ENERGY STAR® Program Requirements
Product Specification for Commercial Ovens

Eligibility Criteria
Draft 2: Version 2.2

Following is the **Draft 2 Version 2.2** product specification for ENERGY STAR qualified commercial ovens. A product shall meet all of the identified criteria if it is to earn the ENERGY STAR.

1) Definitions: Below are the definitions of the relevant terms in this document.

A. Oven: A chamber designed for heating, roasting, or baking food by conduction, convection, radiation, and/or electromagnetic energy.[1]

Oven Types

B. Combination Oven: A device that combines the function of hot air convection (oven mode), saturated and superheated steam heating (steam mode), and combination convection/steam mode for moist heating, to perform steaming, baking, roasting, rethermalizing, and proofing of various food products. In general, the term combination oven is used to describe this type of equipment, which is self-contained.[2] The combination oven is also referred to as a combination oven/steamer, combi or combo.

a. Half-Size Combination Oven: A combination oven capable of accommodating a single 12 x 20 x 2 ½-inch steam table pan per rack position, loaded from front-to-back or lengthwise.

b. Full-Size Combination Oven: A combination oven capable of accommodating two 12 x 20 x 2 ½-inch steam table pans per rack position, loaded side by side, from front-to-back or lengthwise.

c. 2/3-Size Combination Oven: A combination oven capable of accommodating a single 12 x 10 x 2 ½-inch steam table pan per rack position, loaded from front-to-back or lengthwise.

C. Convection Oven: A general-purpose oven that cooks food by forcing hot dry air over the surface of the food product. The rapidly moving hot air strips away the layer of cooler air next to the food and enables the food to absorb the heat energy. For the purposes of this specification, convection ovens do not include ovens that have the ability to heat the cooking cavity with saturated or superheated steam. However, this oven type may have moisture injection capabilities (e.g., baking ovens and moisture-assist ovens). Ovens that include a *hold feature* are eligible under this specification as long as convection is the only method used to fully cook the food.

a. Half-Size Convection Oven: A convection oven that is capable of accommodating half-size sheet pans measuring 18 x 13 x 1-inch.

b. Full-Size Convection Oven: A convection oven that is capable of accommodating standard full-size sheet pans measuring 18 x 26 x 1-inch.

D. Conventional or Standard Oven: An oven that cooks food primarily using the naturally occurring hot air currents to transfer heat over the surface of the food product without the use of a fan or blower. The burner or elements heat the air within the oven cavity as well as the cavity walls,

[1] NSF 170-2010, *Glossary of food equipment terminology*.
[2] ASTM Standard F-2861-10 *Standard Test Method for Enhanced Performance of Combination Oven in Various Modes*.

causing currents of hot air that transfer heat to the surface of the food. The hot air's buoyancy carries it upward through cooler air, which then slowly sinks to the bottom of the oven as it cools off.

E. Conveyor Oven: An oven designed to carry food product on a moving belt into and through a heated chamber.

F. Slow Cook-and-Hold Oven: An oven designed specifically for low-temperature (e.g., less than 300°F) cooking, followed by a holding period at a specified temperature.

G. Deck Oven: An oven that cooks food product directly on the floor of a heated chamber. The bottom of each compartment is called a deck and heat is typically supplied by burners or elements located beneath the deck. The oven ceiling, floor, and walls are designed to absorb heat quickly and radiate that heat back slowly and evenly.

H. Rack Oven: A high-capacity oven that offers the ability to produce steam internally and is fitted with a motor-driven mechanism for rotating multiple pans inserted into one or more removable or fixed pan racks within the oven cavity.

   a. Mini Rack Oven: A stand-mounted rack oven designed with a load-in-place rack that cannot be removed. Mini rack ovens are capable of accommodating up to 10 standard full-size sheet pans measuring 18 x 26 x 1-inch.

   b. Single Rack Oven: A floor-model rack oven that is able to accommodate one removable single rack of standard sheet pans measuring 18 x 26 x 1-inch.

   c. Double Rack Oven: A floor-model rack oven that is able to accommodate two removable single racks of standard sheet pans measuring 18 x 26 x 1-inch, or one removable double-width rack.

   d. Quadruple Rack Oven: A floor-model rack oven that is able to accommodate four removable single racks of standard sheet pans measuring 18 x 26 x 1-inch, or two removable double-width racks.

