Output 2
Testing procedure for electric cooking stoves and assessment of the test facilities

Table of Contents

2 Testing procedure for electric cooking stoves and assessment of the test facilities

The aim of setting up a testing procedure for locally manufactured stoves is to ensure that all appliances subject to the Standard and Labelling (S&L) programme will be tested based on the same criteria and an internationally applied and proven method for consistent comparison. A prerequisite for such comparison is a review of existing testing procedures, clarification of needs and plans of the key stakeholders, assessment of existing capacities and potential needs for adjustment needs, and an overview of the required administrative framework.

2.1 Test procedure – review of existing methods and recommendations for test procedure for Ethiopia

2.1.1 Review of existing international testing methods and procedures

There are several international test methods for the measurement of energy consumption of electric stoves. The test procedures are set for certain heating cycle of liquids. To choose a test procedure suitable for locally manufactured electric stoves in Ethiopia the main attributes are the ease and repeatability of the test.

The following international standard methods are widely used.

- The test method IEC 60350-2:1999 which is based on measurement of energy consumption for heating water in cookware from 15 degrees Celsius to maximum 90 degrees Celsius.
- In case a longer simmering period in cooking is needed to be taken into account, there is a further developed test method IEC 60350-2:2017 (EN 60350-2:2018).
    - This method consists of the heating phase and a longer simmering period. During the simmering period, the temperature of heated water is kept continuously under boiling temperature. To improve energy efficiency and reduce vaporization of water it is beneficial to use a lid on the cookware during testing.
    - Energy efficiency is determined as the energy consumption (Wh) to 1 000 g used water under normalized test conditions, Wh/kg

There are also other testing procedures available.

- Water boiling test (WBT, version 4.2.3) for biomass cooking stoves. The WBT consists of three phases that immediately follow each other.

  1) For the cold-start high-power phase, the tester begins with the stove at room temperature and uses fuel from a pre-weighed bundle of fuel to boil a measured quantity of water in a standard pot. The tester then replaces the boiled water with a fresh pot of ambient-temperature water to perform the second phase.

2) The hot-start high-power phase is conducted after the first phase while stove is still hot. Again, the tester uses fuel from a pre-weighed bundle of fuel to boil a measured quantity of water in a standard pot. Repeating the test with a hot stove helps to identify differences in performance between a stove when it is cold and when it is hot. This is particularly important for stoves with high thermal mass, since these stoves may be kept warm in practice.

3) The simmer phase provides the amount of fuel required to simmer a measured amount of water at just below boiling point for 45 minutes.

- Test procedure in the project document Electric Injera Mitad "Energy Efficiency standards and labelling, EEA".
    - The energy consumption is recorded as the energy consumed during one hour of the baking process and the energy consumption during heat-up time. The energy efficiency is defined as utilized energy divided by the total energy input.
    - The performance test of electric Injera stove is Controlled cooking test (CCT) in Electric Injera Stove efficiency test report. CCT test protocol performs a cook task that is closer to the actual cooking to the local people in their daily livelihood. The energy used in baking is defined as the energy necessary to raise the batter to a particular temperature and evaporate the amount of water that is observed to be lost during the baking process. The efficiency is calculated as utilized energy divided by total energy input.
- Test procedure described in the project document "Locally manufactured electric stoves energy efficiency standards and labelling, Danas, January 2017, pp. 134-135".
    - The water amount 1,5 litre per kilowatt as rated power is heated by 50°C above the initial temperature to the "end" temperature, then water amount 0,75 litre per kilowatt is added and total water is heated again to the end temperature. Thermal efficiency is calculated. The test is repeated with the test vessel rotated 180 degrees relative to the position in the first test. This method is comparable with Indian standard method IS 2994.
- Test method in standard IS 2994 Electric stoves – Specification.
    - This method is comparable with the method in the report "Locally manufactured electric stoves energy efficiency standards and labelling".[1]
- EFCEM´s (European federation of catering equipment manufacturers) procedure of energy efficiency standard for boiling pans (draft).
    - The method is based on water heating by 70 K.
    - Thermal efficiency is calculated in percent.
- Test procedure of the thermal performance test in standard ES 6085:2017 Biomass Cooking stoves and in ES 6086:2017 Biomass baking stoves.

[1] Locally manufactured electric stoves energy efficiency standards and labelling, Danas, January 2017", pp. 134-135.

    - The water is heated to the boiling temperature and then water is kept on the temperature interval during 45 min simmering phase.
    - The cooking thermal efficiency is calculated.
- Eco design for domestic ovens, hobs and range hoods / European Commission Regulation N:o 66/2014 (14th January 2014).
    - The maximum energy consumption limit for electric hobs is determined in watthours per kg used water heated in a normalized measurement under standardised test conditions. The background document "LOT 22 Domestic and commercial ovens, refers to the standard EN 60350:2009 (1999), Task 1 Definition".
- EPA Energy star. Product specification for commercial ovens, Eligibility criteria version 2.1.
    - The specification is only for commercial ovens, not valid for domestic ovens.

These test procedures are summarized in the following table (table 1). The test procedures are available in reference publications.

Table 1. Different test procedures of energy consumption for electric or biomass stoves.

IEC 60350:1999
IEC 60350-2:2017/EN 60250-2:2018
Water boiling test, version 4.2.3 (Biomass Cooking stoves)
Project document Electric Injera Mitad - Energy Efficiency standards and labelling, EEA
Electric Injera Stove efficiency test report, Controlled Cooking Test (CCT) (chapter 4)
Project document for Locally manufactured electric stoves - Energy efficiency standards and labelling, Danas, January 2017 pp. 134-135, testing procedures
Indian standard IS 2994: Electric stoves
EFCEM (European federation of catering equipment manufacturers): Energy Efficiency Standard for boiling pans (Draft)
Ethiopian standard ES 6085:2017. Improved Biomass Cooking stoves – Performance requirements and test methods for household biomass cooking stoves
Ethiopian standard ES 6086:2017. Biomass baking stoves – Performance requirements and test methods for household biomass baking stove.
Ecodesign for domestic ovens, hobs and range hoods / European Commission regulation N:o 66/2014 (14th January 2014)
EPA Energy Star, Product specification for commercial ovens, Eligibility criteria version 2.1

2.2 Assessment of the testing facility

2.2.1 Testing and test equipment

The Laboratory under the Ministry of Water Irrigation and Electricity (MoWIE) is conducting tests on appliances in Ethiopia. The lab has certain testing equipment and instruments available for testing of energy consumption of local electric stoves and it has generally good experience and competence for conducting appliance and product tests.

Testing equipment for measuring of energy consumption for electrical stoves in the Lab are e.g.:

- Digital energy meter, model. Energy meter can register energy use (Wh), voltage (V), current (A), time (sec), power (W)
- Temperature meters, thermocouples
- Non-metallic holder fixture for thermocouple (this shall be constructed for measurements)
- Digital scale (for weighing)
- Air pressure meter
- Cookware, saucepan diameter 22 cm for pre-test
- Non-metallic mixer (this shall be organised for measurements)

The used equipment is assessed to be sufficient for testing electric stoves according to the proposed test procedure in the chapter 2.4. (Due to scheduling difficulties, the cataloguing of the test equipment in the lab could not be conducted during the pre-test phase, as planned).

The laboratory has also a workshop for developing and constructing the testing apparatus.

The measuring and test equipment should comply with requirements of the IEC 61010 series of standards (Safety requirements for electrical measuring equipment for measurement, control and laboratory use).

Findings on assessment of testing and test equipment:

- The Energy lab has basic testing equipment which only makes conducting tests possible with data taken manually by the person during the test period.
- Limited number of equipment to perform several tests in parallel – if series of tests are to be conducted in a number of stoves on a regular basis, this will delay test result notification time.
- Lack of certain equipment such as data loggers make testing prone to error (missing data while recording manually). This becomes more critical when tests are being conducted by a single person.
- Currently, the Energy Lab suffers from shortage of stove testing experts.
- It is necessary for the Energy Lab to acquire better testing equipment with the capability of data storage (data loggers) so that it will avoid the need to manually record equipment readings on a paper. The number of such testing equipment should also be increased so that multiple tests can be run in parallel so that the Energy Lab would be able to efficiently utilize its limited experts to conduct series of tests as a continuous quality monitoring and approval process for the implementation of MEPS.

2.2.2 Electrical safety of testing at the laboratory

Test and measuring equipment[2]

- The measuring and test equipment should comply with requirements of the IEC 61010 series of standards
- In normal use of the measuring equipment should not expose the person doing the testing or other individuals to unacceptable RISKS.
- The accuracy of the measuring functions within the range marked or declared by the measuring equipment manufacturer should be specified in test data sheet.
- The measuring equipment used for the tests should be tested and calibrated according to the reference standards (e.g. voltage, current, impedance) used by the equipment for calibrating measuring and test equipment should be certified and traceable national standards. This ensures that the integrity of calibration accuracy and compliance with IEC/ISO 17025 is respected
- For the tests, protective earth connections may be interrupted in the measuring devices, if protection against electric shock is guaranteed by another means of IEC 61010-1.
- It is recommended to use dedicated test equipment (e.g. dielectric withstand tester, ground bonding and continuity tester, etc.).
- The test equipment should be capable of providing all voltages and currents needed

Preliminary conditions of test facilities or devices[3]

The users of the laboratory equipment must understand how important laboratory personnel checks are. Some equipment and environments may demand special needs; thus, the following checklist should be respected.

