ENERGY STAR®

Uninterruptible Power Supplies Draft 2 Version 2.0 Webinar

October 4, 2017

Webinar Details

- Webinar slides and related materials will be available on the Uninterruptible Power Supplies Product Development Web page:
  - www.energystar.gov/revisedspecs
  - *Follow link to "Version 2.0 is in Development" under "Uninterruptible Power Supplies"*

Webinar Agenda

1. Introductions and Recap of ENERGY STAR Process
2. Version 2.0
   - Efficiency requirements
   - Definitions and product scope
   - Test method revisions
   - Other issues
3. Timeline and Open Discussion

Introductions

Time	Topic
12:00–12:05	**Introductions and Recap of ENERGY STAR Process**
12:05–12:50	Efficiency Requirements
12:50–1:00	Definitions and Product Scope
1:00–1:15	ENERGY STAR Test Method Revisions
1:15–1:30	Other Issues
1:30–2:00	Timeline and Open Discussion

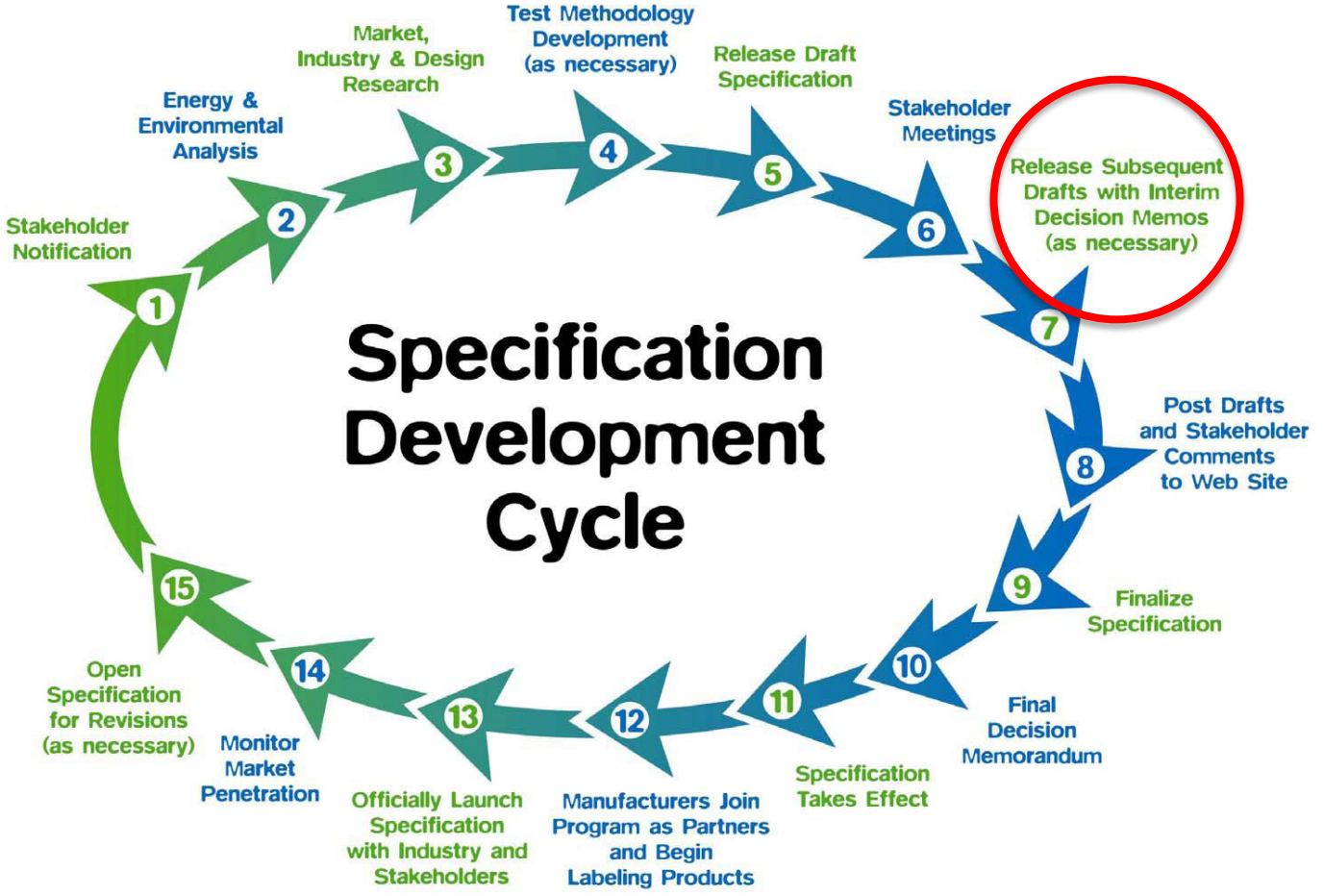
Introductions

Ryan Fogle
U.S. Environmental Protection Agency

Matt Malinowski
ICF

Emily Zhang
ICF

ENERGY STAR Specification Development Process



Objectives for Draft 2

- **Update efficiency requirements**
  - Take into account feedback on market penetration and product performance to recognize top-performing products
- **Continue updates to the ENERGY STAR Test Method**
  - Clarify testing accuracy, humidity
  - Update references to Alliance for Telecommunications Industry Solutions (ATIS) standards
  - Note: The proposed edits to the test method do not pertain to the DOE test procedure. Products that are still within the scope of the DOE Test Procedure must still abide by all requirements within the DOE Test Procedure.