Note: Stakeholders suggested modifying the “mini rack oven” definition in Section 1.H.a., by replacing “fixed rack” with “load-in-place rack” to align with industry terminology. Stakeholders also suggested that EPA remove the rack spacing requirements (i.e., determining number of sheet pans based on a nominal 4-inch spacing between pans) for the mini, single, double, and quadruple rack oven definitions because spacing is addressed in the “single rack” and “double-rack definitions” in Section 1.U and 1.V. Spacing guidelines do not impact the definition of each sub-type of rack oven. After considering these suggestions, EPA amended the definitions in Section 1.H.a-d. Stakeholders are encouraged to provide feedback on the revised rack oven subtype definitions, which are used to determine eligibility, categorization, and performance levels.

I. Range Oven: An oven base for a commercial range top (i.e., burners, electric elements or hobs). Range ovens may use either standard or convection technologies to cook food.

J. Rapid Cook Oven: An oven that utilizes one or more non-traditional heat transfer technologies to cook food product significantly faster than would be possible using conventional (e.g., convection, conduction, radiant) heat transfer technologies. Heat transfer technologies that may be employed include microwave, quartz halogen, and high-velocity or impingement convection.

K. Rotisserie Oven: An oven fitted with a mechanism to move or turn food past a fixed heat source while the food is slowly being cooked on all sides.

Energy Efficiency Metrics

L. Baking-Energy Efficiency: Quantity of energy imparted to the specified load, expressed as a

percentage of energy consumed by the oven during the baking event.

M. Cooking-Energy Efficiency: Quantity of energy imparted to the specified load, expressed as a percentage of energy consumed by the oven during the cooking event.

N. Idle Energy Rate: The rate of oven energy consumption while it is maintaining or holding at a stabilized operating condition or temperature. Also called standby energy rate.

O. Total Idle Energy Rate: The rate of oven energy consumption while it is maintaining or holding at a stabilized operating condition or temperature. Total idle energy rate includes gas and electric energy. Also called total standby energy rate.

Note: Based on stakeholder feedback, EPA amended the cooking-energy efficiency and baking-energy efficiency definitions to better align with the ASTM language.

Following discussion with stakeholders, and in the interest of considering the holistic energy use of ovens, EPA added "total idle energy rate" as an energy efficiency metric in Section 1.O. The definition of total idle energy rate is identical to the idle energy rate definition, with the added caveat that this new metric accounts for both gas and electric energy. More details are provided about the addition of this metric in the note box under Section 3.C. "Idle energy rate" has been replaced by "total idle energy rate" throughout this document, where appropriate. Stakeholders are encouraged to comment on the proposed definition and suggest additional text that provides greater detail and further clarifies this metric.

Water Consumption

P. Average Water Rates: The ratio of the average potable water used to the maximum number of steam table pans the oven can accept during heavy-load cooking in steam and convection modes; expressed as gallons per hour (GPH) per pan.

Q. Average Condensate Temperature: The average temperature of the condensed steam and cooling water mixture exiting the combination oven and directed to the drain during heavy-load cooking in steam and convection modes.

R. Maximum Condensate Temperature: The maximum temperature of the condensed steam and cooling water mixture exiting the combination oven and directed to the drain during heavy-load cooking in steam and convection modes.

Qualification Terms

S. Product Family: Individual models offered within a product line based on the same engineering design, including pan capacity, fuel type, and method of steam generation, as applicable. Acceptable differences within a product family for purposes of certification include: controls, door-opening orientation, and any aesthetic additions that have no impact on oven energy consumption in any operating mode.

T. Pan Capacity: The number of steam table pans the combination oven is able to accommodate as per the ASTM F-1495-05 standard specification.

U. Single Rack: Single racks shall accommodate 15 full-size sheet pans measuring 18 x 26 x 1-inch, at a 4-inch spacing between rack positions. Single racks accommodate 1 full-size sheet pan per rack position.

