

REVIEWER'S REPORT

Manuscript No.: IJAR- 59066

Title: **ENERGY EFFICIENCY: AN ALTERNATIVE FOR REDUCING GREENHOUSE GAS EMISSIONS AND HOUSEHOLD ELECTRICITY BILLS IN TANKPÈ AND ZOPAH, IN THE MUNICIPALITY OF ABOMEY-CALAVI, BENIN.**

Recommendation:

Accept as it is

Accept after Major revision.....

Accept after Minor revision

Do not accept (*Reasons below*)

Rating	Excel.	Good	Fair	Poor
Originality		✓		
Techn. Quality		✓		
Clarity			✓	
Significance			✓	

Reviewer Name: **Dr. ANAPANA GOPAL**

Reviewer's Comment for Publication.

General Comments

The manuscript addresses an important and policy-relevant topic: household energy efficiency, consumer behavior, energy-intensive appliances, electricity expenditure, and greenhouse-gas emissions in Benin. The study focuses on two contrasting neighborhoods, Tankpè and Zopah, in Abomey-Calavi, and uses questionnaires and interviews to investigate appliance purchasing behavior and awareness of energy efficiency. The authors state that 120 households were included, with 60 households from each study area.

The topic is highly relevant because energy-efficient appliances and consumer behavior can influence household electricity demand and environmental impacts. The manuscript also attempts to connect household purchasing power, awareness, appliance labeling, and everyday energy-saving practices.

However, the current manuscript has **substantial methodological, analytical, conceptual, and presentation weaknesses**. Most importantly, the title and stated objective suggest that the study demonstrates reductions in **greenhouse-gas emissions and household electricity bills**, but the study does not appear to directly measure household electricity consumption, electricity bills, appliance energy consumption, or greenhouse-gas emissions. Instead, it mainly reports household perceptions and purchasing behaviors. Therefore, the central claim is currently stronger than the evidence presented.

There are also important concerns regarding the sampling description, the characterization of Tankpè and Zopah by purchasing power, statistical analysis, hypothesis testing, interpretation of percentages, technical explanations of energy efficiency, and the use of energy-label classifications.

Accordingly, **minor revision is required**.

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1. Content and Originality

The manuscript addresses a meaningful issue and has potential practical relevance for Benin's energy-efficiency policy.

The study seeks to:

1. identify factors explaining household use of energy-intensive appliances; and
2. assess residents' knowledge of the benefits of energy efficiency.

The comparison between Tankpè and Zopah is potentially interesting because the authors intend to examine whether household purchasing power influences appliance choices.

However, the manuscript should explain its **specific scientific contribution and novelty** much more clearly.

The authors should answer:

- What new evidence does this study provide compared with previous energy-efficiency studies in Benin?
- Why were Tankpè and Zopah selected beyond their assumed socioeconomic contrast?
- What is the novel contribution of the survey?
- Is the manuscript primarily a consumer-behavior study, an energy-efficiency study, or a policy/market assessment?
- How does this study advance existing knowledge concerning appliance choice and energy labels in Benin?

At present, the manuscript combines several themes—energy policy, household behavior, appliance markets, electricity infrastructure, energy labels, greenhouse gases and consumer education—without establishing a sufficiently focused analytical framework.

2. Title

The title is broad and ambitious:

“ENERGY EFFICIENCY: AN ALTERNATIVE FOR REDUCING GREENHOUSE GAS EMISSIONS AND HOUSEHOLD ELECTRICITY BILLS...”

However, the study does not appear to directly measure:

- household electricity consumption;
- electricity bills;
- greenhouse-gas emissions;
- appliance-specific energy consumption;
- actual savings following replacement of appliances.

Therefore, the title should be reconsidered.

A more evidence-based title could be:

“Household Awareness and Adoption of Energy-Efficient Appliances in Tankpè and Zopah, Abomey-Calavi, Benin”

or:

“Household Appliance Choices and Awareness of Energy Efficiency in Tankpè and Zopah, Benin”

If the authors retain the current title, they need to provide quantitative evidence linking appliance choices with actual electricity consumption, expenditure and/or estimated emissions.

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3. Abstract

The Abstract provides the study rationale, methodology and general findings. It states that 120 households were surveyed, with 60 households in each area, and concludes that many households have difficulty understanding energy labels and energy-saving practices.