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Stakeholder feedback

- **General Efficiency Levels**
  - Proposed energy efficiency levels are too stringent
  - ENERGY STAR market penetration rate is not as high as EPA stated
  - Factor in 0.5% test equipment measuring uncertainty

Analysis

- Modeled pass rate and savings with various assumptions and scenarios
  - DOE Final Rule
  - Market Penetration
  - Measurement Uncertainty
  - Emerging Technologies
- Target: top quartile of the market

Assumptions

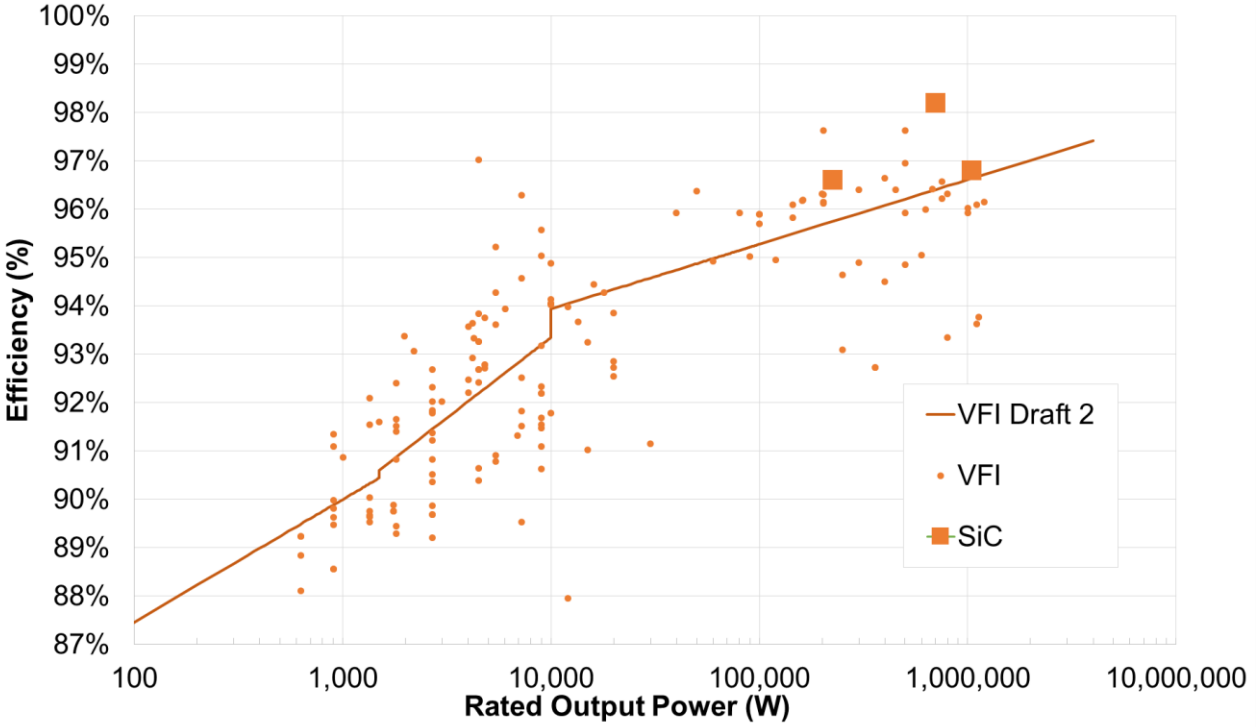
- **DOE Federal Standard**
  - Based on stakeholder feedback, assumed that DOE federal standard levels would be implemented.

- **Market penetration rate**
  - In analysis, assumed 73.5% ENERGY STAR market penetration
  - Two market reports – 48% and 100% market penetration rates

- **0.5% measurement uncertainty**

Assumptions

- **New Technologies**
  - Silicon Carbide (SiC): 3 ENERGY STAR partners with products
  - Gallium Nitride (GaN): no products



Proposed Draft 2, V2.0 Criteria

Draft 1 Requirements:

Minimum Average Efficiency Requirement (Eff_{AVG_MIN}), Where:
- ***P*** **is the Rated Output Power in watts (W),**
- E_{MOD} **is an allowance of 0.004 for Modular UPSs applicable in the commercial 1500–10,000 W range, and**
- **ln is the natural logarithm.**

Rated Output Power	Input Dependency Characteristic		
	VFD	VI	VFI
$P \leq 300$ W	~~$3.7 \times 10^{-5} \times P + 0.971$~~	0.985	$0.012 \times \ln(P) + 0.825$
300 W < $P \leq$ 1500 W	0.984		
1500 W < $P \leq$ 10,000 W	0.983-E_{MOD}	0.983-E_{MOD}	$0.016 \times \ln(P) + 0.797 - E_{MOD}$
$P >$ 10,000 W	0.920	0.940	$0.0059 \times \ln(P) + 0.890$

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300 W < $P \leq$ 1500 W	0.982	0.984	
1500 W < $P \leq$ 10,000 W	0.981 - E_{MOD}	0.983 - E_{MOD}	$0.0145 \times \ln(P) + 0.800 - E_{MOD}$
$P >$ 10,000 W	0.970	0.940	$0.0058 \times \ln(P) + 0.886$

Stakeholder feedback

- **Modular allowance**
  - Stakeholders commented that modular UPSs can enable individual modules to be shutdown when load is low, which increases the load and operating efficiency of the remaining modules while maintaining the target redundancy.
  - EPA retained the modular allowance

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Stakeholder feedback

- **Data Center VFD and VIs**
  - Sought clarification on why the proposed efficiency level for VFD and VI UPSs with output power greater than 10 kW has decreased from Version 1.1 to Version 2.0.

