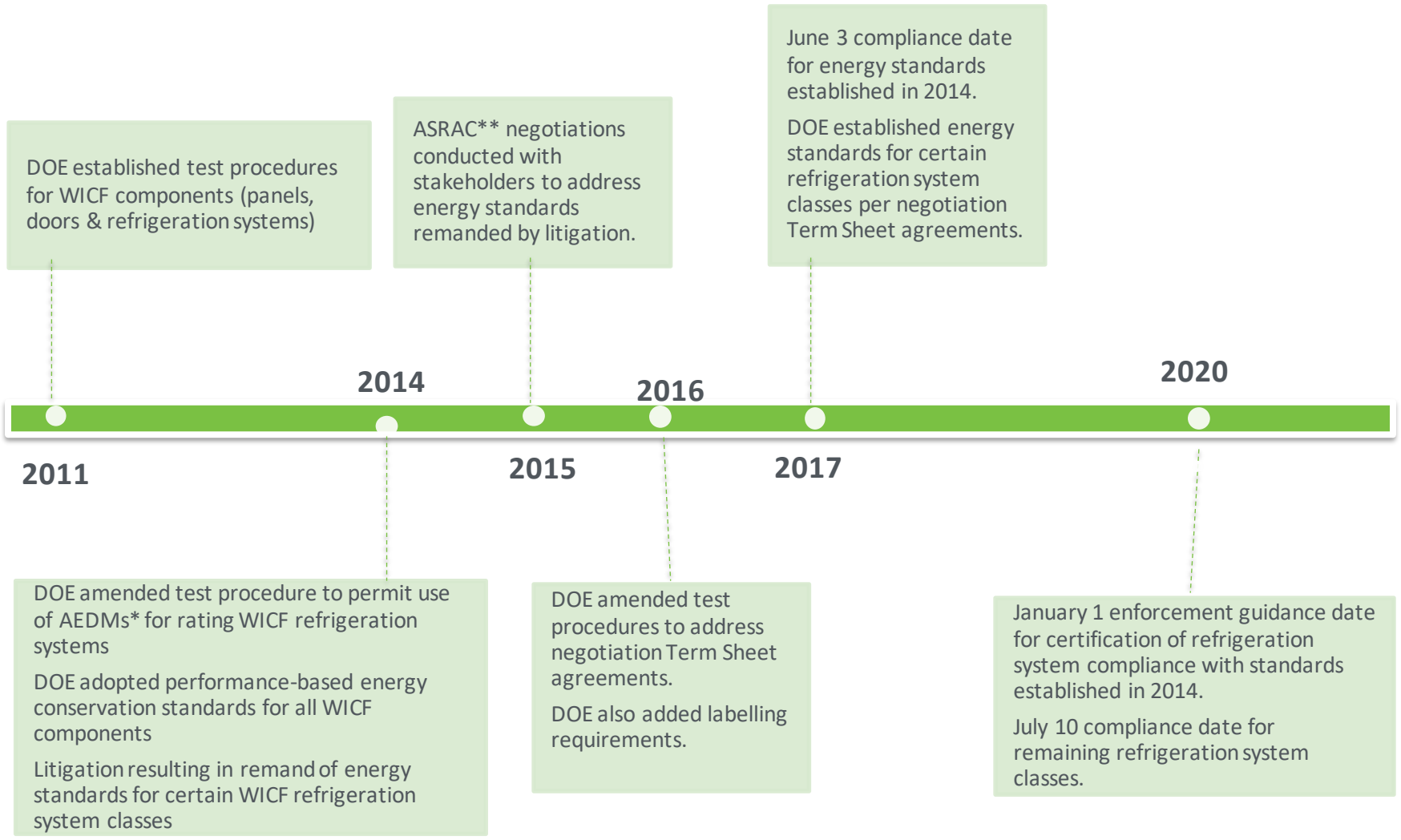
- Testing
- Labeling
- Energy conservation standards
- Certification and enforcement

2007

The Energy Independence and Security Act of 2007 (Public Law 110-140, EISA 2007) amended EPCA to include WICFs

- Established certain prescriptive standards for WICFs
- Directed DOE to establish test procedures and performance-based energy conservation standards for WICFs