V. Double-Width Rack: Double racks shall accommodate 30 full-size sheet pans measuring 18 x 26 x 1-inch, at a 4-inch spacing between rack positions. Double racks accommodate 2 full-size sheet pan per rack position.

2) Scope:

A. Included Products: Products that meet the definitions of a Commercial Oven and Convection Oven, Combination Oven, or Rack Oven as specified herein are eligible for ENERGY STAR qualification, with the exception of products listed in Section 2.B. The following subtypes are eligible:

a. Full-size gas and half- and full-size electric convection ovens.

b. Half- and full-size gas combination ovens with a pan capacity ≥ 6.

c. Half- and full-size electric combination ovens with a pan capacity ≥ 5 and ≤ 20.

d. Single and double gas rack ovens.

To ensure only commercial ovens qualify under this specification, products shall be third-party certified to NSF/ANSI Standard 4, *Commercial Cooking, Rethermalization and Powered Hot Food Holding and Transport Equipment.*

B. Excluded Products: This specification is intended for commercial food-grade ovens. Ovens designed for residential or laboratory applications cannot qualify for ENERGY STAR under this specification. The following oven types and sub-types are ineligible for ENERGY STAR:

a. Half-size gas convection ovens.

b. 2/3-size combination ovens.

c. Dual-fuel heat source combination ovens.

d. Hybrid ovens not listed in Section 2.A, above, such as those incorporating microwave settings in addition to convection.

e. Conventional or standard ovens; conveyor; slow cook-and-hold; deck; range; rapid cook; and rotisserie.

f. Gas combination ovens with a pan capacity of < 6.

g. Electric combination ovens with a pan capacity < 5 and > 20.

h. Mini and quadruple gas rack ovens.

i. Electric rack ovens.

Note: As indicated in the Version 2.2 launch memorandum released on March 30, 2015, and in the Draft 1 specification, EPA intended to address both electric and gas rack ovens of various sizes in this revision. EPA assembled data on several single and double gas rack ovens, however data on other subtypes, such as electric rack ovens, mini rack ovens, and quadruple gas rack ovens has not been made available. Thus, the scope of products covered under this Version 2.2 specification will be limited to the products listed in Section 2.A. EPA may consider future inclusion of other rack oven types should data become available.

3) Qualification Criteria:

A. Convection Oven Cooking-Energy Efficiency and Idle Energy Rate Requirements:

Table 1: Energy Efficiency Requirements for Convection Ovens		
Gas		
Oven Capacity	**Idle Rate, Btu/h**	**Cooking-Energy Efficiency, %**
Full-Size	≤ 12,000	≥ 46
Electric		
Oven Capacity	**Idle Rate, kW**	**Cooking-Energy Efficiency, %**
Half-Size	≤ 1.00	≥ 71
Full-Size	≤ 1.60	

B. Combination Oven Cooking-Energy Efficiency and Idle Energy Rate Requirements:

Table 2: Energy Efficiency Requirements for Combination Ovens		
Gas		
Operation	**Idle Rate, Btu/h**	**Cooking-Energy Efficiency, %**
Steam Mode	≤ 200P+6,511	≥ 41
Convection Mode	≤ 150P+5,425	≥ 56
Electric		
Operation	**Idle Rate, kW**	**Cooking-Energy Efficiency, %**
Steam Mode	≤ 0.133P+0.6400	≥ 55
Convection Mode	≤ 0.080P+0.4989	≥ 76

Note: P = Pan capacity as defined in Section 1.S, above.

C. Rack Oven Baking-Energy Efficiency and Idle Energy Rate Requirements:

Table 3: Energy Efficiency Requirements for Rack Ovens		
Gas		
Oven Size	**Total Energy Idle Rate, Btu/h**	**Baking-Energy Efficiency, %**
Single	≤ 25,000	≥ 48%
Double	≤ 30,000	≥ 52%

Note:
ENERGY STAR Dataset
EPA has, with the help of stakeholders, assembled a dataset of 9 single rack ovens and 23 double rack ovens. Stakeholders informed EPA that these models reflect the vast majority of models available on the market. Further, EPA has confirmed that a minimum of 4 manufacturers have at least 1 model that meets the proposed requirements and that purchasers will have ample selection of ENERGY STAR models. EPA has included the data plots for each rack oven size on the ENERGY STAR product development website.