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Stakeholder feedback

- **Linear requirement for small VI**
  - Similar to VFD, the fixed losses tend to dominate and products are specialized, decreasing efficiency

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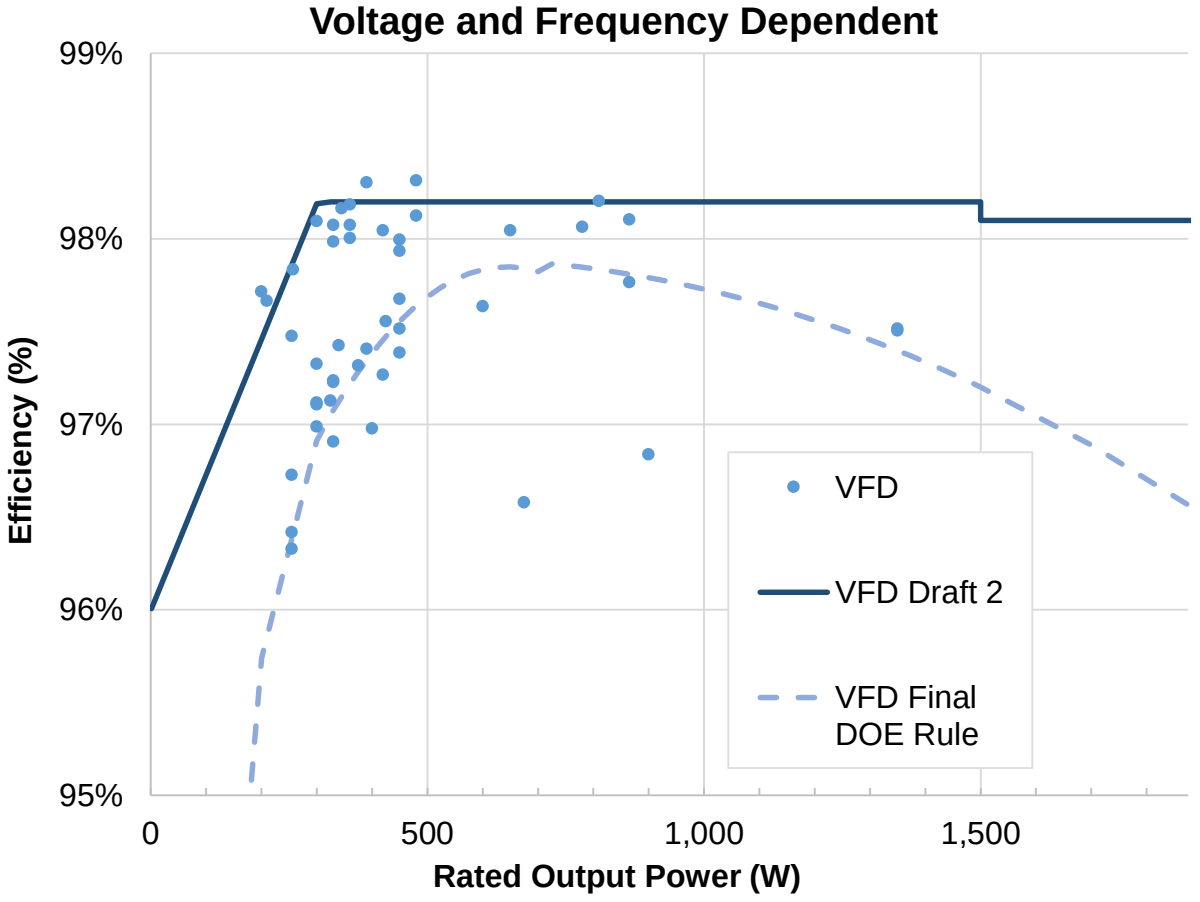
Revised Ac-output Efficiency Requirements - VFD



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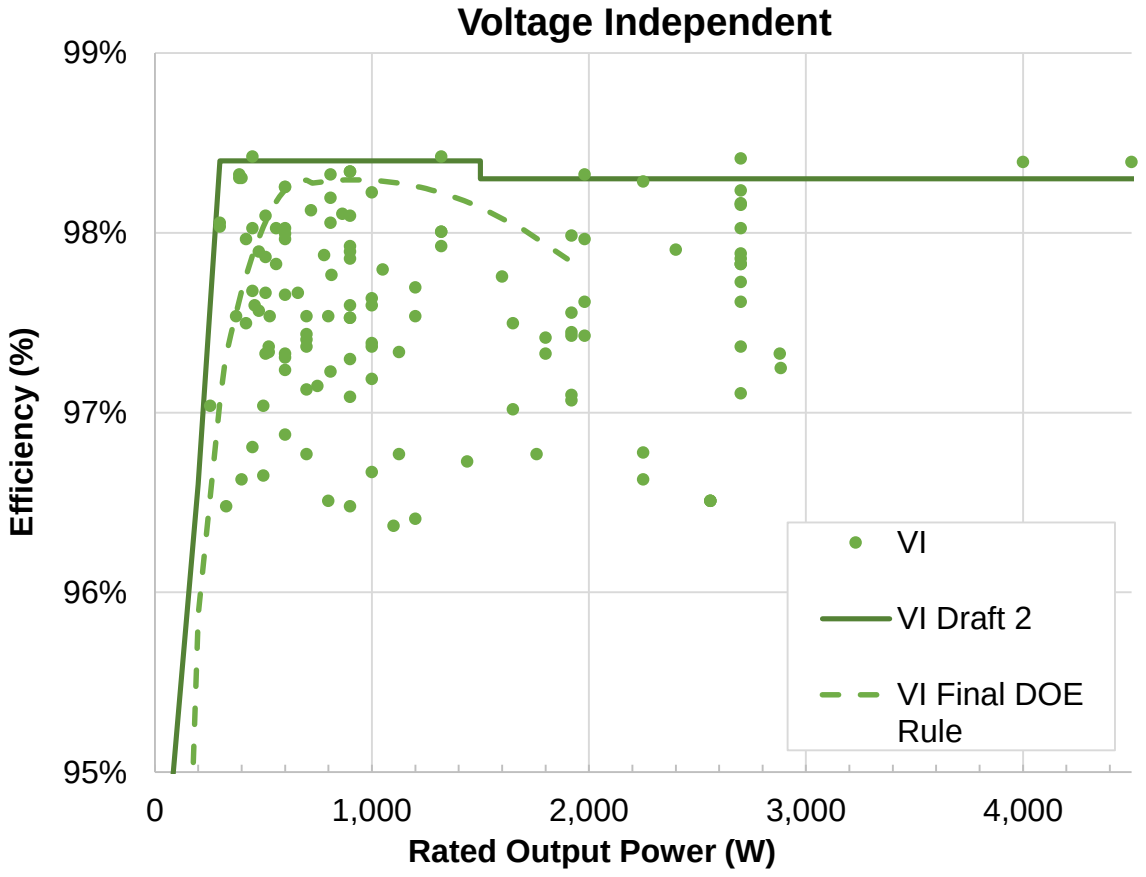
300 W < $P \leq$ 1500 W	0.982
1500 W < $P \leq$ 10,000 W	0.981 - E_{MOD}
$P >$ 10,000 W	0.970