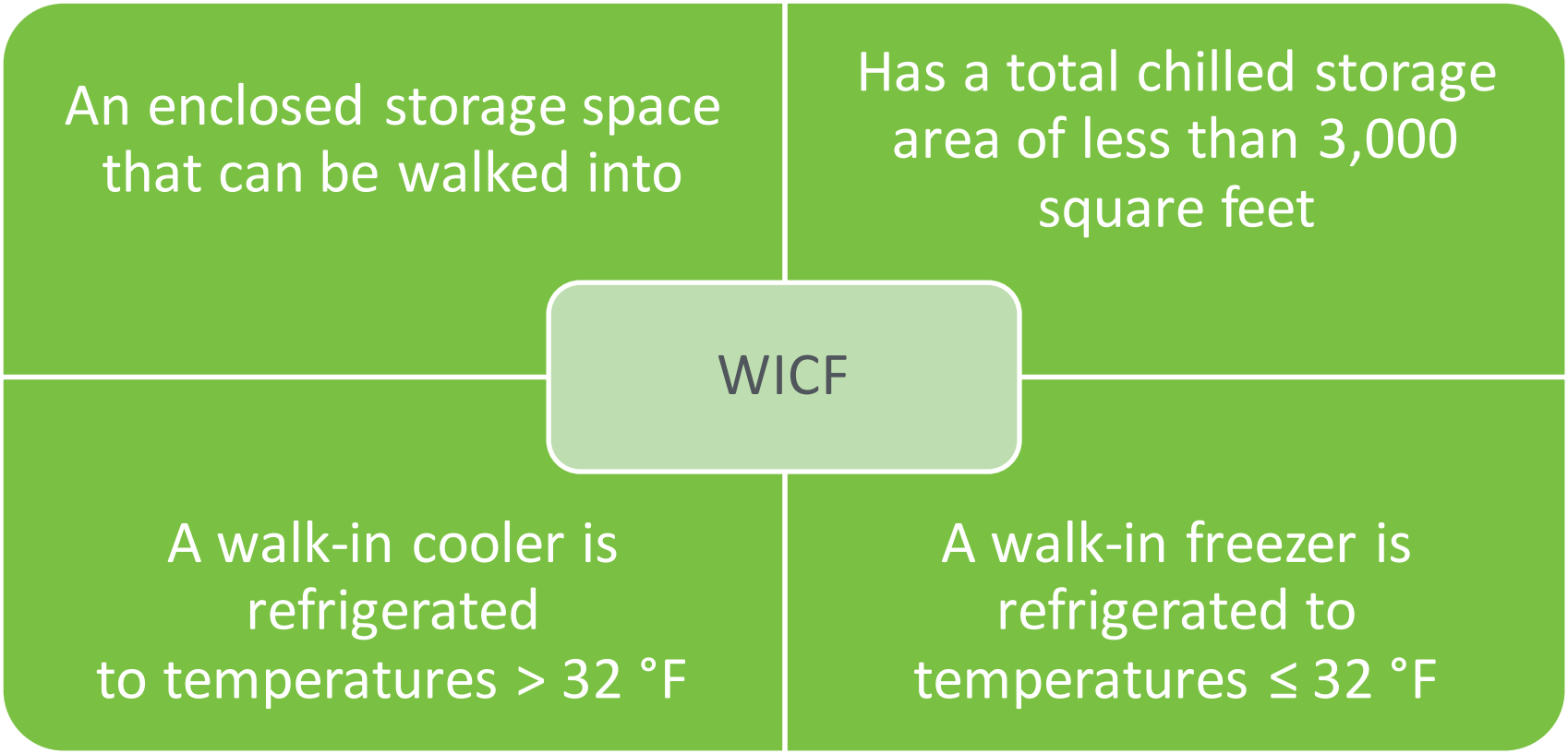
WICF Regulatory History



*Alternative Efficiency Determination Models

**Appliance Standards and Rulemaking Federal Advisory Committee

Definitions



Definitions

Refrigeration system

The mechanism (including all controls and other components integral to the system's operation) used to create the refrigerated environment in the interior of a WICF, consisting of:

- A dedicated condensing refrigeration system; or
- A unit cooler

(10 CFR 431.302)

Annual Walk-in Energy Factor (AWEF)

The ratio of heat removed from the envelope to the total energy input of the refrigeration system over a year

(10 CFR 431.306(e))

Prescriptive Requirements for WICF Refrigeration Systems

	Must have:
Evaporator fan motors < 1 hp and < 460 V	• Electronically commutated motors (brushless DC motors) or • 3-phase motors
Condenser fan motors < 1 hp	• Electronically commutated motors (brushless DC motors) or • Permanent split capacitor-type motors or • 3-phase motors