During the Draft 1 Version 2.2 Commercial Ovens stakeholder meeting, some attendees suggested removing data points that they did not believe were relevant to the current rack oven market (i.e., not currently available in the U.S. market). However, the majority of the data used to develop both single- and double-size gas rack oven levels are masked; therefore EPA is unable to identify and confirm which models are no longer available in the U.S. market, if any. EPA reached out to industry experts and the primary source of the data, representatives of the Pacific Gas and Electric (PG&E) Food Service Technology Center (FSTC), who confirmed that the few data points under question represent currently available ovens from a number of smaller, independent manufacturers that focus sales efforts in regional U.S. markets. Therefore, EPA has decided to keep these data points in the dataset for purposes of developing the Draft 2 proposed levels, listed in Table 3.

Note Continued:
There was an additional stakeholder concern that some of the models included in the dataset do not currently meet national safety and sanitation standards. EPA agrees that any product sold in the U.S. should have the necessary safety and sanitation certification. For this reason, EPA maintains the requirement, as stated under Section 2.A, above, that all commercial ovens shall be third party certified to NSF/ANSI Standard 4 in order to be considered eligible for ENERGY STAR certification.

Total Idle Energy Rate Metric
In the Draft 1 Version 2.2 of this specification, EPA set idle energy levels based on the gas energy rate. In response, stakeholders voiced concerns that the electric energy rate during an idle test was not being taken into consideration, and that it significantly impacts overall energy consumption of rack ovens. EPA performed an analysis to determine the impact of electric energy rate on the total idle energy rate and confirmed that the auxiliary electrical energy does appear to have a meaningful impact on total idle energy. Fortunately, electric idle energy rates were reported for all of the models listed in the dataset allowing EPA to develop a calculation to convert electric energy into Btu/h, thus generating total idle energy rates. Using this calculation, new total idle energy rate levels are proposed for single- and double-size, gas rack ovens in Table 3. (See Section 3.E for more information and a sample calculation.)

The Draft 2 total idle energy rates are 4,000 Btu/h higher for both single- and double-size rack ovens than the proposed Draft 1 gas-only idle rates. In order to effectively identify the most efficient products based on total idle energy rate, EPA amended the baking-energy efficiency levels from 45% and 54% for single- and double-size rack ovens, respectively, to 48% and 52%. These levels recognize the top 22% single-size and 32% double-size most energy efficient gas rack ovens available in the market and represent models from multiple manufacturers.

EPA is establishing total idle energy levels for rack ovens only. For combination and convection ovens, EPA will continue to require that compliance with idle rate requirements shall be based on gas energy only for purposes of qualifying gas models. When calculating the gas oven idle rates, electric energy consumed by auxiliary components shall not be taken into consideration. However, the total electric energy consumption measured during idle tests shall be reported separately. As such, this proposed move to total idle energy rate for rack ovens will not impact currently certified or ongoing certification of other oven types eligible for ENERGY STAR certification under Version 2.2.

Set-Back Idle Mode Feature
During the stakeholder meeting, manufacturers requested that EPA consider accounting for the benefits associated with low energy features (i.e., set-back modes during long idle periods). EPA is supportive of advanced technologies that contribute to further energy savings and carbon reduction. However, since these functionalities are controlled by the end user, reduced idle energy settings may not be used in the field meaning that savings may not be realized by customers. Furthermore, intermittent use of the oven may prevent it from defaulting into a reduced energy mode, which could also result in potential energy savings not being realized. For purposes of ENERGY STAR certification, the idle rate criteria should be representative of the worst case scenario, as per ASTM F2093-11. Setting idle rate criteria to represent a worst case condition (i.e., maintaining ready-to-bake conditions at 400°F) allows the customer to fairly compare product performance. Therefore, EPA will continue to set idle rate levels based on ready-to-bake conditions. EPA will work with stakeholders to educate end-users about the potential benefits low energy features offer. To encourage customer awareness of this feature, EPA has developed an additional reporting requirement for the qualified products list (QPL) indicating whether a rack oven has an energy-saving set-back mode option. Additional information on this requirement is located below in Section 4.