1. Check the overall condition of the equipment,

2. Check the supply cable, connection devices, etc.

3. Check if they have valid label indicating it has been formally inspected and calibrated

4. Check the facility is suitable for the environment.

5. Check the plug and make sure the cable is securely gripped and there is no mechanical damage.

6. Check that the ground connecters have not been removed.

[2] Locally manufactured electric stoves energy efficiency standards and labelling, Danas, January 2017, pp. 130.

[3] Locally manufactured electric stoves energy efficiency standards and labelling, Danas, January 2017, pp. 130-131.

7. Check the socket outlet to make sure there are no signs of damage or overheating.

8. Check that the facility is working correctly as expected. If the standard test precondition is not fulfilled, then following test should not be continued, then

1. Switch off the power and disconnect the sample from the supply.
2. Clearly label to identify that it must not be used.
3. Report to the appropriate responsible person.

This type of inspection should only be carried out by a competent person as defined by the laboratory instruction manual before starting active tests.

Safety requirements [4]

The electric stoves shall comply with the requirements as given in clause 8 to clause 32 of IEC 60335-1 except for clauses 9, 14, 17 and 32. The measurement and test equipment should be selected so that the test operator cannot be accidentally subjected to hazardous voltages and currents such as those used for a dielectric strength test, and protective earthing continuity test. It is recommended to use measurement and test equipment which includes safety interlocks which provide protection by automatically shutting down the VOLTAGE whenever a safety or emergency switch is ON.

Before commencement of the tests, the electric stoves shall be visually examined and inspected for obvious visual defects in respect of components parts and their assembly construction, stability, marking, provision of suitable terminals for supply connection, earthing and the effectiveness of screws and connections. The external surface finish shall be even and free from finishing defects.

Sequence of tests

Unless stated otherwise, the tests are to be sequenced in such a way, that the results of any test do not influence the results of other tests. Tests should, if applicable, be performed in the sequence, unless otherwise stated by this particular standard.

- Durability and legibility of marking
- Mains Terminal Cord physical dimension
- Impedance of PE connection
- Dielectric strength of mains leads cable
- Creepage distances and Air Clearances
- Heating Element Parameter Determination
- Power requirement of the Electrical Stove
- Determination of working voltage, current or energy
- Earth Leakage Current
- Protective Conductor/Touch Current measurement

[4] Locally manufactured electric stoves energy efficiency standards and labelling, Danas, January 2017, pp. 130, 133.

- Load test performance
- Operational temperature parameters determination

Alternatively, the electrical testing shall follow instructions described in the appendix 6 "Electrical Injera Mitad testing procedure" and appendix 7 "Testing facility and existing relevant standards" on the document "Energy efficiency standards and labelling – Project document for Injera Mitad".[5]

2.2.3 Review of availability and condition of the required test equipment

The Motiva project team visited the Laboratory (MoWIE) in September 2018 and discussed the testing of the electric stoves with the Laboratory management. In the laboratory testing room, the available testing equipment and some tested local electric stoves were shown. It was assessed that testing equipment, as shown above in the chapter "Testing and test equipment", is feasible for testing of energy consumption of local electric stoves.

However, the testing equipment are basic and few in number making the test process cumbersome and error prone as data is manually recorded by the experts. Additionally, only one cookstove can be tested at a time as the number because of limitation of the number of equipment and experts to conduct the tests. This will be one of the major limitations of the Energy Lab as it plans to conduct several tests on a regular basis to determine the performance of electric cookstoves available in the marketplace. Regular calibration of test equipment by a licensed agency would also be required to improve the credibility of the test results that would be published by the Energy Lab.

With regard to the set-up of the Energy Lab testing platform, a more standardized setting would be needed to make sure that all electrical fittings, connections and wiring are of the required standard and are properly fixed. Such practice will ensure implementation of electrical safety in the Energy Lab so that personnel doing the test and testing equipment are protected from possible electrical hazards.

2.2.4 Expertise of the testing personal

The tests are to be performed with qualified personnel who have the knowledge, experience, and acquaintance with the relevant technologies and regulations. The personnel shall be able to assess safety and be able to recognize possible consequences and hazards arising from non-conforming stoves.

- The testing personnel in the Energy Lab have many years of experience with testing of electrical and biomass stoves and household appliances. However, the number of the testing personnel available in the Energy Lab is dwindling every time and by the time the pre-test was conducted only one electrical engineer was available for the whole Energy Lab facility.

[5] Energy efficiency standards and labelling – Project document for Injera Mitad, EEA, 2015

To update expertise of the personnel a "Product Test Certificate" for the personnel of the testing labs should be developed. Certification scheme should include a set training material and exam validated by MoWIE. Certification would be acquired through annual training session closing with an exam.

Findings on assessment of testing personnel:

- There is are qualified personnel with knowledge, experience, and acquaintance with the relevant technologies and regulations working in the lab.
- The personnel are able to assess safety and be able to recognize possible consequences and hazards arising from non-conforming stoves.
- The Energy Lab has capable but very few experts: more personnel would be needed as the standards and labelling programme begins so as to meet the demand for testing.

2.2.5 Checklist of operationalization of the testing laboratory

See Annex 1 and Annex 3.

2.3 Quality assurance for testing laboratory

Quality requirements at the laboratory are fulfilled according to the requirements of the EEA. There is still a need to focus more to the quality system.

It is recommended that the quality assurance for performance testing of electrical cooking stoves is developed in phases starting with the basic ISO quality management system and moving forward to the level of international accreditation.

There are international quality systems and standards available:

The standard ISO 9001 (2015) Quality Management Systems is applicable to all types of companies in all industries for certified quality assurance of the operation system.

For testing laboratories there is the international accreditation requirement according to the standard ISO/IEC 17025 (2017) "General requirements for the competence of testing and calibration laboratories". The accreditation is granted against the specific test standard or test method. The accreditation of testing laboratory indicates that the testing lab produces reliable results with testing methods which are included in the accredited competence area. The operation system of the accredited testing laboratory corresponds the requirements of the operating system according to the ISO 9001.

The differences between ISO 17025 and ISO 9001 are due to the applicability of the standards. ISO 9001 is applicable to all types of companies in all industries, whereas ISO 17025 is only applicable to testing and calibration laboratories in any industry. Because of this, the requirements of ISO 9001 are very generic so that they can be applied in different industries, while the requirements of ISO 17025 are very specific about what you need to implement in testing or calibration laboratories.

The general requirements of ISO 9001 on resources and processes are general for any industry, whereas ISO 17025 tells you what resources you need and how each process should be done in a testing or calibration laboratory.

The testing laboratory must perform testing in a competent manner. The laboratory/test institution must be impartial and competent.

2.3.1 Recommendation for development of the quality assurance system of the testing facility

Assuming the test laboratory is aiming to achieve an international accreditation as a testing laboratory, it is recommended to develop the quality assurance system in stages.

- It should be reasonable for better quality assurance that the laboratory at the first stage will acquire the certified quality assurance system encompassing testing operation system according to the standard ISO 9001 Quality Management Systems. ISO 9001 is

directly audited against for third party assessment purposes. Contents of ISO 9001:2015 are as follows:[6]

- Section 1: Scope
- Section 2: Normative references
- Section 3: Terms and definitions
- Section 4: Context of the organization
- Section 5: Leadership
- Section 6: Planning
- Section 7: Support
- Section 8: Operation
- Section 9: Performance evaluation
- Section 10: Continual Improvement

ISO 9001 (2015) requires the organization to document any other procedures required for its effective operation. The standard also requires the organization to issue and communicate a documented quality policy, a quality management system scope, and quality objectives. The standard no longer requires compliant organizations to issue a formal Quality Manual. The standard does require retention of numerous records, as specified throughout the standard. There is a requirement for an organization to assess risks and opportunities (section 6.1) and to determine internal and external issues relevant to its purpose and strategic direction (section 4.1). The organization must demonstrate how the standard's requirements are being met, while the external auditor's role is to determine the quality management system's effectiveness.

- For the second stage, it is recommended for the testing laboratory to develop the quality assurance system further according to the general requirements contained in standard EN ISO/IEC 17025 "General requirements for the competence of testing and calibration laboratories".

  The ISO IEC 17025[7] comprises of the following elements: Scope, Normative References, Terms and Definitions, General Requirements, Structural Requirements, Resource Requirements, Process Requirements, and Management System Requirements.

  General Requirements and Structural Requirements are related to the organization of the laboratory itself.

  - Structural Requirements cite those issues related to the people, plant and other organizations used by the laboratory to produce its technically valid results.
  - Process Requirements are the heart of this version of the standard in describing the activities to ensure that results are based on accepted science and aimed at technical validity.