(42 U.S.C. 6313(f))

EPCA also set prescriptive requirements for walk-in doors, panels, and lighting systems. (42 U.S.C. 6313(f))

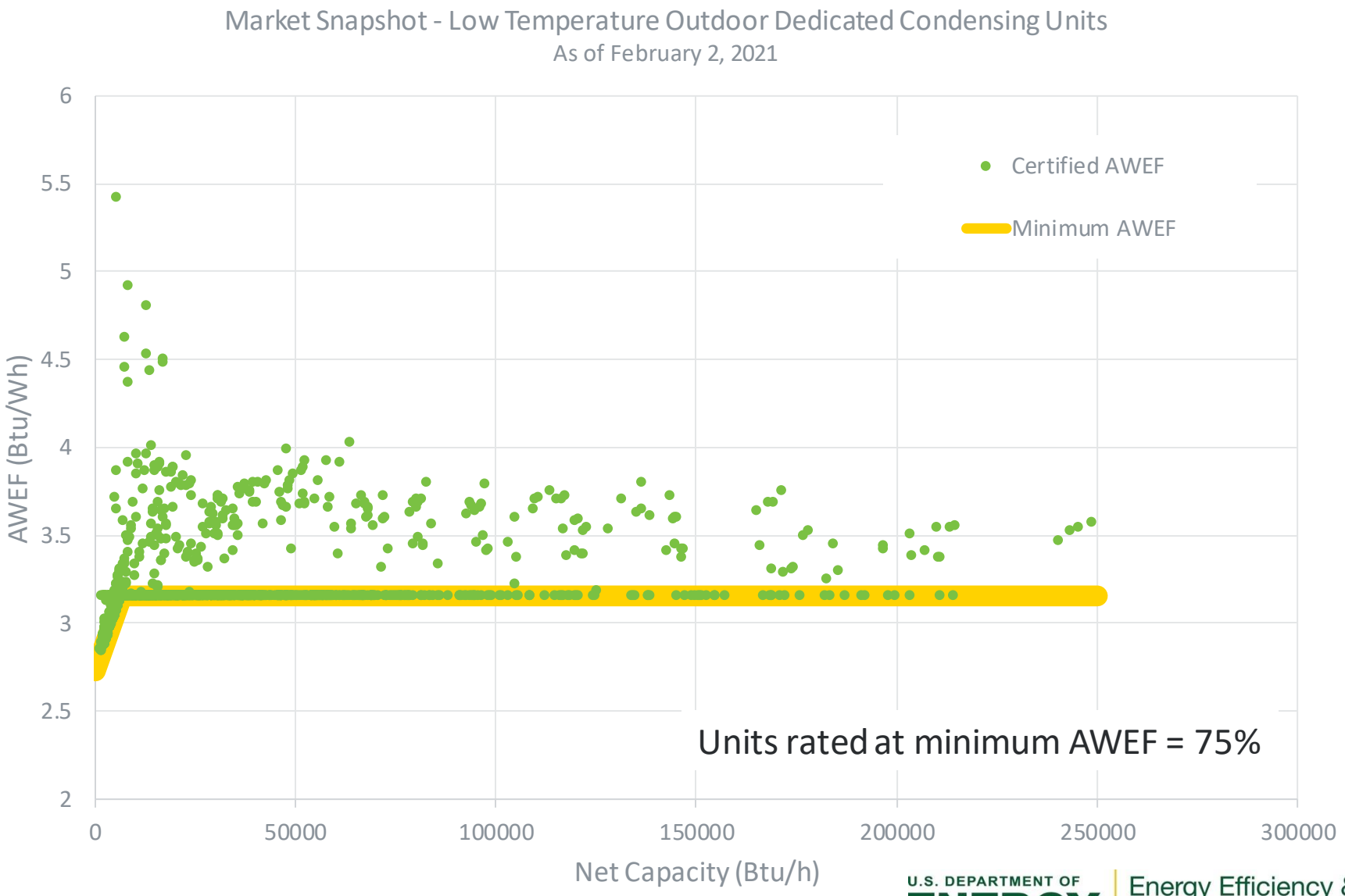
Performance-based Standards for WICF Refrigeration Systems

