ENERGY STAR Water Coolers Stakeholder Webinar

February 16, 2012

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ENERGY STAR Program

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Current ENERGY STAR Approach

- Standby Test
  - 24 hour energy consumption
  - No water draw
- Limitations
  - Not applicable to On Demand units
  - Sensitive to default temperatures
  - Results dependent on chosen test period
  - Not representative of actual product use

Water Cooler Development

- Progress to Date:
  - April 2011: Initiated test method development
  - June 2011: Webinar presenting draft 1 test method
  - July 2011 to January 2012: Validation testing and test method revisions
  - February 2012: Webinar presenting draft 2 test method

Water Cooler Development

	Draft 1 June 7, 2011	Draft 2 February 16, 2012
Test Basis	• Market Research • Existing Test Procedures	• Validation Testing
Tests	• Standby • Active − Heat/Cool Fixed Amount of Water − Replenish & Heat/Cool Fixed Amount of Water • Energy Capacity	• Standby • Active − Water Delivery Performance

Webinar Goals

- Present draft 2 test method
- Discuss findings from testing
- Obtain feedback from stakeholders on draft 2 test method
- Obtain feedback on steps moving forward

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Goals of Draft 2 Test Method

- Ensure universally applicable
- Provide consistent results
- Capture water draw energy consumption

Overview of Draft 2 Test Method

- Revised Standby Mode:
  - Renamed to “On Mode with No Water Draw”
  - Based on version 1.3 ENERGY STAR test method
  - Introduced stabilization period
  - Specified energy measurement guidelines
- Added Active Mode:
  - Introduced in June 2011 webinar
  - Referred to as “On Mode with Water Draw”
  - Determines efficiency of water delivery system (energy delivered vs. energy consumed)

Test Method Scope

- Draft 2 test method applicable to all units
- Proposed Scope:

Operation Method	Water Source	Water Temperature
• Storage • On Demand	• Bottle • Point of Use (POU)	• Hot and Cold • Cook and Cold • Cold Only

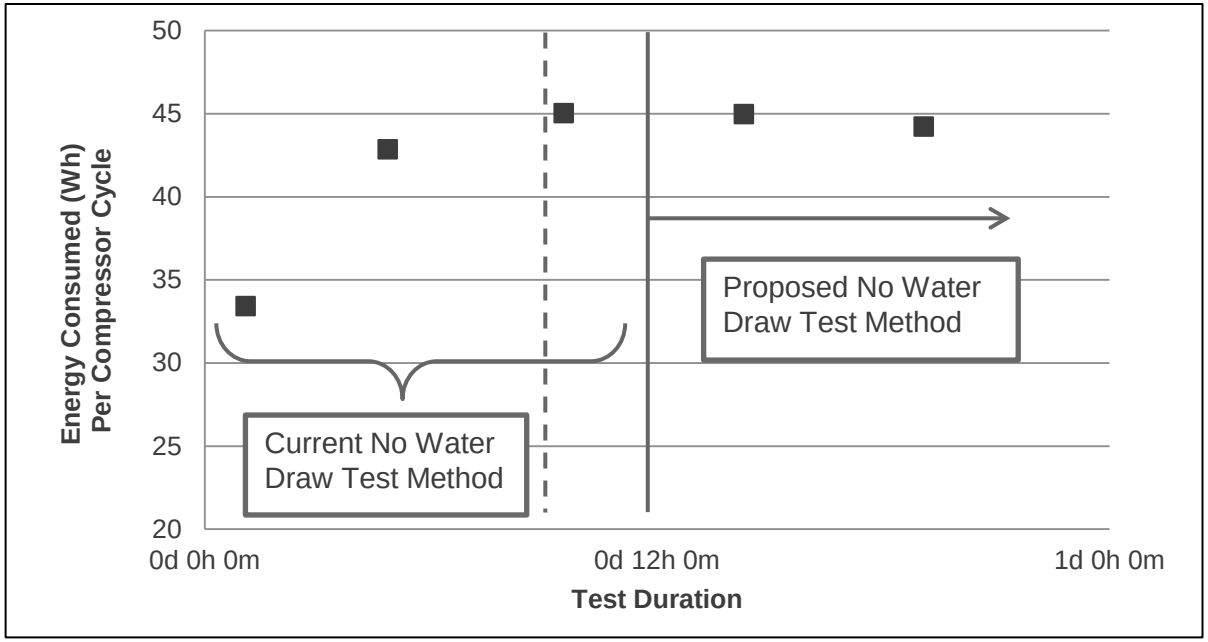
- Propose removing Air-source units from scope
  - Very high energy consumption compared to other units under scope
  - Additional water harvest functionality