[6] Wikipedia ISO 9000: https://en.wikipedia.org/wiki/ISO_9000
[7] Wikipedia ISO/IEC 17025: https://en.wikipedia.org/wiki/ISO/IEC_17025

- Management System Requirements are those steps taken by the organization to give itself tools quality management system[8] in supporting the work of its people in the production of technically valid results.

- In the future at the third stage, it is recommended that the laboratory will acquire the official accreditation by the accrediting organization according to ISO/IEC 17025 against the testing standard IEC 60350-2:2017 or the specified method presented in appendix 3.

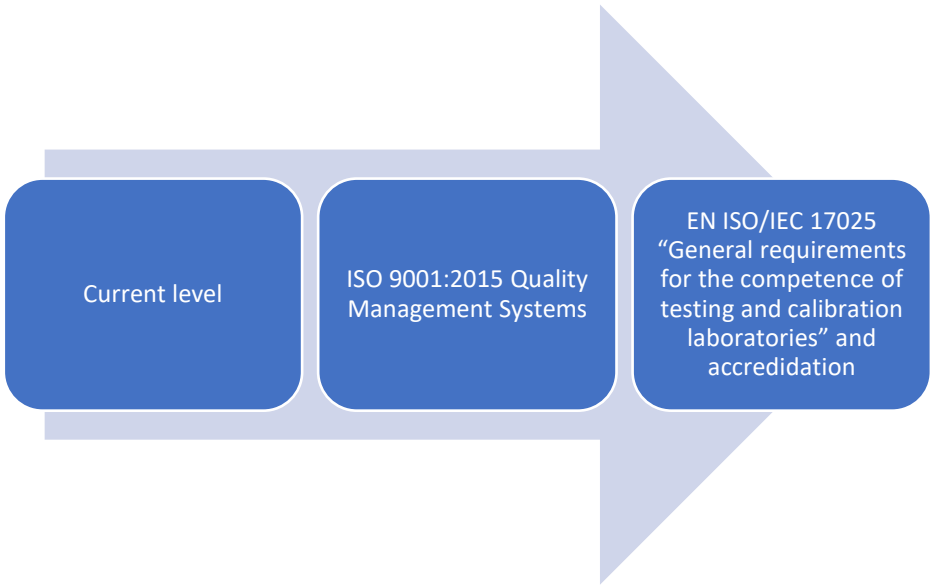

Figure 1. Development stages of the testing facility

[8] https://en.wikipedia.org/wiki/Quality_management_system

2.4 The testing procedure for Ethiopia, recommendation

The testing of locally manufactured stoves is recommended to proceed in two phases. In the first phase, the testing procedure will adhere to the modified testing procedure developed for the pre-test. In the second phase, the testing should be done according to the procedure depicted in annex 3.

The proposed test method for locally manufactures electric stoves is modified from the standard method IEC 60350:1999 and 2017 as well as water boiling test. This method was evaluated to be best suited for the local products and actual facility of the test laboratory.

Test procedure for the pre-test is shown in annex 1, in chapters 1-6. The recommendation was done based on the pre-test and its findings. The specified simmering time shall be 45 min.

Testing procedure for electric cookstoves for Ethiopia, recommendation:

- Cold start test with High Power and Simmering Phases (No Hot Start)
- Cooking or boiling typical food in most part of Ethiopia takes about 1 hour including simmering
- Cold start test is conservative estimation of the performance of the stove
- 45 minutes simmering – most foods are simmered for 30 to 45 minutes
    - This is an equivalent task in the procedure for biomass stoves testing which makes comparison of cost of cooking with different energy sources possible.

2.4.1 Description of the test procedure

The purpose of the testing procedure and test method is to determine the energy consumption of stoves for heating up a defined water load to boiling temperature and keeping it at a defined temperature level representing a simmering phase in cooking.

The testing procedure includes the requirements for

- testing equipment,
- testing conditions,
- testing process
- test results
- pre-test instruction, and
- documentation format of test report.

2.4.2 Requirements for manufacturers / producers:

Compliance testing for MEPS / product certification:

Manufacturers are required to provide at least two product samples of the same model of electric cooking stove for performance testing. The samples will be collected by the EEA or the organisation delegated by the EEA. The samples will be selected according to the agreement by EEA and the producer/manufacturer. (More on mandatory compliance and market surveillance procedures in part 3 MEPS and energy labelling).

Performance test of electrical cooking stoves at the testing laboratory is based on the developed testing procedure for locally manufactured electric stoves "Testing procedure for locally manufactured electrical cooking stoves in Ethiopia - phase 1 pre-test" (annex 1).

2.4.3 Requirements for testing safety of products, recommendation

Design and production of electrical cooking stoves shall ensure that the following safety requirements are met (following the criteria in 2.4.3.1):

- Sharp edges and points present on the exterior surfaces shall not catch or tear any article of clothing or cut hands during normal use.
- Outside surface temperature of the stove's body must meet requirements.
- Stability of the Cookstove during operation;
    - Cook stove shall be stable enough to maintain an upright orientation when in operation. A cooking stove shall come back to rest upright position after being lightly tipped from its regular resting position.
- Electrical safety – earthing, appropriate electrical components (i.e. cable size, plugs) must be tested.

2.4.3.1 Safety and Functionality Evaluation Criteria

The criteria for safety and functionality assessment for electrical cookstoves are based on physical inspections. The criteria for safety and functionality assessment will be evaluated as High, Medium, Low, Minimum having associated values of 4, 3, 2 and 1 respectively.

Table 2. Assessment Criteria

No.	Criteria Group	Criteria	Rank Range (1 to 4)	Ranked
1	Stove Safety	Stability	Yes or No	
3		Handling	High/Medium/Low/Minimum	
4		Surface Temperature	High/Medium/Low/Minimum	
6		Sharp Edges/Points	High/Medium/Low/Minimum	
9		Power Control/ regulation	High/Medium/Low/Minimum	
11		Rated Power	Yes or No	
12	Stove Design and components	Electrical Safety & Durability	High/Medium/Low/Minimum	
13		Aesthetics	High/Medium/Low/Minimum	

Ranking: High/Very Good = 4; Medium/Good = 3; Low = 2; Minimal/Poor =1;

Most of these criteria are taken from Biomass Safety Protocol Guideline developed by Nathan G. Johnson from Iowa State University. They have been used to test many stoves, and are generally accepted by most folks working with improved cook stoves as a fair assessment.

Criteria for safety and functionality assessment

- Stability – the tendency of the stove to fall down due to actions performed during operation; while stirring the food, accidental pushes, etc,
- Handling – portability, size,
- Surface Temperature –any surface of the stove body touchable during cooking should not be hotter than that can be touched (including the handles),
- Sharp Edges/Points – that can cause cuts while handling the stove,
- Power Control/regulation – Is there ON/OFF switch, how smooth is power controlling
- Power rating – The rated power of the stove and its compatibility for the required purposes. This helps to categorize the stove so that the size of the cooking pan and the volume of water for testing would be determined accordingly.
- Electrical safety and Durability – quality and durability of the cookstove parts includes the workmanship, the material and components used for the manufacturing of the stove, how well they are fixed, availability of earthing to avoid electrical shocks, etc.
- Aesthetics – the attractiveness of the stove.

2.4.4 Testing procedure in the future

In the future, when the locally manufactured stoves have developed and have better energy efficiency and better power control possibilities, it is possible to use more accurate testing methods and developed testing facility. At that point it is recommended that the testing be done according to the test procedure for phase 2, annex 3.

Annex 1
The recommended test method and testing procedure for locally manufactured cooking stoves in Ethiopia (phase 1, used for pre-test in January and in April 2019)

The test procedure is developed with the background information about the standard methods IEC 60350:1999 and 2017 as well as the water boiling test. This method is evaluated to be best suitable for the local products and actual facility of the test laboratory.

The pre-test will be conducted on about ten electric stoves on the market. The main aim of the test is to gather information on the energy consumption of the tested electric stoves.

This document consists of the test procedure and test instructions for the Lab with reporting instructions for test results.

All references within this Annex 1 point to parts of the Annex 1, not to other documents or parts of the whole report.

The purpose

The purpose is to determine the energy consumption of stoves for heating up a defined water load to boiling temperature and keep it at a defined temperature level for representing a simmering phase in cooking.

Heating up and keeping the temperature for a defined period represents a typical household cooking process. Additionally, the quality of the control is measured by keeping an amount of water at a defined temperature as exactly as possible.

The Pre-test

The simmering time of 20 min represents an average household cooking duration in the standard. Additionally, at least 20 min further simmering time is necessary to assess the quality of a control that influences the energy consumption.

To better depict the local cooking habits, it is deemed necessary to have 45 min simmering phase.

- In the standard from 2017 the simmering time is set for 20 min. It is possible to change the simmering time e.g. to 45 min. Energy consumption under 20 min simmering phase is lower compared to the heating phase. Energy consumption with 20 min simmering time compared to 45 min simmering would be reasonably accurate. Because the time for testing in the Lab is limited, in some pre-test the simmering period was with the 20-minute simmering time compared to the 45-min simmering in the pre-test.