Equipment	Temperature	Location	Net Capacity (Btu/h)	Minimum AWEF (Btu/W-h)
Dedicated Condensing System	Medium	Indoor	All	5.61
		Outdoor	All	7.60
	Low	Indoor	< 6,500	$9.091 \times 10^{-5} \times q_{net} + 1.81$
			≥ 6,500	2.40
		Outdoor	< 6,500	$6.522 \times 10^{-5} \times q_{net} + 2.73$
			≥ 6,500	3.15
Unit Cooler	Medium		All	9.00
	Low		< 15,500	$1.575 \times 10^{-5} \times q_{net} + 3.91$
			≥ 15,500	4.15

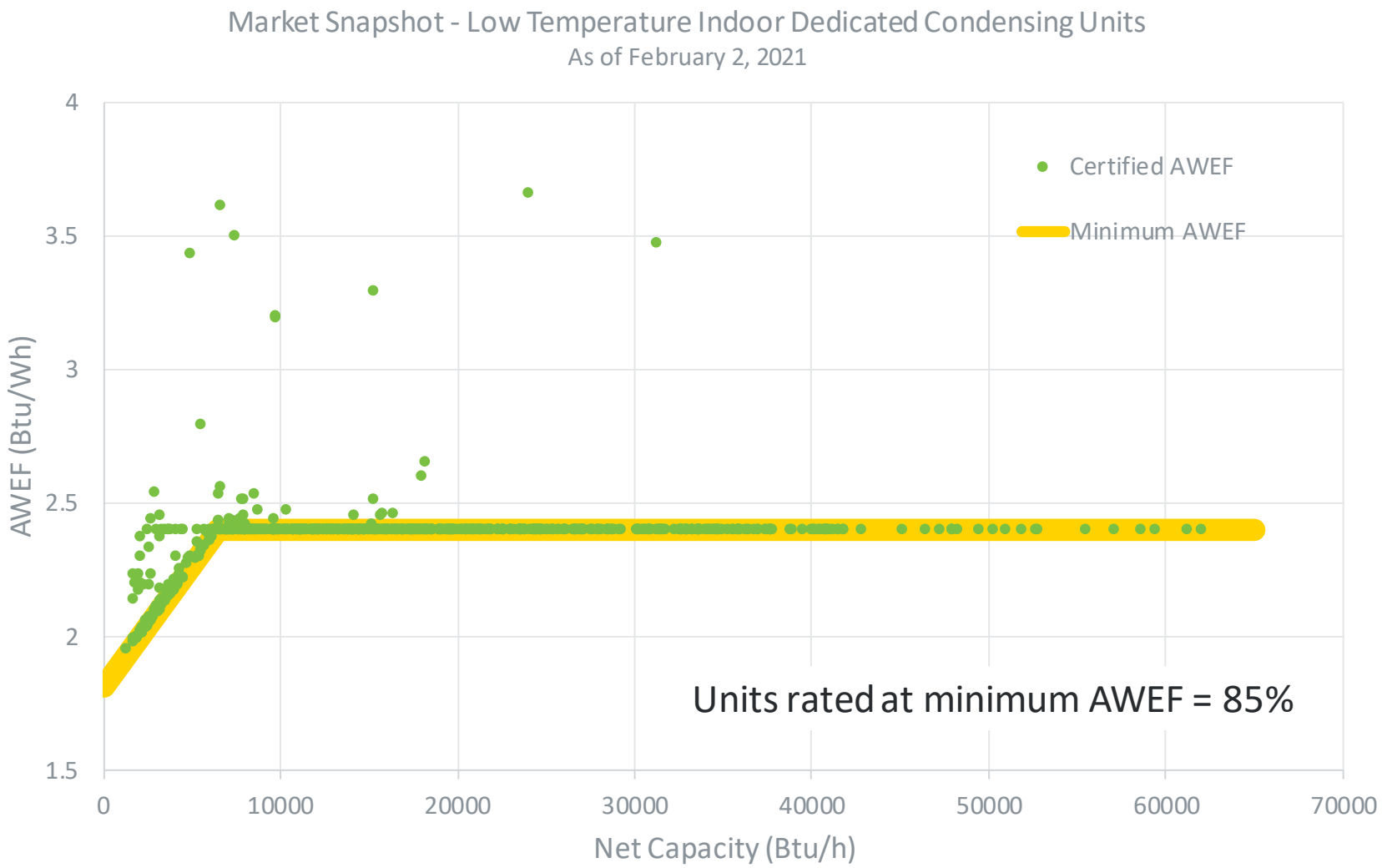
q_{net} = net capacity

(10 CFR 431.306(a)(5,6))