However, the Abstract requires substantial revision.

It should clearly provide:

- study design;
- sampling method;
- exact sample size;
- participant characteristics;
- key quantitative results;
- statistical analysis;
- principal findings;
- limitations;
- evidence-based conclusion.

The statement that the study demonstrates that energy efficiency can reduce greenhouse-gas emissions and household bills is not directly demonstrated by the reported data.

The Abstract should instead state what was **actually measured**.

4. Introduction

The Introduction provides a broad discussion of energy transition, energy security, energy efficiency and electricity demand in Benin.

The background is relevant, but it is somewhat general and should be more closely connected to the research question.

The authors should strengthen the Introduction by discussing:

- household electricity consumption in Benin;
- appliance ownership patterns;
- energy-labeling policy in Benin;
- minimum energy-performance standards;
- consumer awareness;
- barriers to adoption of efficient appliances;
- socioeconomic determinants of appliance choice;
- existing evidence from Benin or comparable West African countries.

The final section of the Introduction should clearly establish the **research gap**.

5. Study Objectives and Hypotheses

The manuscript provides two hypotheses:

1. household preference for energy-intensive appliances is explained by low purchasing power;
2. low knowledge of energy efficiency explains poor energy-saving practices.

These are reasonable hypotheses, but the methodology does not adequately explain how they were statistically tested.

For example, if the first hypothesis concerns purchasing power, the study should measure purchasing power using variables such as:

- household income;

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- expenditure;
- employment;
- socioeconomic status;
- ownership of durable goods;
- housing characteristics.

Instead, Tankpè is characterized as a relatively low-purchasing-power neighborhood and Zopah as a relatively high-purchasing-power neighborhood.

This is not sufficient to establish individual household purchasing power.

The authors should either:

- collect/analyze actual socioeconomic indicators; or
- reformulate the hypothesis as a comparison between the two study areas.

6. Study Design and Sampling

The manuscript states that 60 households were selected from each neighborhood. However, an important inconsistency occurs in the sampling description.

The manuscript states that participants were selected randomly from a **total population estimated at sixty households per neighborhood**.

If there were only approximately 60 households in each neighborhood and the study sampled 60 households from each, then the study would effectively be attempting a census rather than a random sample.

This needs clarification.

The authors should provide:

- total number of households in Tankpè;
- total number of households in Zopah;
- sampling frame;
- sampling method;
- number approached;
- number responding;
- response rate;
- inclusion/exclusion criteria.

This is a **minor methodological issue**.

7. Representativeness of the Sample

The manuscript states that the research targeted more than 5,000 houses but subsequently reports a sample of only 60 households per neighborhood.

The relationship between these figures is unclear.

The authors should clarify:

- whether 5,000 represents the total number of households in both neighborhoods;
- whether it represents the broader municipality;
- how the sample of 120 households was calculated;
- why 60 households per area were considered sufficient.

A formal sample-size calculation should be provided if inferential conclusions are intended.

8. Data Collection Instruments

The manuscript indicates that questionnaire surveys and interview guides were used. However, insufficient information is provided about the instruments.

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The authors should describe:

- questionnaire structure;
- number of questions;
- question types;
- language used;
- translation procedures;
- interviewer training;
- duration of interviews;
- pretesting;
- reliability/validity assessment.

If a questionnaire was used to assess knowledge of energy efficiency, the authors should explain how **knowledge was scored**.

At present, "level of knowledge" is discussed conceptually, but there is no clearly defined knowledge index or scoring system.

9. Ethical Considerations

No clear statement regarding:

- ethical approval;
- informed consent;
- confidentiality;
- voluntary participation;
- protection of respondents' information

is provided in the available methodology.

For household surveys involving human participants, the authors should provide an appropriate ethics statement or explain the applicable institutional requirements.

10. Definition of Energy Efficiency

The manuscript defines energy efficiency as the ratio between useful energy delivered and energy consumed.

The definition is broadly appropriate, but the manuscript should distinguish among:

- energy efficiency;
- energy conservation;
- energy sobriety;
- energy consumption;
- energy intensity.

The manuscript sometimes treats reduced electricity use as synonymous with improved energy efficiency.

These concepts are related but not identical.