1 Definitions (in standard IEC 60350-2:1999)

cooking range;
appliance having a hob and at least one oven. It may incorporate a grill.

hob;
appliance or part of an appliance which incorporates one or more cooking zones

cooking zone;
part of the hob or area marked on the surface of a hob on which pans are placed for heating

hotplate;
part attached to the surface of a hob which forms a cooking zone

solid hotplate;
hotplate having a closed surface which is usually constructed from east iron with an integrated heating element

tubular hotplate;
hotplate having a surface which is formed by the configuration of a tubular sheathed heating element in a substantially flat plane.

glass ceramic hob;
hob in which the heating elements are located beneath a glass ceramic surface

induction cooking zone;
cooking zone on which the pan is heated by means of eddy currents

See footnote for notes[9]

[9] *NOTE 1- A hob is also known as a cooktop.*

NOTE 2 - The eddy currents are induced in the bottom of the pan by the electromagnetic field of a coil.

NOTE 3 - The hob surface may be of glass ceramic.

2 Dimensions of stoves (with hotplates and cooking zones)

The main dimensions of hotplates and cooking zones are determined as follows

- for solid hotplates, the diameter of the surface intended to come into direct contact with the bottom of saucepans is measured;
- for tubular hotplates, the diameter of the smallest periphery excluding any lead-in section is measured;
- for glass ceramic hobs, the diameters of the cooking zones are measured

The dimensions are indicated in millimetres rounded to the nearest 1 mm.

Mass of the appliance (stove)
The mass of the appliance, including accessories, is determined and expressed in grams, rounded to the nearest gram.

3 List of measurements

The performance of the appliance is determined by the tests listed in 3.1.

3.1 Stoves with cooking zones

The following tests are carried out:

- water heating to the boiling temperature (see 6.1);
- low power heating (simmering) (see 6.2)
- calculation for the result of the stove (see 6.3)

4 General conditions for the measurements

Unless otherwise specified, the measurements are made under the following conditions.

4.1 Test room

The tests are carried out in a substantially draught-free room in which the ambient temperature is maintained at 20 °C ± 5 °C.

4.2 Voltage

The appliance is supplied at rated voltage, 220 V ± 5 Volt.

- This voltage is based on the voltage range used for previous tests in the Lab.

If the appliance has a rated voltage range; the tests are carried out at the nominal voltage of the country where the appliance is intended to be used.

4.3 Instrumentation

The temperature measuring instrument including thermocouples shall have an accuracy of 0,5 K within the temperature range of 0°C to 100°C.

The energy measuring meter shall have an accuracy of 1 %.

4.4 Positioning the appliance

Table-top appliances are positioned away from side walls.

4.5 Setting of controls

The control is set to give the temperature specified for the test.

However, if the temperature cannot be attained due to the construction of the control, the nearest setting related to the specified temperature is chosen.

5 Specifications

5.1 Specifications of the saucepan

The saucepan is made of low carbon steel having a maximum carbon content of 0,08 %.

It is cylindrical without metallic handles or protrusions.

The maximum concavity of the base of the saucepan is to be not more than 0,006 a, where a is the diameter of the flat area at the base of the saucepan.

The size of saucepan shall match the size of the cooking zone as well as possible. However, it may vary by a maximum of +20 mm and −10 mm.

For determining the size of the saucepan, the outer diameter of the flat bottom of the saucepan/ (a) is measured.

Saucepan sizes are shown in table below. Saucepan for pre-test is fitted with holder for thermometer without lid. The temperature sensor is positioned in the middle of saucepan on the level 15 mm above the inner saucepan bottom.

NOTE 1 - The fixture is adapted to accommodate a stirrer.

NOTE 2 - The base of the saucepan shall not to be convex for flat cooking area.

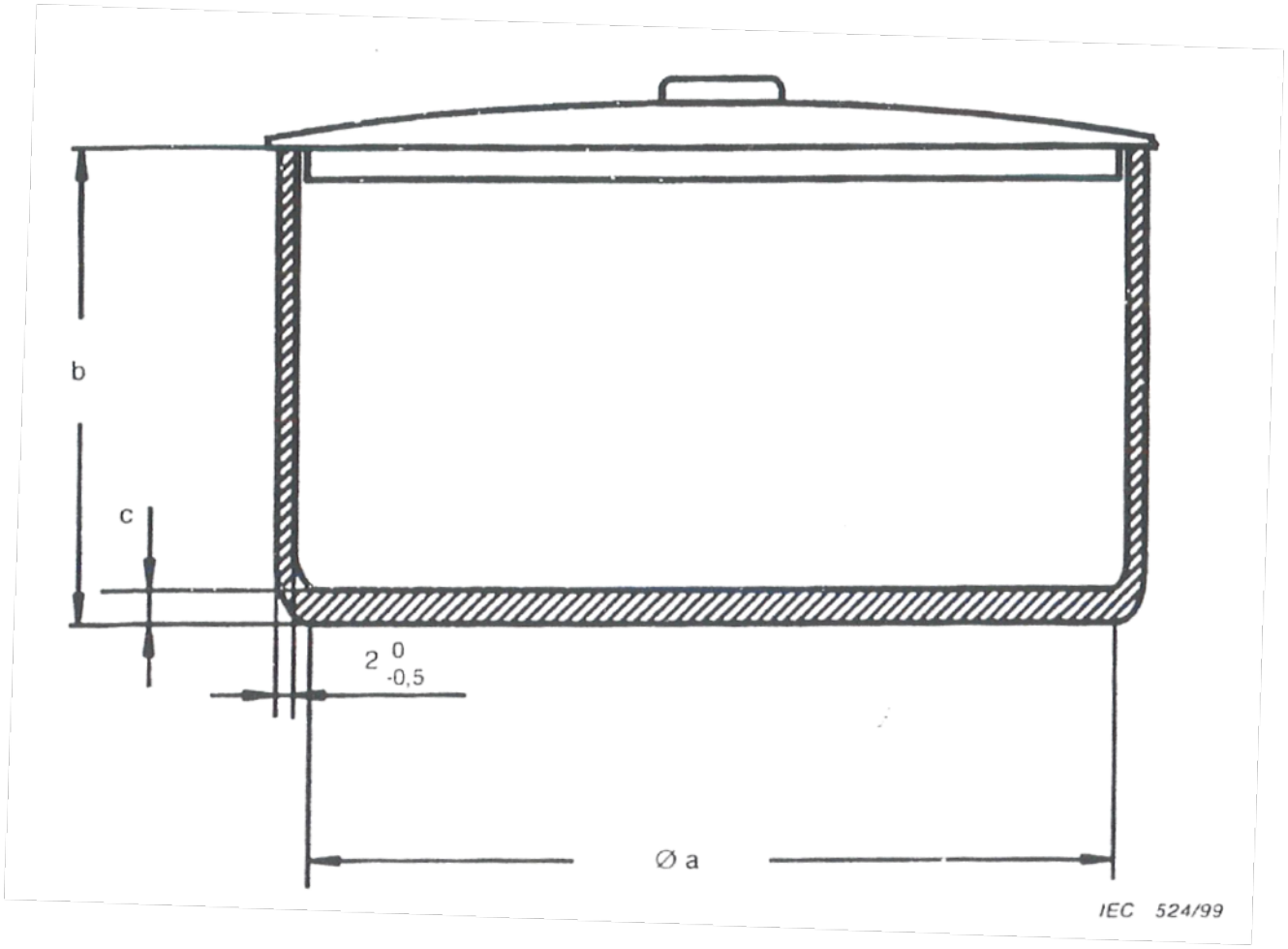

Figure 1 Saucepan specifications The several sizes of cooking zones and saucepans (according to the standard 2017) are better representing for stoves on the market than a few (three) sizes (according to the standard 1999).

Table 1 Saucepan dimensions

Diameter of cooking zone Mm	Diameter of the saucepan bottom (a outside) Mm	Height of the saucepan (b outside) Mm
≥100<130	120	125
≥130<160	150	125
≥160<190	180	125
≥190<220	210	125
≥220<250	240	125
≥250<280	270	125
≥280<310	300	125
≥310<330	330	125

6 Testing process for locally manufactured stoves (measurements)

Measuring the energy consumption

The test is performed three times (the stove is tested only with one saucepan piece.)

6.1 Water heating to the boiling temperature (High power heating)

A steel saucepan is used for the test, as specified in 5 Specifications, figure 1.

The saucepan is filled with the quantity of potable water specified in table 2.

The water has a temperature of 20 °C ± 1 °C.

The saucepan with the fixture of thermometer is positioned centrally on the cooking zone. The fixture for the thermometer is used and sensor is placed on the centre of the pot and 15 mm from the inner bottom of the saucepan. See footnote for notes[10]

Table 2 - Quantity of water in the saucepan The several sizes of cooking zones and saucepans (according to the standard 2017) are better representing for stoves on the market than a few (three) sizes (according to the standard 1999).