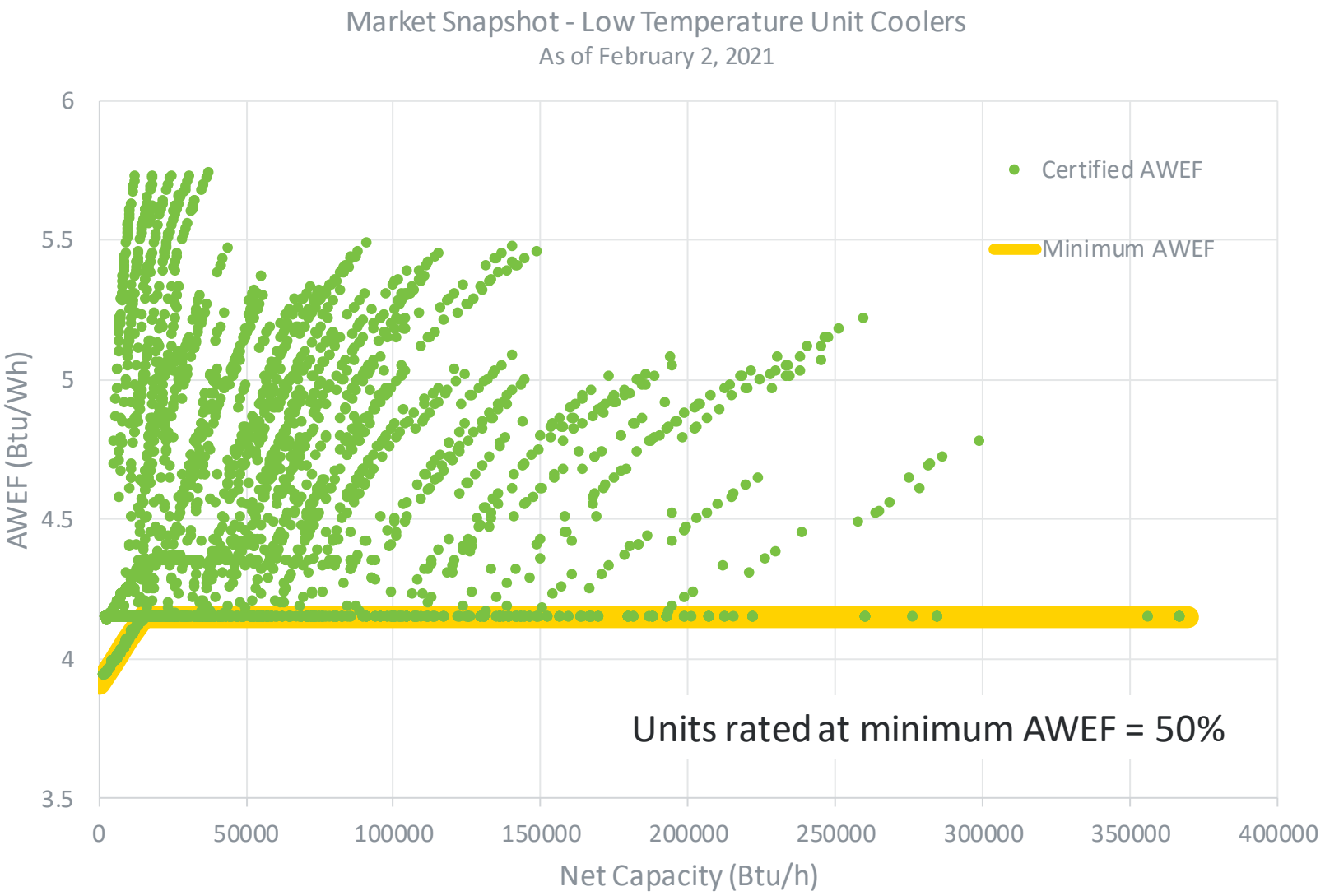
Performance Snapshot – Low Temp Outdoor DCU



Performance Snapshot – Low Temp Indoor DCU



Performance Snapshot – Low Temp Unit Coolers



Efficiency Standards - Next Steps

DOE expects to evaluate design options that could increase WICF efficiencies relative to current baseline in its next rulemaking

- Current minimum AWEF is the baseline
- Evaluate single and a combination of design options until reach the maximum technologically feasible efficiency for WICF refrigeration systems
  - Multiple-capacity and variable speed compressors
  - Fan motor and fan blade technology
  - Coil size and technology
  - Improved crankcase heaters