Note Continued:

Total Annual Energy Metric

One stakeholder recommended EPA consider qualification criteria based on total annual energy consumption rather than idle and baking-energy efficiency levels. While there are industry accepted assumptions that could be used to determine total annual energy, calculating product performance using those assumptions does not yield absolute total energy consumption figures. This may not be representative of how some customers operate their ovens. At this time, EPA does not consider total annual energy to be a better metric than idle and baking-energy efficiency, because the calculated energy savings would be dependent on a set operating schedule than may not be representative of all end users and usage patterns. Thus, the results obtained from calculations using those assumptions could be misleading to the customer. EPA offers buyers a calculator that enables them to assess the energy use of products based on their expected operation. EPA appreciates the intent of the suggestion; however, the agency does not deem it as a suitable requirement for this product category at this time.

Consumer Payback

A stakeholder also inquired about the analysis that EPA conducted to determine customer payback at the proposed levels. EPA used AutoQuotes and various other on-line pricing sources to compare known eligible and non-eligible models to determine if there is a reasonable payback for the customer (ideally less than 5 years). Based on the limited known models in the dataset, in some cases, products that would meet the proposed levels are less expensive than the models that would not meet, effectively making the payback immediate.

Stakeholders are encouraged to provide feedback on the proposed levels in Table 3.

D. Additional Idle Calculation Guidance: Compliance with the Convection Oven and Combination Oven idle rate requirements shall be based on gas energy only for purposes of qualifying gas models. When calculating the gas oven idle rates, electric energy consumed by auxiliary components shall not be taken into consideration. However, the total electric energy consumption measured during idle tests shall be reported separately.

E. Additional Total Idle Calculation Guidance: Compliance with the Rack Oven total idle rate requirements shall be based on gas and electric energy for purposes of qualifying gas models. When calculating the gas rack oven total idle rates, electric energy consumed by auxiliary components shall be converted to Btu/h and added to the gas idle rate expressed in Btu/h. The total electric energy consumption measured during idle tests shall also be reported separately as expressed in kW.

Example: Consider a double-size gas rack oven with a gas idle energy rate of 30,000 Btu/h; and the electric idle energy rate of 1.5 kW. First convert the 1.5 kW electric idle energy rate to Btu/h by multiplying the 1.5 kW by 3,412.142. Then add the result to the 30,000 Btu/h gas idle rate.

1 kW = 3,412.142 Btu/h
Electric idle energy rate, converted to Btu/h: 1.5 kW X 3,412.142 Btu/h = 5,118.213 Btu/h
Total idle energy rate: 30,000 Btu/h + 5,118.213 Btu/h = 35,118.213 Btu/h

Note: Additional Total Idle Calculation Guidance, in Section 3.E, was added to provide instruction on how to determine total idle energy rates. When calculating the gas oven idle rates, the electric energy consumed by auxiliary components (such as, lights, control displays, and motors) shall be converted into Btu/h and added to the gas Btu/h idle rate to calculate the total idle energy rate. Similar to other ENERGY STAR oven categories, EPA also requires that the electric energy idle rate be reported separately to determine total cost of ownership.

EPA encourages stakeholders to provide comments on this conversion and total idle energy rate approach.

F. Significant Digits and Rounding:

a. All calculations shall be carried out with directly measured (unrounded) values. Only the final

result of a calculation shall be rounded.

b. Unless otherwise specified, compliance with specification limits shall be evaluated using exact values without any benefit from rounding.

c. Cooking and Baking-Energy Efficiency: Calculated values that are submitted for reporting on the ENERGY STAR website shall be rounded to the nearest significant digit as expressed in the corresponding specification limit.

d. Idle Energy Rate: Calculated values for gas convection, combination, and rack oven idle rates that are submitted for reporting on the ENERGY STAR website shall be rounded to the nearest whole number. The calculated energy consumption values for electric convection and combination ovens shall be rounded to 0.01 for idle rates.