Test Method Development

- Purpose
  - Capture all energy consumption
  - Develop repeatable and low error test method
  - Identify gaps in current test method
  - Validate revised test method
- Test Setup
  - Setup identical to Version 1.3 ENERGY STAR Test Method
- Test Units
  - 6 Storage and 2 On Demand
  - Bottle, POU, and Air-source

No Water Draw Test Method Revisions

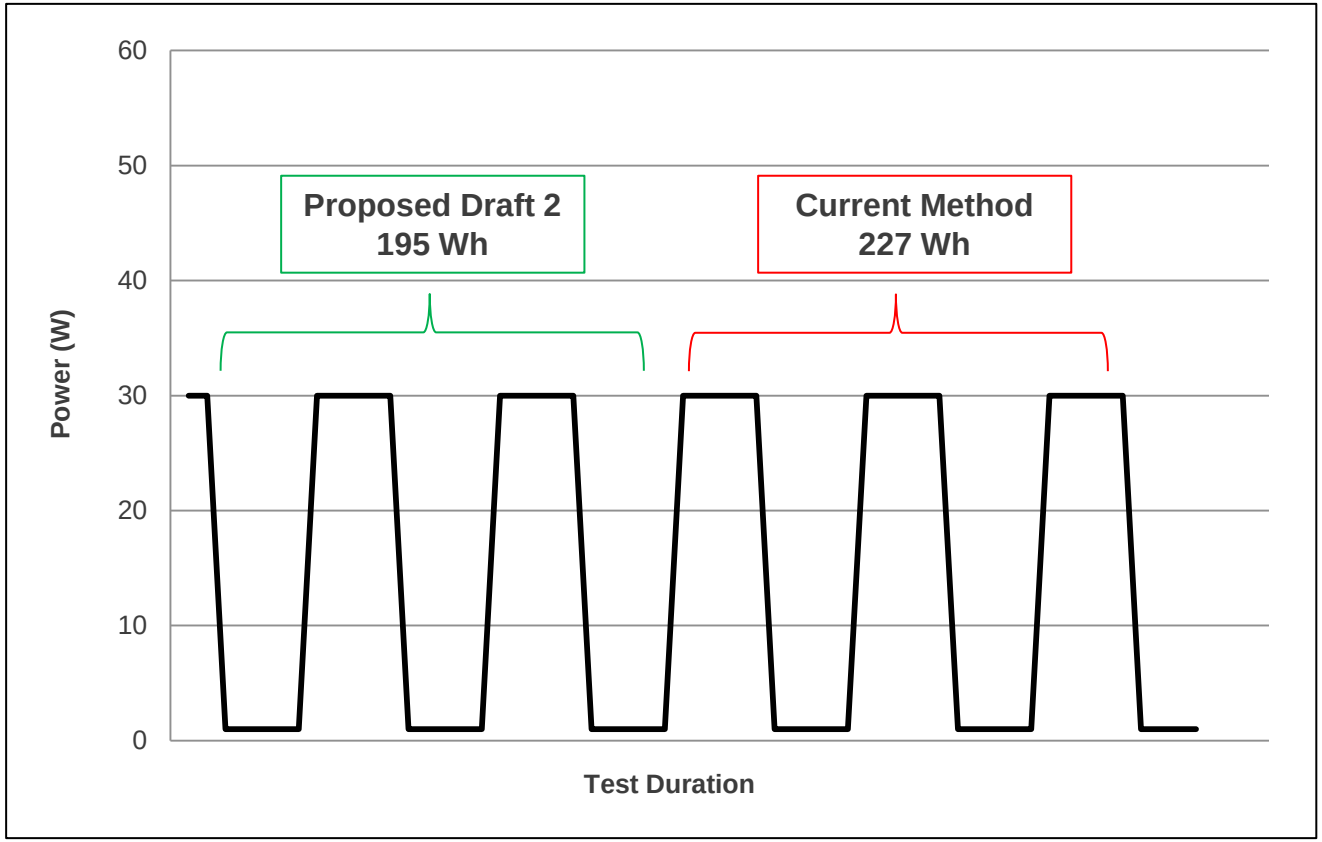
- Run-in compressor to ensure consistent performance in No Water Draw test
- Proposed 12 hour stabilization period