WICF Refrigeration System Test Procedure

- Appendix C to Subpart R of Part 431 (Appendix C)
  - Determines AWEF and net capacity
- Industry test standards incorporated by reference (10 CFR 431.303)
  - AHRI 1250-2009 with modifications in Appendix C
  - AHRI 420-2008 (unit coolers)
  - ASHRAE 23.1-2010 (dedicated condensing units)
- Applies to three scenarios
  - Unit coolers and condensing units sold together as a matched system
  - Unit coolers and condensing units sold separately
  - Unit coolers connected to compressor racks or multiplex condensing systems

Test Procedure Waivers

Manufacturers may apply for a test procedure waiver when a model has one or more design features that prevent testing in accordance with the test procedure or result in ratings inconsistent with actual performance

DOE reviews and requests comment on an alternate test approach

Affected models are still required to meet prescriptive standards and meet performance-based energy consumption standards when using the alternate test to determine performance

Current Waivers to WICF Refrigeration System TP

Single Package Refrigeration Systems

Current Test Procedure	Test Procedure Issues	Requested Alternate Approach
• Capacity measurement using the refrigerant enthalpy method. • Measure refrigerant mass flow and refrigerant conditions entering and leaving the unit cooler.	• No space for mass flow meters inside single package systems. • For testing, must run liquid line out of unit, through mass flow meter, and back in. • Refrigerant enthalpy method often provides inconsistent results.	• Indoor Air Enthalpy Method – Measure enthalpy change and mass flow rate of air passing through evaporator side • Secondary Measurement using Outdoor Air Enthalpy Method – Measure enthalpy change and mass flow ratee of air passing through condenser side • Refrigeration capacity determined by subtracting system input power from the condenser side measurement

Current Waivers to WICF Refrigeration System TP

Wine Cellar Refrigeration Systems

Current Test Procedure	Test Procedure Issues	Requested Alternate Approach

• Unit cooler air entering dry bulb T = 35 °F
• Unit cooler air entering RH < 50% to prevent condensation or frost collection
• Testing of single package units not addressed
	• Non-representative
	  • Operating conditions
	  • Load/capacity ratio
	  • Indoor unit fan control
	• No provisions for ducted indoor and/or outdoor units
	• Unclear provisions for testing single-package systems.
		• Unit cooler air entering dry bulb T = 55 °F
		• Unit cooler air entering RH = 55%
		• Air enthalpy or calorimetric methods of testing single package units with and without evaporator and/or condenser ducting

Current Waivers to WICF Refrigeration System TP

Unit Coolers for use in Transcritical CO_2 Booster Systems

Current Test Procedure	Test Procedure Issues	Requested Alternate Approach
• Liquid inlet saturation temperature = 105°F • Liquid inlet subcooling temperature = 9°F	• CO_2 does not exist as a liquid at 105°F saturation. • Booster system refrigerant supplied to unit cooler from intermediate-pressure flash tank.	• Liquid inlet saturation temperature = 38°F • Liquid inlet subcooling temperature = 5°F

Test Procedure – Next Steps

- DOE is required to review test procedures for covered equipment every 7 years.
- DOE required to adopt alternate test approaches for waivers into the test procedure.
- Equipment and test procedure developments that DOE may consider in future:
  - Two-speed and multi-capacity condensing units
  - CO_2 compressor units*
  - Water/liquid-cooled units
  - Hot gas defrost default heat and energy contributions based on AHRI 1250-2020
  - Taking standard frost loads into account for defrost tests (ASHRAE research project scheduled to start Fall 2021)

*Term being adopted for transcritical "condensing" units

Questions

Resources

Submit a Question and Find DOE Guidance:	http://www1.eere.energy.gov/guidance/default.aspx?pid=2&spid=1
Request a Test ProcedureWaiver:	Email: AS_Waiver_Requests@ee.doe.gov
File a Complaint:	Email energyefficiencyenforcement@hq.doe.gov. The Office of Enforcement will protect the identity of complainants to the maximum extent permitted by law.
Find Certified Models:	http://www.regulations.doe.gov/certification-data/
DOE's Online CertificationSystem:	https://www.regulations.doe.gov/ccms/
WICF Rulemakings and Notice:	https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=56&action=viewlive#current_procedures
Enforcement Information:	https://www.energy.gov/gc/legal-resources/office-assistant-general-counsel-enforcement
Test Procedure Waivers In Process and Finalized:	https://www.energy.gov/eere/buildings/current-test-procedure-waivers#walk-ins
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