- Linear requirement for UPSs rated below 300 W ensures full range of models captured

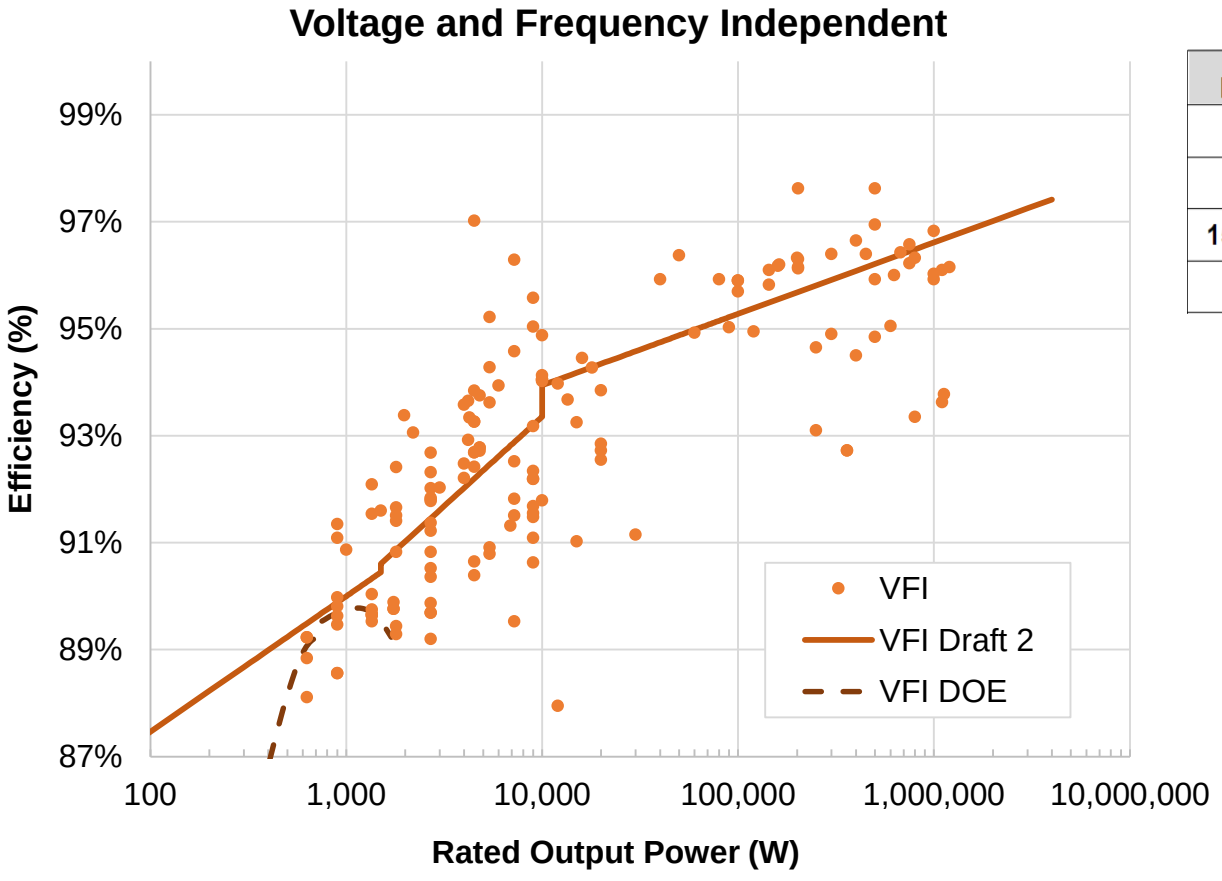
Revised Ac-output Efficiency Requirements - VI



Rated Output Power	VI
$P \leq 300$ W	$1.4 \times 10^{-4} \times P + 0.938$
300 W < $P \leq$ 1500 W	0.984
1500 W < $P \leq$ 10,000 W	0.983 - E_{MOD}
$P >$ 10,000 W	0.940

- Stringent DOE level requires ENERGY STAR consumer requirements to be near market-best
- Limited market information for datacenter VI models (2 products on QPL)