No Water Draw Test Method Revisions

- Inconsistent Test Results
  - Up to 17% difference in No Water Draw energy consumption based on selected test window
- Proposed End-to-end Test Window
  - Begin test at start of compressor/heater off cycle
  - After 24 hours, end test during a compressor/heater off cycle
  - If necessary, normalize to 24 hours

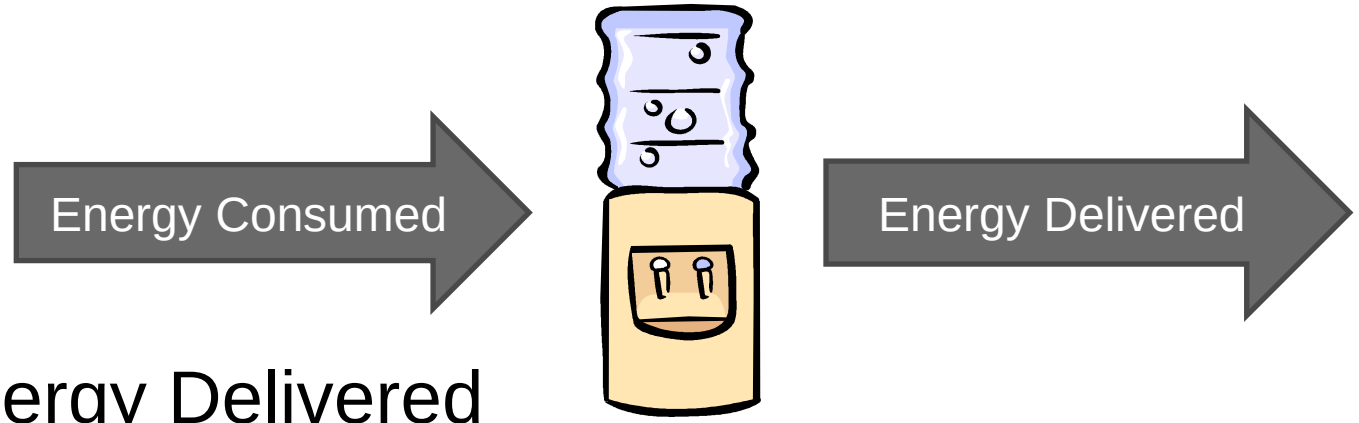
No Water Draw Test Method Revisions



Additional No Water Draw Considerations

- On Mode with No Water Draw Test Period
  - Draft 2 Test Period
    - Minimum of 24 hour
  - For Discussion: Reduce Test Period
    - Minimum of 5 compressor cycles (max 24 hours) or minimum of 4 hours
    - Normalize energy consumption to 24 hours