Diameter of cooking zone Mm	Quantity of water *gram*
≥100<130	650
≥130<160	1030
≥160<190	1500
≥190<220	2050
≥220<250	2700
≥250<280	3420
≥280<310	4240

10

NOTE 1 - This test Is applicable tor comparative testing only.

NOTE 2 - In order to prevent distortion of the base, a saucepan with sidewalls glued to the base by silicon-rubber may be used for heating water.

NOTE 3 - Commercially available saucepans which have equivalent thermal and mechanical properties may be used.

NOTE 4 - For non-circular cooking zones, an appropriately shaped saucepan may be used.

≥310<330	5140

The cooking zone is heated with the control set at maximum.
During the test the water is stirred continuously with the aid of a non-metallic stirrer.
The time taken for the water temperature to rise to the local pre-determined boiling temperature and for continuous heating for simmering phase and the corresponding energy consumption are measured.

The time is stated in minutes and seconds.

The energy consumption is expressed in watt-hours.

6.2 Low power heating (simmering)

A simmering phase is 45 minutes.

During the simmering phase the water temperature shall be recorded every 60 seconds.

The water temperature shall not drop more than 6 °C below the boiling temperature.

The cooking zone is heated with the in keeping control set at the level within water temperature requirement.

During the test the water is stirred continuously with the aid of a non-metallic stirrer.

The time taken for the water temperature control within 6 °C below the local boiling temperature for continuous heating for simmering phase and the corresponding energy consumption are measured.

The time is stated in minutes and seconds.

The energy consumption is expressed in watt-hours.

The test with water heating (6.1) and simmering (6.2) is performed three times (the stove is tested only with one saucepan piece.) The test is repeated with the pan turned through 90°. The average value of the three results is determined.

6.3 Calculation of the result for a stove

The energy consumption for cooking stove shall be noted with the saucepan size under the test normalized to 1 000 g. The result of each saucepan is normalised to 1 000 g of water; the energy consumption is divided by the quantity of water used for the saucepan under test.

- This is the measure for energy consumption which is comparable for different sizes of cooking stoves (it is given in 2017 standard)

7 Test results

Test report should include the following per tested stove (appendix 1):

- Date/time of test
- Manufacturer / Brand
- Model/Name/Serial number
- Power rating / Rated power proclaimed by manufacturer (if available)
- Material, weight and dimensions of appliance (see part 2)
- Test conditions (see part 4), if differ from baseline
- Type of switch/regulator
- Photo for the stove
- Test data (see part 6)

The test results can be reported on the test data sheet of test results for energy consumption of cooking process.

Data sheet for testing, original document in excel form

Data for stoves in test

The data for stoves in test will be summarized in the following table. In pre-test shall be stoves with 22 cm cooking zones measured.

Stove	Manufacturer (Name, Brand)	Model, type (e.g. SF-04, single open resistor)	Material (e.g. steel, ...)	Dimensions/Diameter of cooking zone (mm)	Weight,g (e.g.2100 g)	Rated power, W	Switch, regulator (e.g. On/Off)	Photo (x) Photos added to separate file/sheet, label with stove number)
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

8 Pre-test instructions for the Lab

8.1 Preparation for test

General

For measuring the energy consumption, a saucepan with diameter variable between 150 mm shall be used for diameter 150 mm cooking zone of stove and 240 mm shall be used for diameter 220 mm cooking zone of stoves according to the table 1 in the section 5.1.

The empty saucepan is filled with the quantity of portable water quantity between 1030 grams and 2700 grams according to the table 2 in section 6.1.

The stove and the determined saucepan shall be at ambient temperature.

8.2 Preparation before start of testing

Prepare fixture for hold of thermometer.

Measure and record ambient air temperature.

Determine the local boiling temperature of water. The boiling temperature is the temperature where water is boiling at the stabilized temperature with small different.

Before the first test is taken, operate a cooking stove with determined water amount for at least 10 min at maximum setting. This is only necessary once to make sure that residual water in the components is vaporized. Afterwards, cool down the stove to approximately ambient temperature before starting measuring the energy consumption.

Preparation for testing

- Measure and record the ambient air temperature.
- Record dry weight of the pot (g).
- Weigh the determined water amount G1 and pour water to the pot.
- Place the saucepan without lid centrally on the stove.
- Using the fixture for the thermometer, place thermometer in the centre of the pot and 15 mm from the bottom of the pot.
- Stir the water is to ensure a uniform temperature and measure the temperature of the water when the average temperature of saucepan and water has stabilized. The initial water temperature (T1) shall be in the range of 20 °C ± 1 °C.
- Measure and record the initial water temperature in the pot.

High power heating (HP)

- Start stove heating. Set the control is set to maximum power and start the measurement immediately.
- Start the timer and record the starting time (t1).
- Start the energy meter and record energy consumption (Watthours).
- When the water reaches the pre-determined local boiling temperature record the time (t2) and this temperature (T2).

- With boiling test weigh and record water amount from the pot. Weigh the pot with its water. A loss of water is assessed to be vaporized during the test.
- Record the energy consumption E2.

Low power heating (LP) (simmering)

A simmering phase is 20 or 45 minutes.

- During the simmering phase record the water temperature every 60 seconds.
- Check that the water temperature does not drop below 6 °C below the boiling temperature.
- End the test on 20 or 45 minutes, record the time t3 and temperature T3.
- Weigh and record the water mass in the pot (G3). Do not weigh the pot with its water.
- Record the vaporized water mass (G3-G1).
- Record the energy consumption (Watthours) at the end of test E3.
- Measure and record ambient air temperature at the end of the test.

Perform the test with water heating phase (HP) and low power phase (LP) only once in pre-test.

Calculation and report of the result for a stove

- Note the energy consumption (E3) per cooking stove with the saucepan size under the test normalized to 1 000 g. The result of each saucepan is normalised to 1 000 g of water.
- Divide the energy consumption by the quantity of water used for the saucepan under test.

Annex 2
Results on the pre-test conducted in January 2019

Pre-test of electrical cooking stoves

To ascertain that the test method was suited for testing locally manufactured stoves in the local test laboratory, a pre-test was conducted in January 2019 (using pre-test procedure detailed in Annex 1). The pre-test was designed to be conducted with ten electric stoves on the market.

Due to scheduling difficulties the pre-test was only partially conducted in January and continued in April. Only four stoves were initially tested. To gain more information, albeit not in testing conditions, the Swan Management local team tested one appliance and created a hypothetical example of one appliance based on calculations.

Pre-test results

The pre-test shows the energy consumption of the tested electric stoves. Energy efficiency is described in terms of energy consumption per kilograms of heated water used in test (in Watthours per kg water).

The pre-test results are used to define requirement levels for the minimum energy performance standard and the energy label for locally manufactured stoves. As only a few stoves were tested, these results are used cautiously to have some basis for setting up the efficiency level for MEPS and energy efficiency tiers for energy labelling classes. For actual MEPS and energy label classes more testing should be conducted to have a wider data set.

The tested locally manufactured electric stoves are shown in table 1a. The results of the pre-test are shown in table 1b. Analysis of the test data is shown in table 2.

Table 1a Locally manufactured stoves in pre-test

Locally Manufactured Electric Cookstoves Test
Description of Stoves, Pot Dimenstion and Amount of Water

No.	Manufacturer/ Brand	Model/ Type	Material	Diameter of cooking zone (mm)	Weight of stove (g)	Rated Power (W)	Switch, regulator	Pot size (mm)	Pot height (mm)	Amount of water (g)
1	Gogle	Large single pot	Mild steel cladded fired clay	200	3378	1420	On/Off	210	125	2050
2	Admass	Large single pot	Mild steel cladded fired clay	220	2414	1480	On/Off	210	125	2050
3	A&H	Large single pot	Mild steel cladded fired clay	198	3460	1440	On/Off	210	125	2050
4	Local 1	Large single pot	Mild steel cladded fired clay	220	2480	1430	On/Off	240	125	2700
5	Damas	Large single pot	Mild steel cladded fired clay	195	2176	1040	On/Off	210	125	2050
6	Local 2	Medium singel pot	Mild steel cladded fired clay	150	1857	840	None	150	125	1030

Table 1b. Results of the pre-test and added examples.