Revised Ac-output Efficiency Requirements - VFI



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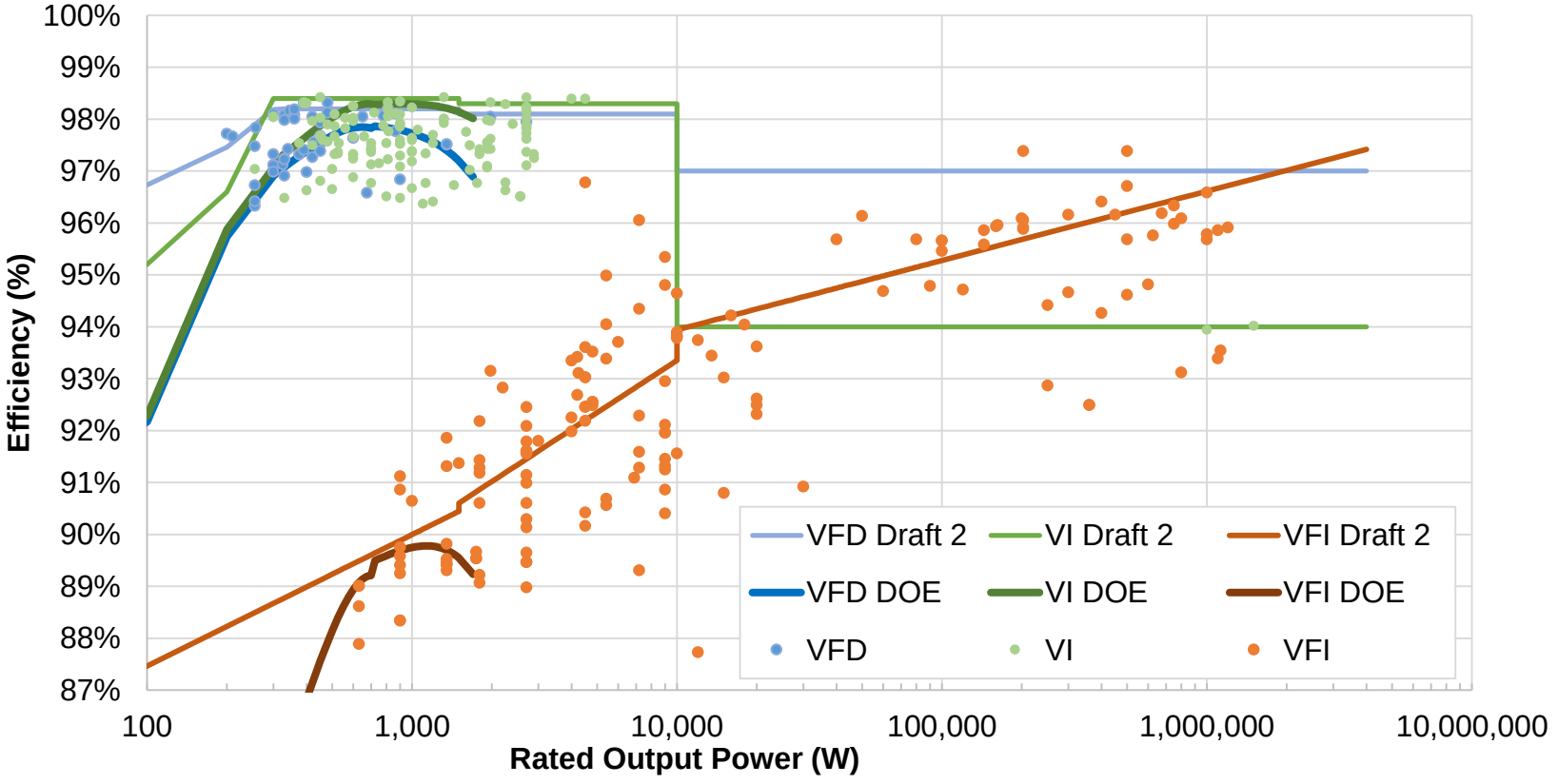
Version 2.0

Revised Ac-output Efficiency Requirements – with DOE Standard



Introductions

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1:15–1:30	Other Issues
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VI UPS definition

- Stakeholders commented that using the DOE definition would make the distinction between VI and VFD UPSs unclear
- For consistency with IEC 62040-3, reverted to Version 1.1 definition of VI UPSs (Section 1.E))

2) Voltage Independent (VI) UPS[5]: Capable of protecting the load as required for VFD, above, and in addition from:
    a) Under-voltage applied continuously to the input; and
    b) Over-voltage applied continuously to the input[6]

Hybrid UPSs

- Stakeholders commented that testing requirements did not adequately cover hybrid ac and dc systems, and should consider loading ac and dc outputs simultaneously
- Excluded hybrid UPSs that can deliver more than 10% of their rated output power through both ac and dc outputs (Section 2.2.2)

- **Test Method:**

B) The UUT shall be tested in "as-shipped" configuration, with the following exceptions:

1) Any dc output port(s) of the UUT that provide less than 90% of the rated output power must remain unloaded during testing, unless that would result in all ports unloaded.

Expanded Product Family Definition

L) Product Family: A group of product models that are (1) made by the same manufacturer, (2) subject to the same ENERGY STAR certification criteria, and (3) of a common basic design. For UPSs, acceptable variations within a product family include:

. . .

7) Software or jumper settings that affect rated output power.

4.2 Number of Units Required for Testing

4.2.1 Representative Models shall be selected for testing by either the sampling requirements defined in 10 CFR 429.25, which references 10 CFR 429.11, or the following requirements:

. . .

ii. For certification of a Modular UPS Product Family where models vary by number of installed modules or Product Family where models vary by software or jumper settings that affect rated output power, the manufacturer shall select the maximum and minimum configurations to serve as Representative Models—i.e., the system shall meet the eligibility criteria in both its maximum and minimum non-redundant configurations. If the maximum and minimum configuration Representative Models meet the ENERGY STAR certification criteria at their respective output power levels, all intermediate configuration models within a Modular or software- or jumper-set UPS Product Family may be certified to ENERGY STAR.

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Humidity

- EPA reviewed a paper by P.T. Tsilingiris, "Thermophysical and transport properties of humid air at temperature range between 0 and 100 °C", Energy Conversion and Management, 49 (2008) 1098–1110
- Humidity should not have a major effect on electronics efficiency between 20 and 30 °C
  - Thermal conductivity
  - Density
  - Specific heat
- Therefore, EPA proposes to remove the humidity requirement:

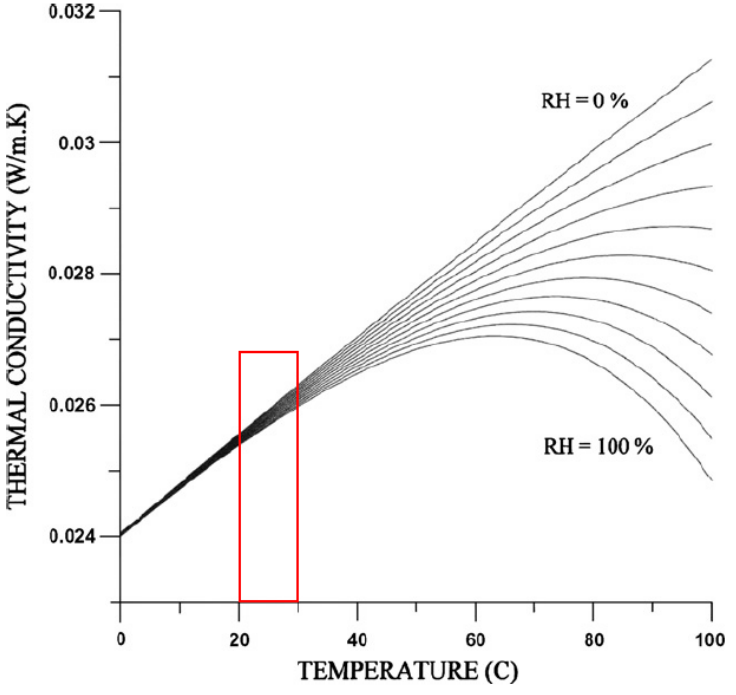


Fig. 3. The thermal conductivity of moist air as a function of temperature with the relative humidity as a parameter ranging between dry air (top curve RH = 0%) and saturation conditions (lower curve RH = 100%) in 10% steps.