Water Draw Test Method

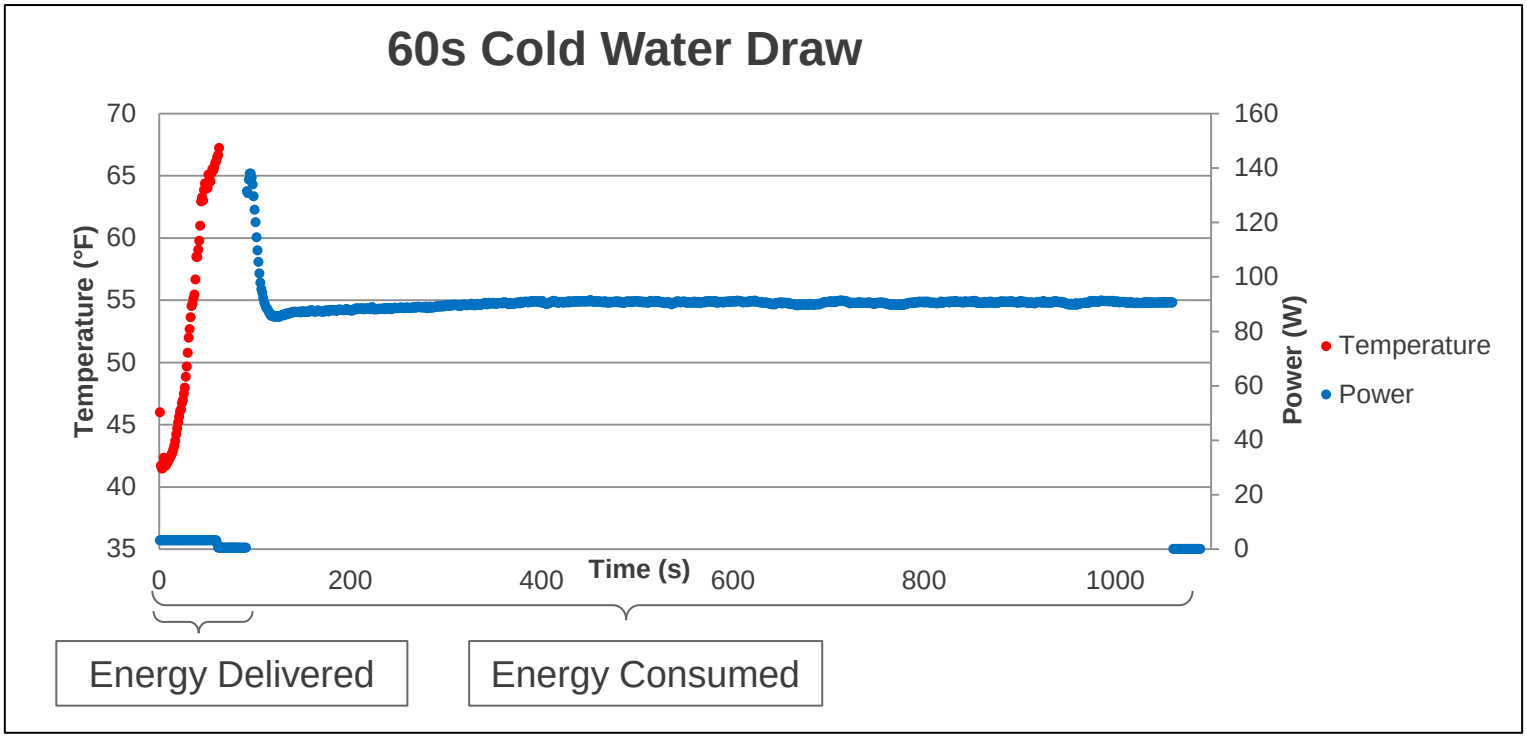


- Energy Delivered
  - Calculate energy delivered during water draw
    - Mass of delivered water, m (lbs)
    - Source and delivered water temperatures, ΔT (°F)
    - Specific heat of water, c (1 BTU/lbs·°F)
- Energy Consumed
  - Record recovery energy due to water delivery
  - Recovery duration determined via power trace