			Tests Conducted in the Energy Lab (2.1.2019 and 2.4.2019)					
	Date	**Date**	**2.1.2019**	**2.1.2019**	**2.1.2019**	**2.1.2019**	**2.4.2019**	**2.4.2019**
	Test No.	**No.**	1	2	3	4	5	6
	Name of Stove	**Name**	Gogle SP1.4	Gogle SP1.4	A&H SP1.4	A&H SP1.4	Gogle SP1.4	Danas SP1.05
Initial Reading (Test Setup)	**Initial Ambient Air Temperature**	**(°C)**	19,4	19,6	20,2	19,6	21,5	19,8
	Current (I)	**(A)**					6,3	4,6
	Rated Power	**(kW)**	1,4	1,4			1,4	1,05
	Dry Wt. of Pot	**(g)**	190	190	190	190	198	200
	Initial Wt. of Water	**(g)**	2050	2050	2050	2050	2050	2050
	Wt. of Pot + water	**(g)**	2240	2240	2240	2240	2248	2250
	Initial Water Temperature	**(°C)**	18,1	18,6	19,3	19,28	18,5	18,7
High Power Heating (HP)	**Initial kWh Reading (E1)**	**(kWh)**	0	0	0	0	0	0
	Starting Time (T1)	**(H:M:S)**	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
	Time Water Boils (T2)	**(H:M:S)**	0:23:06	0:17:13	0:19:16	0:14:12	0:21:25	0:21:28
	Boiling Temperature	**(°C)**	90,8	90,8	90,8	91,2	91,5	91,5
	Wt. of pot + water	**(g)**	2146	2162	2164	2179	2175	2166
	Boiling kWh Reading (E2)	**(kWh)**	0,55293	0,41714	0,47714	0,35376	0,51671	0,38287
***Low Power Heating (LP) (Simmering)**	****Avg. Simmering Temperature**	**(°C)**		88,5		88,4	88,7	88,3
	Final Time (*20 or 45 min from boiling*)	**(H:M:S)**		0:37:13		0:34:12	1:06:25	1:06:28
	Final kWh Reading (E3)	**(kWh)**		0,65957		0,55826	1,02742	0,78973
	Final Temperature of water	**(°C)**		88,3		88,5	88,7	88,3
	Final Wt. of Pot + Water	**(g)**		1935		1958	1719	1695
End of Test	**Final Ambient Air Temperature**	**(°C)**		19,8		20,3	21,3	20,5
	Name of Expert conducting the test	**Name**		**Adnew**	**Adew**	**Adnew**	**Adnew**	**Adnew**

Notes:

Test 1) and 3) are only high-power tests (no simmering)

Tests 2) and 4) are done with 20 minutes simmering

Tests 5, 6, 7, and 8 are with 45 minutes simmering

Test 7 is conducted by Hilawe at home, and Test 8 is a hypothetical example

**Check and keep the water temperature not to drop more than 6oC below the boiling temperature*

***Measure and record the simmering water temperature every 60 seconds*

Analysis of the test data is shown in table 2.

Table 2. Analysis of Pre-test data.

	Date	Date	1/2/2019	1/2/2019	1/2/2019	1/2/2019	4/2/2019	4/2/2019
	Test No.	No.	1	2	3	4	5	6
	Name of Stove	Name	Gogle SP1.4	Gogle SP1.4	A&H SP1.4	A&H SP1.4	Gogle SP1.4	Danas SP1.0
Analysis of Test Results	Time for Boiling	(min)	23.10	17.22	19.27	14.20	21.42	21.47
	Simmering Time	(min)	0.00	20.00	0.00	20.00	45.00	45.00
	Total Time	(min)	23.10	37.22	19.27	34.20	66.42	66.47
	HP Energy Input	(kWh)	0.553	0.41714	0.477	0.35376	0.51671	0.38287
	HP Energy Output	(kWh)	0.23	0.22	0.22	0.21	0.22	0.23
	HP Efficiency	(%)	42.0	53.0	45.7	59.3	42.5	59.1
	LP Energy Input	(kWh)		0.24		0.20	0.51	0.41
	LP Energy Output	(kWh)		0.14		0.14	0.29	0.30
	LP Efficiency	(%)		58.8		67.8	56.1	72.7
	Total Energy Input	(kWh)	0.553	0.660	0.477	0.558	1.027	0.790
	Total Energy Output	(kWh)	1.580	0.364	1.577	0.348	0.506	0.522
	Total Power Input	(kW)	0.02	1.06	1.49	0.98	0.93	0.71
	Total Power Output	(kW)	0.07	0.59	4.91	0.61	0.46	0.47
	Overall Efficiency	(%)	285.66	55.1	330.44	62.4	49.26	66.09
	HP-Time to Boil	(min/kg)	**11.27**	**8.40**	**9.40**	**6.93**	**10.45**	**10.47**
	HP-Specific Energy Consumption	(kWh/kg)	**0.27**	**0.20**	**0.23**	**0.17**	**0.25**	**0.19**

**Test data was incomplete and consists of only a few tested appliances. It is highly recommended that more testing is done before setting the MEPS and the Energy Labelling tiers for Ethiopian stoves.*

List of Testing Equipment

Testing equipment for measuring of energy consumption for electrical stoves in the Lab are e.g.:

- Digital energy meter, model.
  - Energy meter can register energy use (Wh), voltage (V), current (A), time (sec), power (W)
- Temperature meters, thermocouples
- Non-metallic holder fixture for thermocouple
  - (this shall be constructed for measurements)
- Digital scale for weighing the water
- Air pressure meter
- Cookware, saucepan diameter 150-240 mm
- Non-metallic mixer
  - (this shall be organised for measurements)

Main findings of the Pre-test

The Pre-test brought into light many issues of which scheduling problems were one (the test lab began field work in December, so the initial schedule of the pre-test was changed. In January the testing began but only a few stoves where tested. In March the test lab was very understaffed with only one expert onsite.

Findings of the Pre-test:

1. Testing method is labour intensive especially since the lab did not have data loggers.

    - To successfully test the stoves, data loggers are essential. Each stove goes through the test twice and each round consists of several measurements and multiple sets of data to be recorded.
    - As the number of stoves to be tested grows, so will the amount of information.

2. Testing method is time-consuming as test is conducted two times on each stove.

3. Simmering phase is labour intensive to test, as most stoves do not have power regulators and the simmering must be done using the on/off switch aka switching power on and off manually to keep the water at simmer during the simmering test phase.

- Simmering phase should be included to better depict the actual usage of the stoves.

4. Testing equipment in the Lab should be catalogued thoroughly to see what essential equipment is needed.

- **Due to scheduling difficulties with the lab, the complete cataloguing of the testing equipment available in the lab was not conducted.**
    - The equipment (types/models) for testing of energy consumption of electrical stoves in the Lab should be checked and a detailed list supplied on what equipment and how many items are present in the Lab.
    - This should be compared to the complete list of testing equipment listed in the recommended testing method (according to the recommended standard).
    - It is also noted that equipment such as dataloggers will help in data gathering though data loggers are not mentioned as essential testing equipment.

Annex 3
Test procedure for the energy performance of locally manufactured electric stoves, phase 2 (In the future)

The recommended test method is comparable to the standard IEC 60350-2:2017 with needed modifications for local electric stoves where heating and simmering periods for water are included.

The heated water temperature is kept continuously under boiling temperature. It is essential to use a lid of cookware under testing because of vaporization of water.

The testing temperatures shall be applied to local circumstances in Addis Ababa.

The information on testing procedure is described as follows. All references within this Annex are references to the IEC 60350-2:2017 standard document (this pertains to references mentioning tables, figures and annexes).

1 General conditions

1.1 Test room

The tests are carried out in a substantially draught-free room in which the laboratory ambient temperature is maintained at (23 ± 2) °C.

This ambient temperature is measured at a point that is at the same height as the hob positioned at working height and at a distance of 0,5 m diagonally from one of the front edges of the appliance.

NOTE: The working height is normally between 800 mm and 1 000 mm.

The measurement of the ambient temperature shall not be influenced by the appliance itself or by any other appliance.

1.2 Electricity supply

The appliance is supplied at rated voltage with a relative tolerance of ±1 %.

If the appliance has a rated voltage range, the tests are carried out at the nominal voltage of the country where the appliance is intended to be used.

For the test, the supply voltage shall be maintained at the main terminal at 220 V with a tolerance of ±5 V or defined by the manufacturer's installation guide, while the heating elements are switched on.

The supply voltage shall be essentially sinusoidal.

NOTE: In case of a fixed cable, the plug (or the end of the cable) is the reference point to maintain the voltage.

The supply frequency shall be at the rated frequency ±1 % throughout the test. If a frequency range is indicated, then the test frequency shall be the nominal frequency of the country in which the appliance is intended to be used.

1.3 Instruments and measurements

Parameter	Unit	Minimum resolution	Minimum accuracy
Mass/volume	g/ml	0,5 g / 5 ml	+-1 g/10ml
Temperature	C	0,1 C	+- 1 C
-Ambient temperature	0,1	+- 1 K	
-temperature of the water	0,1 C	+- 0,5 K	
Time	s	1 s	+-1 s
Energy	Wh	-	+-1%
Air pressure	hPa	1 hPa	+-1%
Voltage	V		+- 0,5 %

The required accuracy of temperature measurement in the water load can be fulfilled by calibrating the temperature measurement or, for instance, by a PT100 sensor according to IEC 60751.

1.4 Positioning the appliance

The cooking stoves are positioned away from sidewalls.

1.5 Initial conditions

The appliance shall be at the laboratory's ambient temperature at the beginning of each test.

Forced cooling may be used to assist in reducing the temperature.

All tests are carried out with the default factory settings.

1.6 Cookware

General

Cookware is an integral part of the cooking process; it affects different process parameters such as the adaptation of a cooking zone, the required settings and the needed cooking time.