G) Relative Humidity: Relative humidity shall be between 0% and 100%.

Energy Storage Requirements

- **Combined two separate sections into one**

E) The UPS shall not be modified or adjusted to disable energy storage charging features.

F) Energy Storage System:

1) If the energy storage system is able to be disconnected by physical means or by using default controls while maintaining normal operation, and the user manual or other publicly available documents do not advise against disconnecting it, the UPS shall be tested with the energy storage system disconnected.[4]

E) Energy Storage System: The UPS shall not be modified or adjusted to disable energy storage charging features, with the following exceptions.

Measurement Accuracy

- **Clarified requirements**
  - ≥ 2 W: Consistent with IEC 62040-3 and IEC 62040-5-3
  - < 2 W: Consistent with IEC 62301 Measurement of Standby Power and other ENERGY STAR test methods.

F) Measurement Accuracy:

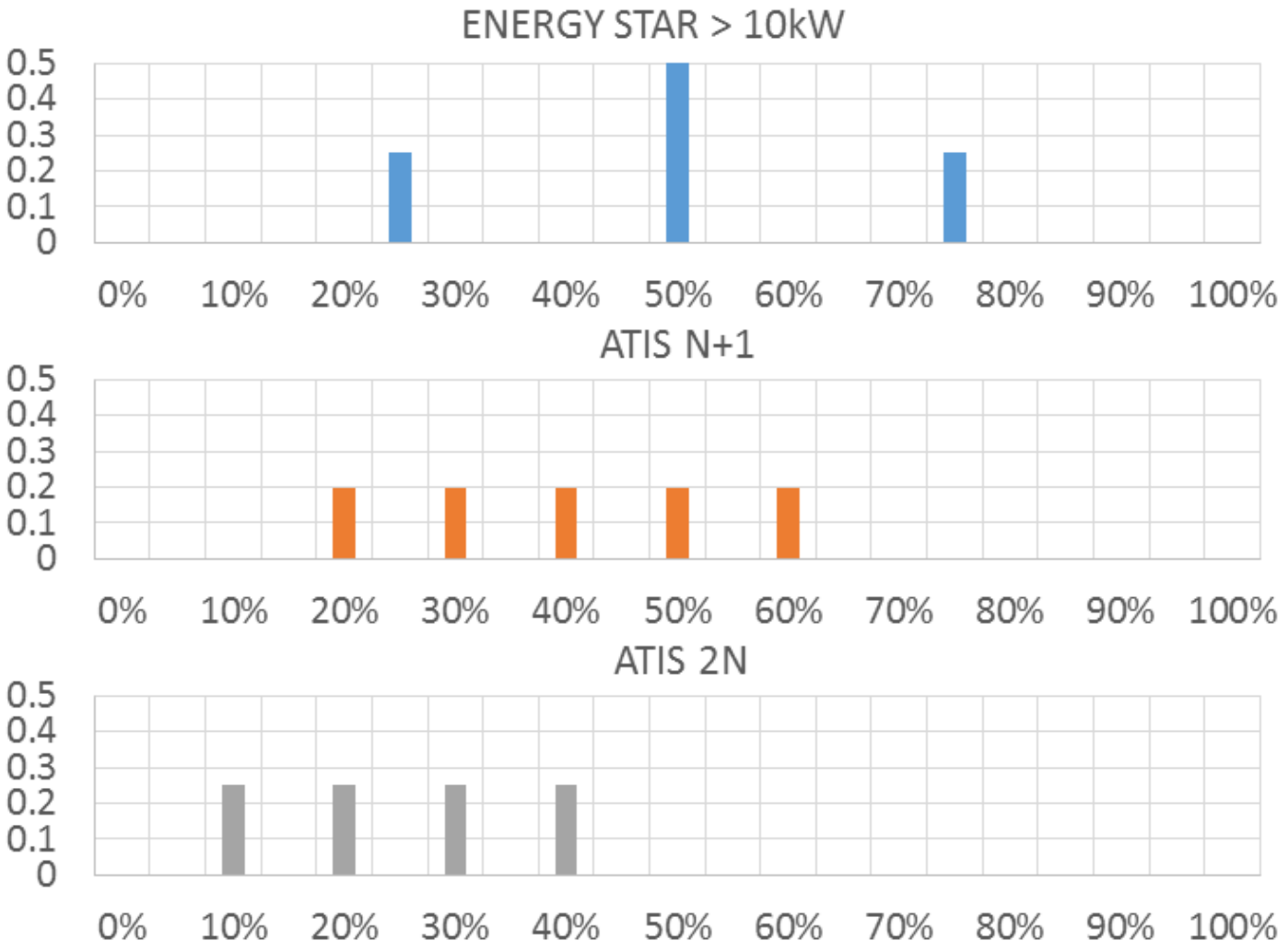
1) Power measurements with a value greater than or equal to 2 W shall be made with an uncertainty of less than or equal to 0.5% at the 95% confidence level.

2) Power measurements with a value less than 2 W shall be made with an uncertainty of less than or equal to 0.01 W at the 95% confidence level.

3) Output power measurement shall be taken as close to the output of the UUT as is feasible to ensure compliance with accuracy requirements specified in the referenced test methods.