Water Draw Test Method

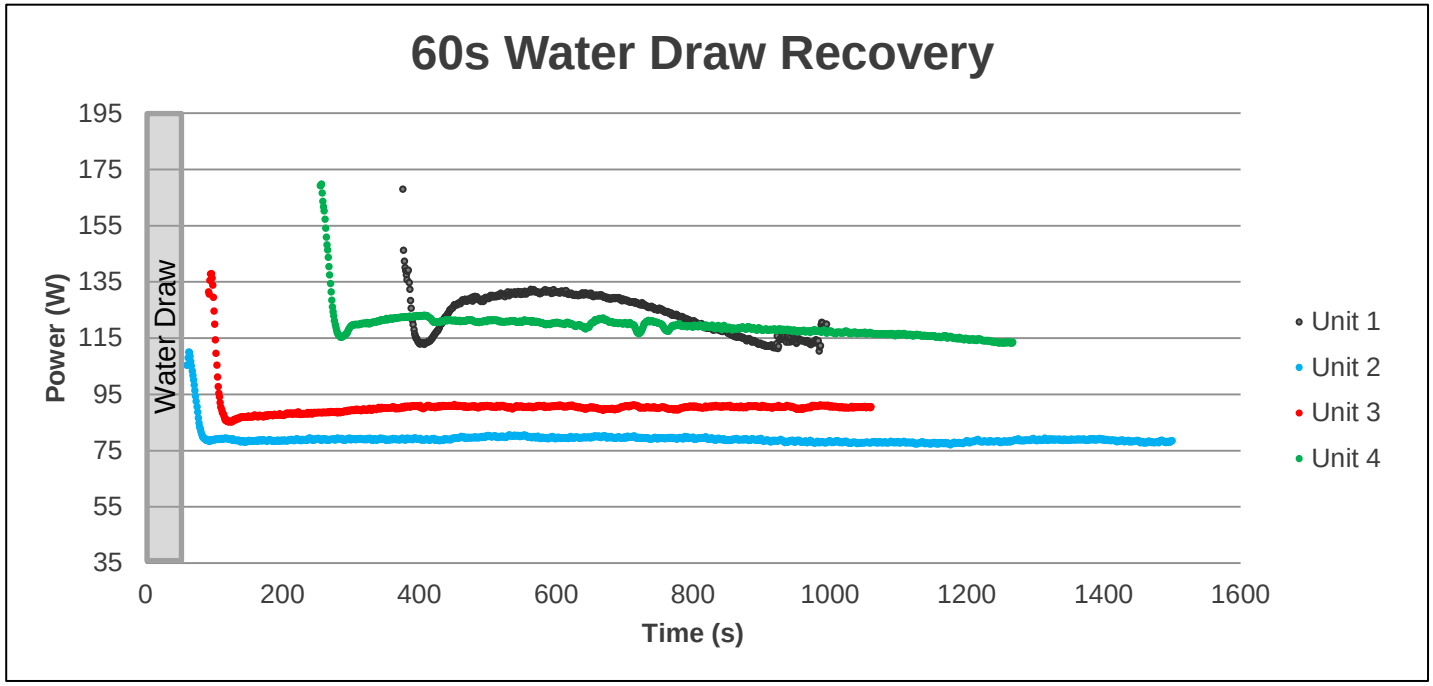
Stabilize unit → Draw water / Begin energy recording* → Weigh delivered water → Average water temperatures → Record recovery energy

*Recovery energy recording begins at time of water request for On Demand unit hot draws