A sufficient degree of reproducibility is only guaranteed if a piece of standardized cookware and lid is used as described in 5.6.1 in the standard IEC 60350-2:2017.

Hobs working exclusively with a piece of supplied cookware and not with household-like cookware shall be tested with its supplied cookware, but it shall be covered with a lid in accordance with Table 3.

NOTE Suppliers for the stainless steel and for the cookware are indicated in Clauses F.3 and F.4 in the annex F in the standard.

Standardized cookware

Standardized cookware – bottom material and construction (according to the standard)

– Material: stainless steel AISI type 430, non-shiny surface;

– Thickness: 6 mm ± 0.2 mm (see Figure 1);

– Dimensions as specified in Table 3;

– Flatness of bottom plate as specified in Table 3;

A convex shaped bottom plate is not allowed. The flatness of the base has to be checked before starting a measurement.

– Annealing required.

For a sufficient permeability of the cookware bottom, the disc has to be annealed. The annealing should be done for approximately 2 h at approximately 650 °C in a nitriding furnace.

Grinding for adjustment after alteration is allowed within the given tolerances of (6 ± 0,2) mm.

Standardized cookware – sidewall (according to the standard)

– Material: stainless steel AISI type 304;

– Thickness: 1 mm ± 0,05 mm;

– Shape: cylindrical without handles or protrusions (see Figure 1).

The sidewall is fixed to the bottom plate with heat resistant glue.

The sidewall of the cookware can be built up of a metal sheet. The metal sheet is rolled and welded to a sheet-metal jacket. The sidewall can be fixed additionally by three welding points to the bottom, but the required bottom flatness has to be checked.

Standardized cookware – lid with temperature sensor (according to the standard)

– Material: aluminium;

– Thickness: 2 mm ± 0,05 mm;

– Dimensions as specified in Table 3;

– With holes, where each hole on the circle of the lid has diameter of (16 ± 0,1) mm; the

holes shall be evenly distributed on the circle (see Figure 1).

NOTE 1 The thermal energy which is needed to keep the water boiling for a real cooking process, including evaporation and the energy absorption of the food during the simmering phase, is considered for the holes.

The flat lid is adapted to accommodate a temperature sensor in the centre. The temperature sensor is positioned (15 ± 1) mm above the inner cookware bottom. To achieve this, place a (15 ± 1) mm reference block on the bottom of the cookware. Mark the sensors and tighten the screws.

NOTE 2 An example how to fix the temperature sensor to the lid is shown in Annex B. In order to reduce measurement noise generated by the electromagnetic field of an induction cooking zone or cooking area, the lid of the cookware shall be connected to ground through a clamp (see Figure 1 d). The ground connection of the electric installation of the testing laboratory shall be according to IEC 60364-5-54.

NOTE 3 An earthed wire of 2 mm 2 cross section and a maximum length of 2 m is welded to the metallic clamp.

Standardized cookware – dimensions and water amounts

The standardized cookware sizes and water amounts are defined in Table 3.

Table 3 – Sizes of standardized cookware and water amounts

Diameter of the cookware bottom (outside) mm	Diameter of the lid mm	Lid hole circle diameter mm	Number of holes on the circle	Total cookware height (outside) Mm	Flatness of cookware bottom mm	Water Load g	Cooking zone size category mm
120±0,5	130±1	80±1	7	125±0,5	0<0,075	650	≥100<130
150±0,5	**165**	**110**	**11**	**125±0,5**	**0<0,075**	**1030**	**≥130<160**
180±0,5	**200**	**140**	**16**	**125±0,5**	**0<0,075**	**1500**	**≥160<190**
210±0,5	230	170	22	125±0,5	0<0,1	2050	≥190<220
240±0,5	**265**	**200**	**29**	**125±0,5**	**0<0,1**	**2700**	**≥220<250**
270±0,5	300	230/210	18/18	125±0,5	0<0,15	3420	≥250<280
300±0,5	330	260/210	23/22	125±0,5	0<0,15	4240	≥280<310
330±0,5	365	290/270	27/27	125±0,5	0<0,15	5140	≥310≤330

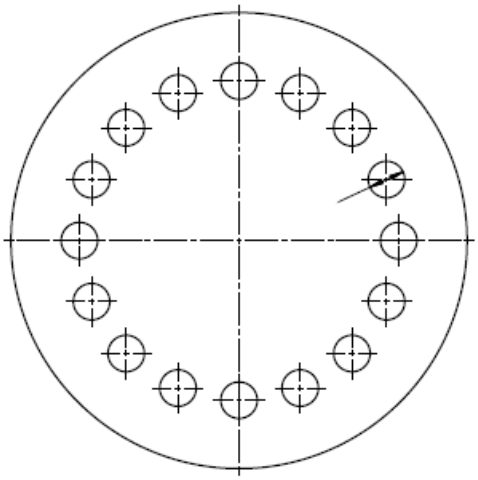

Figure 1 Example – lid with a diameter of 180 mm

NOTE The standardised cookware categories in Table 3 are only relevant for the standardized cookware.

Categories are necessary to make sure that different cookware sizes – as relevant in a household – are considered.

Fixing the temperature measurement instrument to the lid – Example (annex B I in the standard)

The temperature measurement instrument according to 5.3 should be fixed in the centre of the lid (see 5.6.1) as shown in Figure B.1. The mounting part shall be made of plastic material. Screws are used in order to position the temperature sensor correctly.

Dimensions in millimetres

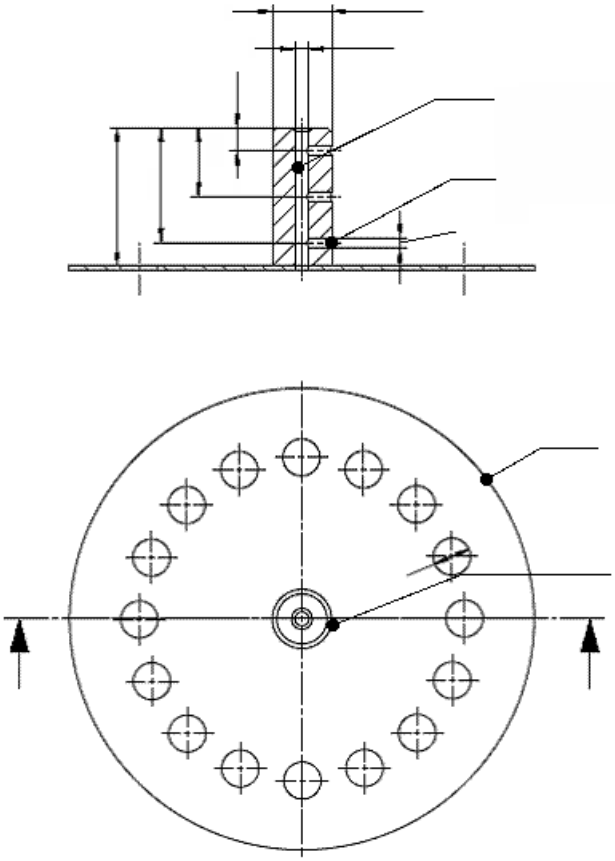

Figure B.1 – Position of the temperature measurement instrument *Fixing ø16 for temperature sensor*

Alternative cookware for comparative testing

General

For comparative testing, **alternative cookware** may be used.

The cookware used is noted. For comparative testing, for example on different sizes of cooking zones, always the same cookware samples shall be used.

Alternative cookware – bottom material and construction

– Material: stainless steel bottom cladded with several layers, which typically clad a stainless-steel layer (e.g. AISI 430 or AISI 439 steel), an aluminium layer and a ferromagnetic layer (often also called "sandwich layer bottom" or "aluminium clad").

– Flatness: < 0,003 *a*, where *a* is the outer diameter of the cookware's bottom.

A convex shaped bottom plate is not allowed. The flatness of the base has to be checked before starting a measurement.

– Thickness: ≥ 3 mm.

– No aluminium or copper spots in the surface.

– Without an aluminium ring outside.

– No ferromagnetic coating or sputtering.

– Without reliefs and stamps. Except one smaller stamp (ferromagnetic material) with a diameter less than 30 % of the outer flat bottom diameter and a depth < 0,8 mm in the centre.

– Uncoated.

Alternative cookware – sidewall

– Material: non-ferromagnetic stainless steel, e.g. AISI type 304.

– Thickness: ≥ 0,8 mm.

– Shape: cylindrical, angle between sidewall and hob surface 80° to 90°.

– Uncoated.

Alternative cookware – dimensions

The size of cookware shall match the size of the **cooking zone** (see 6.3.2 in the standard) as well as possible. However, it may vary by a maximum of +20 mm and −10 mm.

For **cooking areas**, the sizes of the cookware under test are described in the test procedures.

For determining the size of the cookware, the outer diameter of the flat bottom of the cookware (*a*) is measured.

1.7 Dimensions and mass

Overall dimensions

The overall dimensions of the appliance are measured and stated in millimetres (mm).

Mass of the appliance

The mass of the appliance is determined and expressed in grams (g), rounded to the nearest gram (g).