ATIS References for DC Output

- **Updated ATIS references**
  - **ATIS-0600015.2009 updated** to ATIS-0600015.2013 Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting – General Requirements. May 6, 2013.
  - **ATIS-0600015.04.2010**, Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting DC Power Plant – Rectifier Requirements **unchanged**
- **Did not adopt ATIS--0600015.12.2016** Measurement and Reporting Power Systems – Uninterruptible Power Supply Requirements
  - Proposes additional loading profiles to reflect redundancy and modularity


ENERGY STAR > 10kW
0.5
0.4
0.3
0.2
0.1
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
ATIS N+1
0.5
0.4
0.3
0.2
0.1
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
ATIS 2N
0.5
0.4
0.3
0.2
0.1
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

UPS devices with USB

- EPA is interested in incorporating into scope

- May need to specify:
  - Number available ports to use
  - Utilized voltage(s)
  - Distribution of power consumption across ports
  - Guidance on measuring power

- EPA welcomes feedback from stakeholders on the potential of these products and required testing language

USB Type-C Voltage for Test

Table 2: Dc-output Power Requirements and Precedence

Nominal Voltage and Precedence	Voltage for Test[1]	Voltage Tolerance
1. 380 V dc	418 V dc	+/- 1 %
2. 48 V dc	53 V dc	+/- 1 %
3. 60 V dc	66 V dc	+/- 1 %
4. 24 V dc	26 V dc	+/- 1 %
5. USB Type C	20 V dc	+/- 1%
6. 575 V dc	595 V dc	+/- 1%

Some USB Type-C outputs may operate at 5 V rather than the 20 V indicated in the table above. However, 5 V outputs have fewer products and less output power, and therefore would be less of a focus for efficiency testing.

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Classifying DC-output UPSs

- Stakeholder concerns: splitting definitions and requirements for low and high voltage DC UPSs could fragment a growing market for DC UPSs.

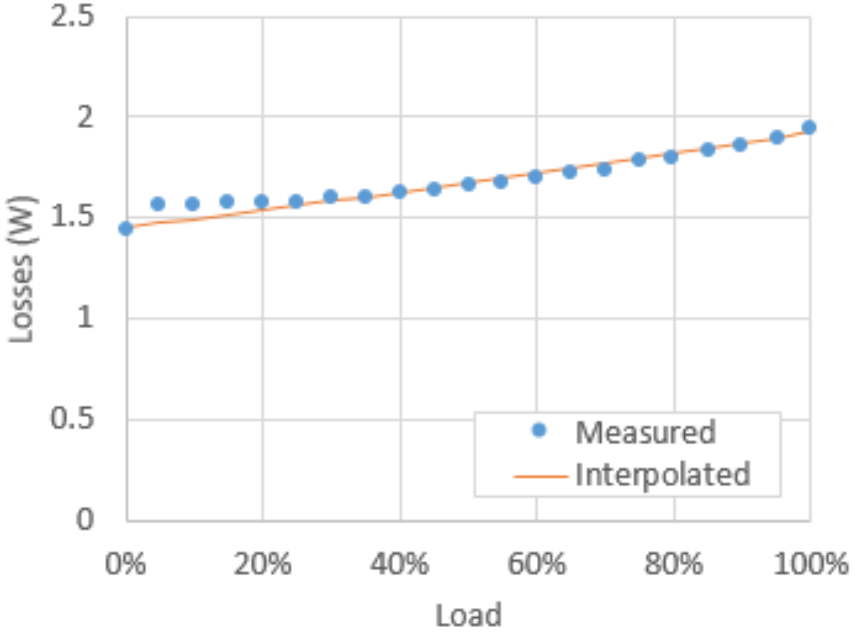
Voltage	Application	Test Method	Loading Assumption
≤ 60V	Telecom	ATIS-0600015.2009 and ATIS-0600015.04.2010	Unchanged from V1.0, average of 30%-80% (per ATIS)
> 60V	Datacenter	IEC 62040-5-3:2016	Aligned with Ac-output loading assumptions for VFI, 0%, 25%, 50%, 75%, and 100% (per IEC)

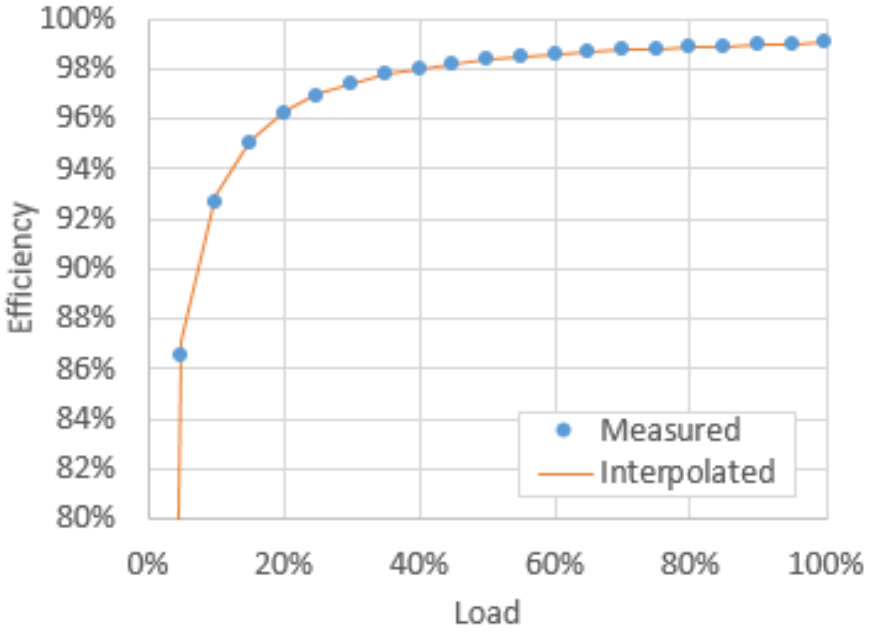
- EPA proposes to retain approach but welcomes additional comment

Low Loads

- Stakeholders requested addition of 0%, 5%, and 10% load points for VFD UPSs to reflect their low usage
- These values may be obtained from existing measurements using interpolation.
- EPA compared measured versus interpolated data for 10 models provided by a manufacturer (from 200 W to 10 KW)

Low Loads





- Found average percentage difference is 0.05% for the 5% and 10% loading points, with a minimum of -0.7%.
- EPA therefore proposes to keep the weightings as-is.