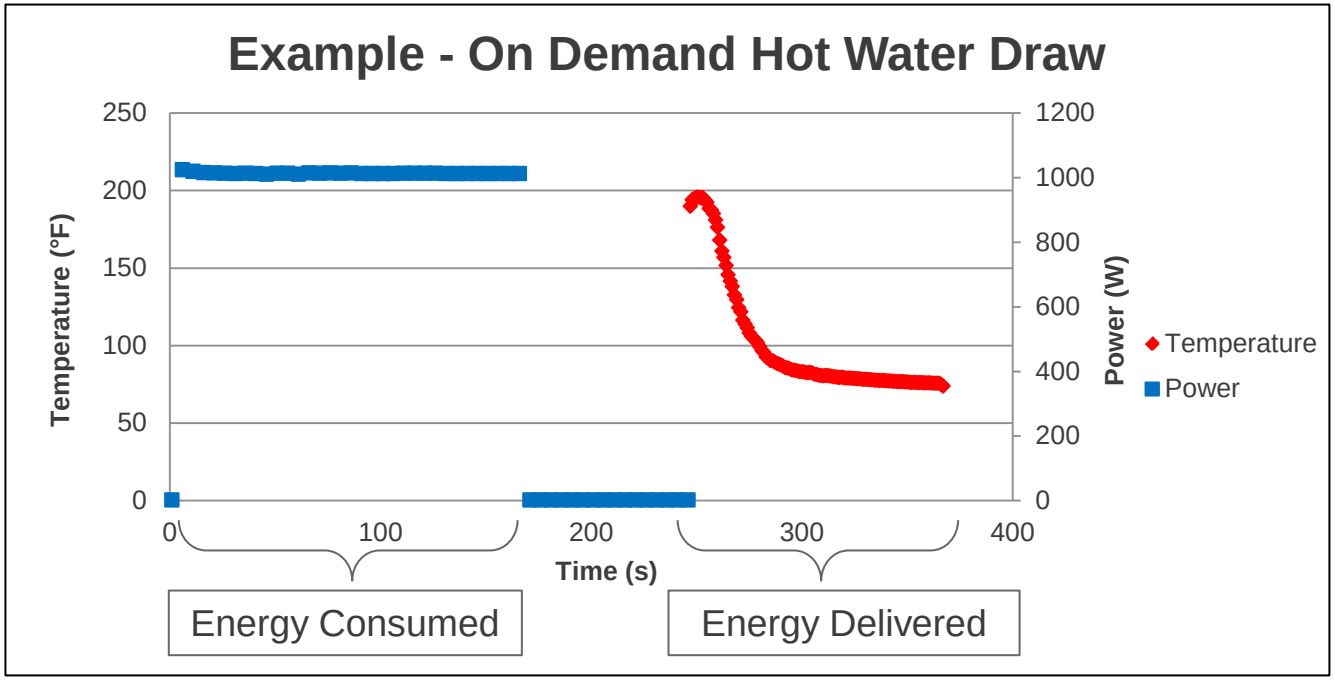
Recovery Energy Comparison

- Recovery duration and power vary for identical water draw
- Water recovery is inconsistent across different units



Water Draw Test – On Demand

- On Demand units heat water upon request
- Recovery energy recorded prior to the water draw
- Draw water until within 1°F of source water



Water Draw Metric

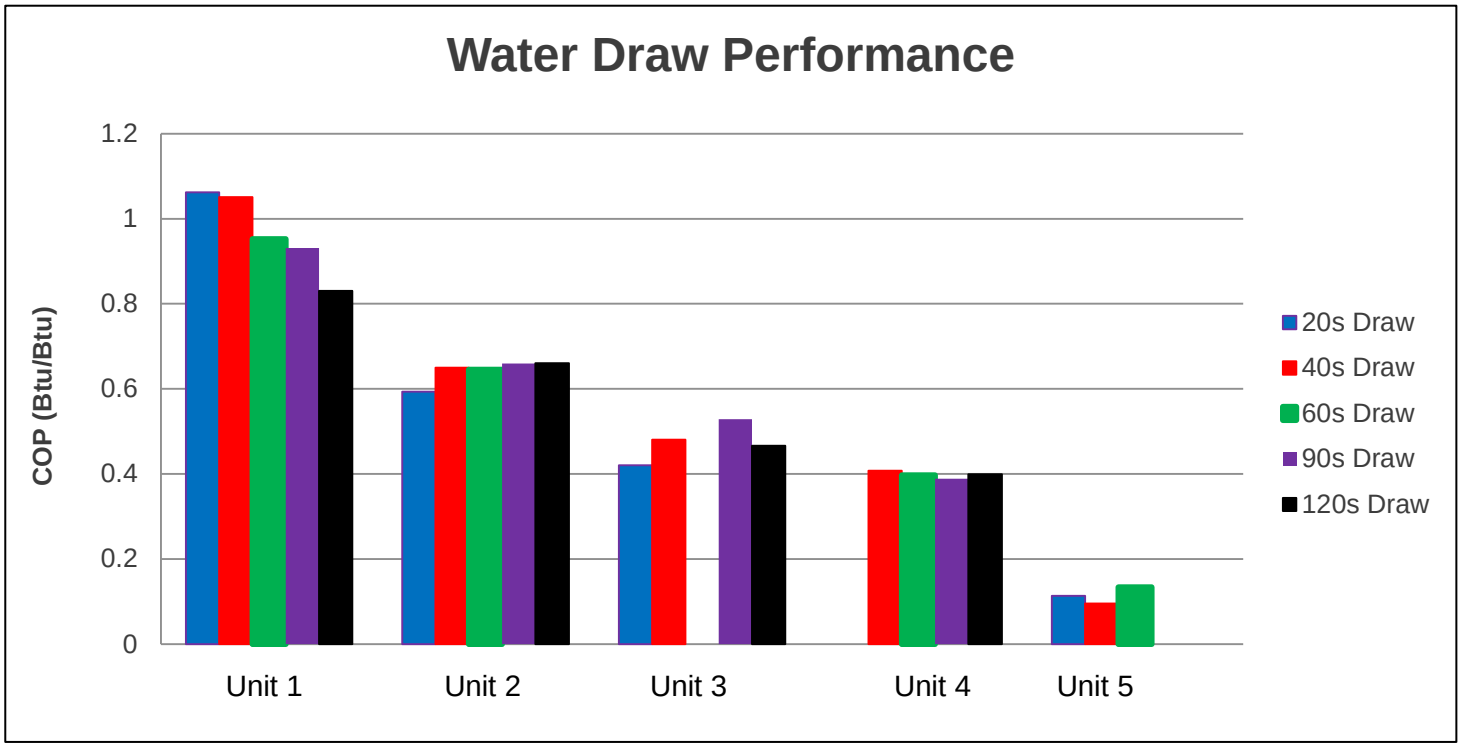
- Coefficient of Performance (COP)

$$\boxed{\text{COP} = \frac{\text{Energy Delivered}}{\text{Energy Consumed}}}$$

- COP is averaged over hot and cold water draws of 20s, 40s, 60s, 90s, and 120s.
- COP captures On Mode with Water Draw unit performance in a single metric.
- A larger COP indicates better performance.