1.8 Cooking zones and cooking areas

Number of cooking zones per hob

The number of cooking zones is determined by the maximum number of controls that can be operated independently all at the same time.

Dimensions of cooking zones

The dimension of a cooking zone is determined by measuring the marked area on the surface.

For a circular cooking zone, the outside diameter of the largest marked circle is measured.

For a solid hotplate stove, the diameter of the surface intended to come into direct contact with the bottom of the saucepan is measured.

For a tubular stove, the diameter of the largest periphery excluding any leading section is measured.

If the cooking zone is not circular, the dimensions are determined as follows:

– for rectangular and similar shapes, the lengths of the sides are measured;

– for elliptical and similar shapes, the major and minor dimensions are measured.

The dimension of a radiant or induction cooking zone is determined by the printing on the surface independently of the size of the heating element. The dimensions are indicated in mm.

1.9 Energy consumption and heating up time

General

To guarantee reproducible results, the tests shall be carried out with standardized cookware.

The test method described are applicable to cooking stoves with a diameter ≤ 330 mm and ≥ 100 mm.

Purpose

In the first place, the purpose is to determine the energy consumption for heating up a defined water load and keep it at a defined temperature level for 20 min.

In a second measurement, the heating up time of a defined water load can be determined.

NOTE 1 Heating up and keeping the temperature for a defined period represents a typical household cooking process. Additionally, the quality of the control is measured by keeping an amount of water at a defined temperature as exactly as possible.

NOTE 2 The simmering time of 20 min represents an average household cooking duration. Additionally, at least 20 min further simmering time is necessary to assess the quality of a control that influences the energy consumption.

1.10 Procedure for measuring the energy consumption for heating water

Preparation

Before the first measurement is taken, all cooking zones have to be operated for at least 10 min at maximum setting. This is only necessary once to make sure that residual water in the components is vaporized. Afterwards, the hob has to be cooled down to approximately ambient temperature before starting measuring the energy consumption.

For measuring the energy consumption, only one control and one cookware shall be used. The appliance and the standardized cookware shall be at ambient temperature.

The empty standardized cookware is filled with the quantity of portable water specified in Table 3. Alternatively, in order to avoid lime sediment, distilled water may be used.

The water is stirred to ensure a uniform temperature and the temperature of the water is measured when the average temperature of cookware and water has stabilized. The initial water temperature shall be in the range of 20 °C ± 0,5 °C (T20).

The standardized cookware covered with the lid is positioned centrally on the stove, the control is set to maximum power and the measurement shall be started immediately.

Preliminary measurements

Determine Tc

A preliminary test is carried out to determine the appropriate water temperature for reducing the power setting (Tc).

The procedure described in 7.5.1 in the standard shall be followed.

The power shall be switched off when the water temperature reaches 70 °C (T70).

The temperature rising is recorded continuously (see Table 2). The difference between the highest temperature value and T70 is stated as temperature overshoot (Δ To) in K.

A valid temperature *T*70 is determined by the average of the recorded temperature between *t*70 – 10 s and *t*70 + 10 s. If the result is within the tolerance of (70 ± 0,5) °C, then this temperature is noted. If not, the test is repeated by adjusting the switch-off temperature.

Tc, the temperature for reducing the power setting, is calculated according to the following Formula (1):

$Tc = 93\ °C - \Delta To$ (1)

where *Tc* is rounded to the nearest integer.

If the temperature limiter of a **radiant cooking zone** switches down the power during the *tc* period, i.e. the time when the setting is reduced, a 2 K higher *Tc* is allowed.

If the calculated *Tc* is ≤ 80 °C, then 80 °C is taken as *Tc*. *Tc* is stated.

NOTE 2 Empirical tests show that **induction cooking zones** / **cooking areas**, **radiant cooking zones** and **solid plates** have each a similar *Tc*. The following values are representative, and they can substitute the result of 7.5.2.1 in the standard as fixed values:

– **induction cooking stove** *Tc* = 89 °C;

– **radiant cooking stove** *Tc* = 85 °C;

– **solid plate cooking stove** *Tc* = 80 °C.

Determine the simmering setting

A second preliminary test is carried out to determine the lowest level to set to achieve ≥ 90 °C during the remaining cooking period.

The procedure stated in 7.5.1 in the standard is followed.

If *Tc* is reached, the setting is reduced to achieve the water simmering at a temperature ≥ 90 °C and as close as possible to 90 °C. A further change of setting is not allowed. For *Tc*, the tolerances are +1,0 K / −0,5 K.

At first, the lowest simmering setting is selected. If the temperature of the water is < 90 °C during the simmering time, the energy consumption measurement has to be repeated with an increased setting – provided that the temperature of the water is < 90 °C after the measured data *T* are evaluated according to 7.5.4.1 in the standard.

When the water temperature reaches 90 °C for the first time (*T*90), the simmering time starts independently of *Tc*.

The simmering time is 20 min.

The lowest possible simmering setting is noted.

For **control** units without detent, the knob position should be marked. The simmering setting could differ if a knob is turned from a higher position to a lower position compared to turning from a lower position to a higher position.

NOTE For a clear marking of the lowest possible simmering setting, a polar coordinate paper can be useful (see Annex B).

Measuring the energy consumption

The procedure stated in 7.5.1 in the standard is followed. The results from 7.5.2.1 and 7.5.2.2, illustrated in Figure 6, are applied. After finishing, the appliance is **set to off mode**. If the appliance doesn't offer an off mode, it is **set to standby mode**.

where

*t*90 is the time when the temperature of 90 °C is reached and the simmering period starts, in s;

tc is the time when the setting is reduced, in s;

ts is the simmering time, in s;

*T*c is the water temperature when the setting is reduced, in °C;

*T*S is the water temperature at the end of the process, in °C.

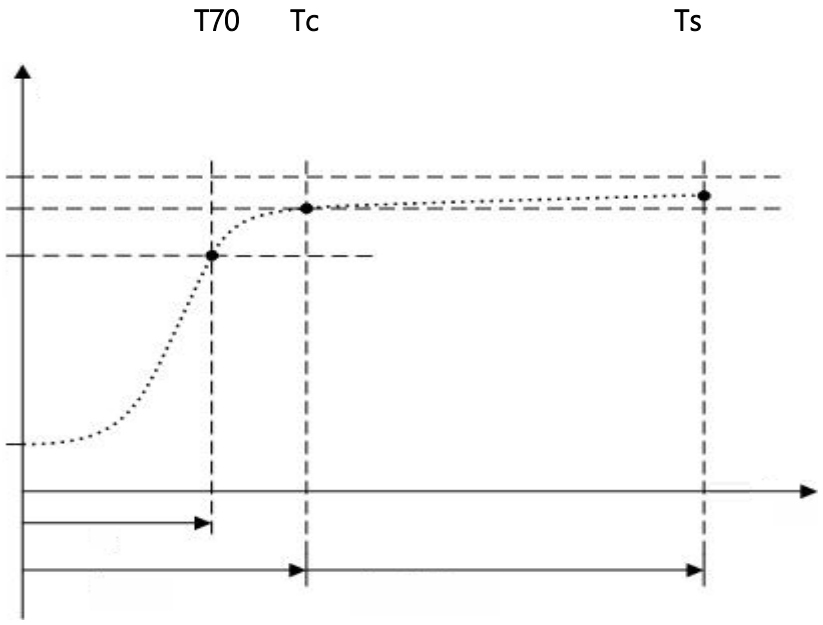

Figure 6 – Energy consumption measurement process for a cooking process

The following data shall be recorded:

– Continuously, the energy consumption starting at *t*0 and ending at *ts* + 1 min, in W·h;

– *t*C and *t*90, in min and s;

– initial temperature of water, *T*C, and the temperature *T*S of the water in °C;

– average power during the simmering time *ts*, in W;

– ambient temperature in °C at the start of the test (when the stove is switched on) and at the end of the test (after 20 min of simmering time);

– relative air pressure at the start of the test and at the end of the test, in hPa.

The test is performed three times if the stove is tested only with one or two cookware pieces.

Calculation of the result for a stove

The energy consumption per cooking stove is equal to *E*cw and shall be noted with the cookware size under the test normalized to 1 000 g. The result of each cookware is normalised to 1 000 g of water; the energy consumption is divided by the quantity of water used for the cookware under test.

Procedure for measuring the heating up time

Before the first measurement is taken, all cooking zones must be operated for at least 10 min. This is only necessary once to make sure that residual water in the components is vaporized. Afterwards, the hob must be cooled down to approximately ambient temperature before starting measuring the heating up time.

For measuring the heating up time, only one control and one cookware shall be used.

The standardized cookware is filled with the quantity of potable water specified in Table 3.

The water has a temperature of (20 ± 0,5) °C. The standardized cookware covered with the lid is positioned centrally on the cooking zone.

The cooking stove is heated with maximum power.

The time taken for the water temperature to rise by 70 K is measured.

The test is performed three times and the average value of the results is determined.

The time is stated in min and s, rounded to 10 s.