4) Test Requirements:

A. Representative models shall be selected for testing per the following requirements:

a. For qualification of an individual product model, the representative model shall be equivalent to that which is intended to be marketed and labeled as ENERGY STAR.

b. For qualification of a product family, any model within that product family can be tested and serve as the representative model. When submitting product families, manufacturers continue to be held accountable for any efficiency claims made about their products, including those not tested or for which data was not reported.

B. When testing commercial ovens, the following test methods shall be used to determine ENERGY STAR qualification.

Table 4: Test Methods for ENERGY STAR Qualification

Oven Category	ENERGY STAR Requirement	Test Method Reference
Convection Ovens	Cooking-Energy Efficiency, Idle Energy Rate, and Production Capacity	ASTM F1496-13, *Standard Test Method for Performance of Convection Ovens*
Combination Ovens	Cooking-Energy Efficiency, Idle Energy Rate, Production Capacity, and Water Consumption	ASTM F2861-14, *Standard Test Method for Enhanced Performance of Combination Oven in Various Modes*
Rack Ovens	Baking-Energy Efficiency, Total Idle Energy Rate, and Production Capacity	ASTM F2093-11, *Standard Test Method for Performance of Rack Ovens*

Note: During the stakeholder meeting, manufacturers commented that the current ASTM F2093-11 standard does not factor in the energy absorbed by the racks in the baking-energy efficiency equation. It was recommended that the racks be specified by size and material (e.g., steel versus aluminum) for this test. According to industry experts at the FSTC, the assumption is that food product cannot be baked in a rack oven without a rack and therefore is considered part of the oven's system, even if racks can be acquired separately from a separate manufacturer. EPA is in agreement that the racks should be specified in the test method, and understands that this topic is being considered at the ASTM committee level. EPA will continue to monitor ASTM test method efforts.

C. For ovens with variable Btu/h or kW input, each available input shall be tested and reported individually. Ovens need to meet the idle energy rate or total idle energy rate, and cooking or baking-energy efficiency requirements presented in Table 1, Table 2, or Table 3, of this specification.

D. For electric ovens with multiple voltage-versatility and those that are available in different voltage configurations, the representative oven shall be tested at the most energy consumptive voltage

according to the manufacturer.

E. If the representative combination oven model under test is designed to hold 18 x 26-inch sheet pans, manufacturer-supplied wire racks shall be positioned in the oven to accommodate 12 x 20 x $2^1/_2$-inch steam table pans.

F. Combination ovens with roll-in, removable racks shall have the racks positioned in place during steam mode and convection mode idle tests.

G. For the steam mode idle and cooking-energy efficiency tests, the combination oven shall be manually set to operate at a nominal temperature of 212°F.

H. Additional Reporting Requirements:

a. The average water consumption rates, the average condensate drain temperatures, and the maximum condensate drain temperatures shall be reported for all combination ovens. If the oven does not require condensate cooling water during convection mode operation, then it shall be reported as "0".

b. The production capacity for all convection oven, combination oven, and rack oven cooking or baking-energy efficiency tests shall be reported.

c. The electric energy idle rate for gas convection, combination, and rack oven idle rate tests shall be reported.

d. Rack ovens with an energy saving set-back idle mode feature shall be reported.

Note: EPA has added a new reporting requirement for rack ovens with an energy saving set-back mode in Section 4.H.d. In an effort to promote additional potential energy savings, the ENERGY STAR Qualified Product List (QPL) will indicate if an ENERGY STAR certified rack oven has this energy saving feature. Stakeholders are encouraged to provide feedback on this additional reporting requirement.

5) Effective Date: The ENERGY STAR Commercial Oven Specification effective date is to be determined. To qualify for ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect on the model's date of manufacture. The date of manufacture is specific to each unit and is the date on which a unit is considered to be completely assembled.

Note: EPA plans to finalize the Version 2.2 requirements of this specification in the coming months. Upon finalization of the revision to this specification, manufacturers may immediately begin submitting rack ovens for third party testing and certification under the new Version 2.2.

6) Future Specification Revisions: EPA reserves the right to change the specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. In keeping with current policy, revisions to the specification are arrived at through industry discussions. In the event of a specification revision, please note that ENERGY STAR qualification is not automatically granted for the life of a product model.