Water Draw Metric

- Multiple Water Draws Improve Repeatability
  - Water draw durations of 20s, 40s, 60s, 90s, and 120s



Water Draw Mode Metric

Test Units	Water Draw Mode COP*	No Water Draw Mode kWh/day**
Unit 1	0.97	0.59
Unit 2	0.64	0.27
Unit 3	0.48	1.01
Unit 4	0.47	0.34
Unit 5	0.11	0.30

Rankings do not align

*A larger COP indicates better performance.

**Lower kWh/day indicates better performance.

Water Draw Test Impact

- Advantage: Provides valuable energy consumption data
- Disadvantage: Increases test time (includes water draws and varying recovery time)
- What might be other impacts of the proposed On Mode with Water Draw test?

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Overall Energy Consumption

- Primary energy consumption savings are expected to come from modifications to the No Water Draw performance
- Test results show inconsistent ranking between units
- DOE evaluated the overall impact of testing with Water Draw
- DOE calculated overall annual energy consumption based on:
  - No Water Draw Only (Current ENERGY STAR Method)
  - No Water Draw + Water Draw (Draft 2 Test Method)

Assumptions for Annual Energy

- Annual energy consumption calculations used the following assumptions:
  - Annual Water Consumption
    - Residential: 250 gallons/year
    - Commercial: 1000 gallons/year
  - Hot/Cold Water Draws
    - 50% Hot and 50% Cold
  - Draw Time
    - 40 seconds

Annual Energy Consumption

Unit Tested	Combined Annual Energy Rank*	No Water Draw Annual Energy Rank
Unit 6	1	1
Unit 2	**2**	**3**
Unit 7	**3**	**2**
Unit 3	**4**	**5**
Unit 5	**5**	**4**
Unit 1	6	6
Unit 4	7	7

*Calculations of annual energy consumption based on EPA usage assumptions

- On Mode with No Water Draw ranking does not align with combined overall energy ranking, in red
- Water draw testing is necessary for full energy consumption profile

Mode Analysis Conclusions

	No Water Draw	Water Draw	Combination
Applicability (On Demand)	No	Yes	**Yes**
Reflect Actual Annual Usage	No	No	**Yes**
Repeatability and Error Reduction	Yes	Yes	**Yes**
Learning Curve	None	Small	**Small**
Test Burden (hours)	36h (stabilize + test)	4.5h (tech + recovery*)	**Tech Time: 1.5h Total: 40.5h**

*Recovery time varied between different units while test time remained consistent. The average recovery time is presented.

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Next Steps

- EPA and DOE propose the following options for moving forward:

Option	Description	No Water Draw (kWh)		Water Draw (COP)	
		Report	Qualify	Report	Qualify
1	Revised Test Method	x	x	x	x
2	Alternate Approach	x	x	x	-
3	Reevaluate Program	-	-	-	-

Next Steps - Timeline

Milestone	Date
Test Method Development Initiated	April 2011
Stakeholder Webinar - Draft 1 Test Method	June 2011
Draft 1 Validation Testing	August – October 2011
Draft 1 Test Method Revisions	November 2011
Stakeholder Webinar – Draft 2 Test Method Options	February 16, 2012
Stakeholder Comments Due	**March 9, 2012**
Revision and Determination of Approach	**March 2012**

Questions?

Contact Information

Please send any additional comments to watercoolers@energystar.gov or contact:

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Supporting Information

Units Tested

Unit	Operation Method		Water Source			Temperature	
	Storage	On Demand	Bottle	POU	Air	Hot	Cold
1	x		x			x	x
2	x		x	x			x
3	x			x		x	x
4	x		x			x	x
5	x		x				x
6		x				x	x
7		x				x	x
8	x				x	x	x