Tri-mode Loading Assumptions

- Lack of tri-mode UPSs in market
- EPA proposes to retain current approach; pending data on prevalence of tri-mode UPSs

$$Eff_{AVG} = 0.75 \times Eff_{LOW} + 0.25 \times Eff_{HIGH}$$

- Under the current approach, tri-mode UPSs could be tested, but only their highest- and lowest-input-dependency modes would be used for test.

http://www.eceee.org/static/media/uploads/site-2/ecodesign/lot-27-consolidated-final-report.pdf pg. 337

Connected Functionality

- **Removed metering incentive**
- **No new incentive/requirements proposed for connected functionality**
  - **Connected capabilities:** EPA research indicated that virtually all UPS were “connected” with capabilities that would allow prepare devices for shut down.
  - High degree of interoperability with 3rd party UPS management software – therefore, including ENERGY STAR communication and reporting requirements is not likely to drive a significant market response.
  - **Demand response:** While such functionality is technically feasible, only identified one instance where UPSs were being tapped for load balancing. EPA intends to monitor for future specification revisions.

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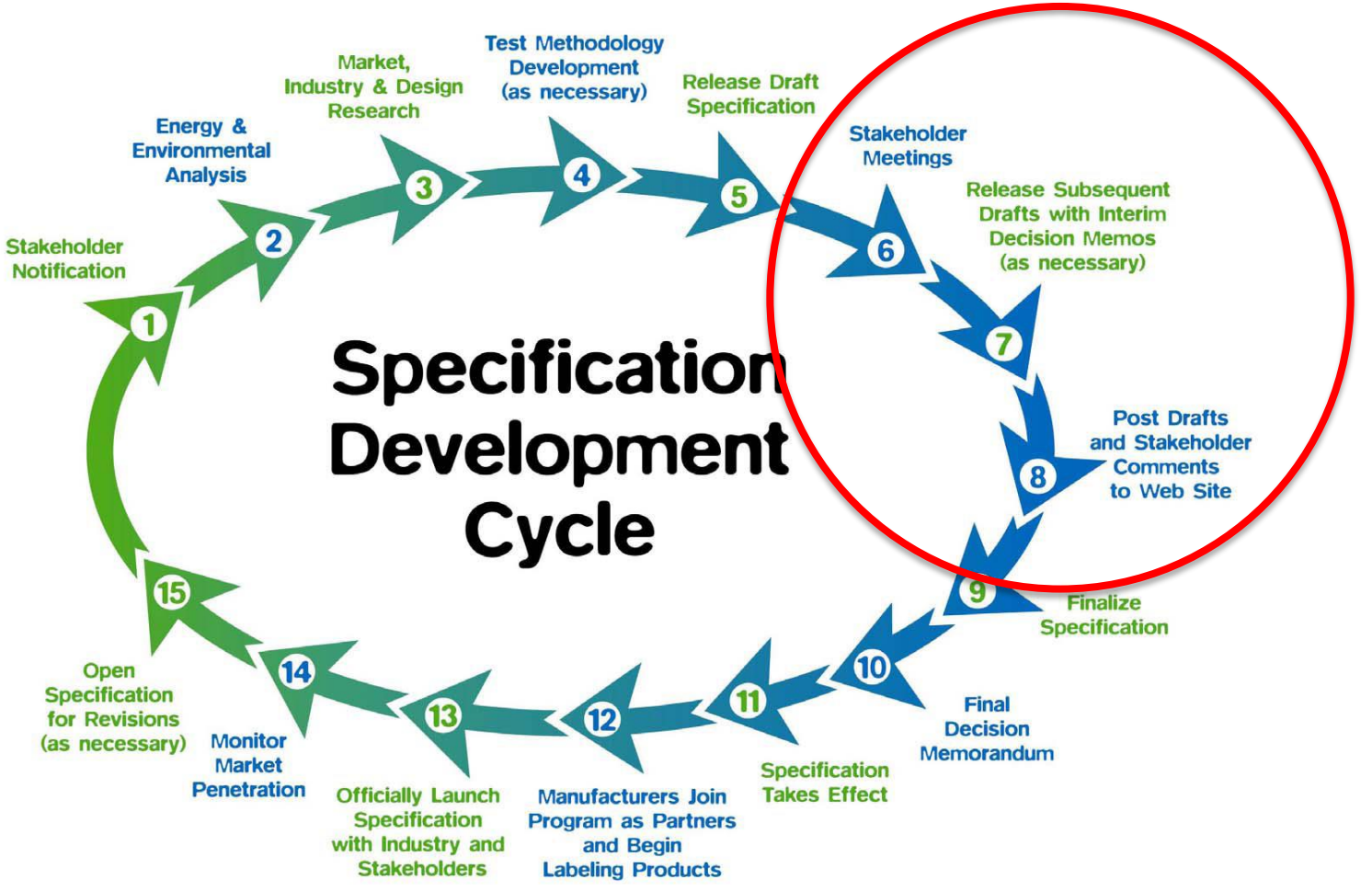

Timeline

- Q4 2017: Final Draft Specification and Test Method; finalize by end of year.
- Sep/Oct 2018: Version 2.0 Effective

Final Questions or Comments

Written Comment Submission

Please send any data and written feedback on the discussion document to ups@energystar.gov no later than **October 20, 2017.**

Unless marked as confidential, comments will be posted on the Uninterruptible Power Supplies Version 2.0 product development pages at www.energystar.gov/products/spec/uninterruptible_power_supplies_specification_version_2_0_pd

also accessible through www.energystar.gov/revisedspecs

Thank You!

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