For example, turning off an appliance reduces energy consumption through **behavioral conservation**, whereas replacing an appliance with one that provides the same service with lower energy consumption represents **energy efficiency improvement**.

This distinction should be maintained throughout the manuscript.

11. Conceptual Framework

The section on "Energy 1.0," "Energy 2.0," and "Energy 3.0" occupies considerable space.

However, its connection to the empirical research is weak.

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The manuscript should explain how this framework was operationalized in the survey. If the framework is not actually used to construct variables or analyze results, this section should be substantially shortened.

The discussion of “kWh Cumac” and the French Energy Savings Certificate system is also not clearly relevant to the specific household context of Benin.

The authors should focus the conceptual framework on variables directly investigated in the study.

12. Socioeconomic Classification of Tankpè and Zopah

The central comparison between the two areas is based on the assertion that Tankpè has relatively low purchasing power while Zopah has relatively high purchasing power.

However, this classification appears to be based primarily on neighborhood characteristics rather than measured household-level socioeconomic data.

This is a significant limitation.

The authors should provide measurable indicators such as:

- monthly household income;
- occupation;
- household size;
- education;
- housing type;
- number/value of electrical appliances.

Without such variables, the statement that **purchasing power explains appliance choice** is not adequately demonstrated.

13. Results on Second-Hand Appliances

The manuscript reports that **72% of Tankpè respondents** admitted buying second-hand household appliances because of their purchasing power, while **86.36% of Zopah respondents** purchased new appliances from stores.

This is an important finding.

However, the denominators are not reported.

The authors should state:

43/60 (71.7%)

rather than simply 72%, for example.

Similarly, **86.36%** is unusually precise compared with the rest of the data and appears not to correspond to a denominator of 60. The authors must provide the exact numerator and denominator.

All percentages should be independently checked.

14. Statistical Testing of the First Hypothesis

The manuscript states:

“the initial hypothesis ... is confirmed.”

This conclusion is not adequately supported by the analysis presented.

A difference in second-hand appliance purchasing between two neighborhoods does not by itself prove that **low purchasing power causes the behavior**.

The authors should perform an appropriate statistical analysis, such as:

- chi-square test for categorical variables;
- logistic regression for second-hand versus new appliance purchasing;

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- association between socioeconomic indicators and appliance choice.

Potential confounding variables should also be considered.

The wording should therefore be changed from “**confirmed**” to something like:

“The findings are consistent with the hypothesis...”

unless appropriate statistical evidence is provided.

15. Energy-Label Awareness

The manuscript reports that **37.44%** of Zopah residents take the energy label into account when purchasing appliances.

This is potentially an important result.

However, the authors should clarify:

- how respondents were asked this question;
- whether they could correctly interpret the label;
- whether they could distinguish efficiency classes;
- whether they actually compared labels before purchasing;
- whether they knew the meaning of A–G classifications.

Simply stating that consumers “take the label into account” does not establish actual understanding.

A knowledge score would strengthen the study considerably.

16. Electricity Consumption and Electricity Bills

This is perhaps the **most important issue in the manuscript**.

The title explicitly refers to reducing household electricity bills, yet the study does not appear to provide:

- monthly electricity consumption;
- electricity meter readings;
- electricity bill amounts;
- appliance-level energy consumption;
- before-and-after comparison;
- estimated electricity savings.

The manuscript states that energy-intensive appliances result in higher electricity bills, but this appears to be an inference rather than a measured outcome.

The authors should either:

Option A

Add actual household electricity-consumption/bill data.

or

Option B

Modify the title and conclusions so that they concern **awareness, appliance choice and potential energy savings**, rather than demonstrated reductions in electricity bills.

17. Greenhouse-Gas Emission Claims

The manuscript also claims that energy efficiency reduces greenhouse-gas emissions. This is scientifically reasonable at a general level, but the present study does not quantify emissions.

There is no apparent calculation of:

- electricity consumption;
- electricity generation emission factor;

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- household CO₂-equivalent emissions;
- avoided emissions.

Therefore, the study cannot directly conclude that the surveyed households reduced greenhouse-gas emissions.

The authors should either provide an appropriate emissions calculation or moderate the claims to:

“Energy-efficient appliance adoption has the potential to reduce electricity consumption and associated greenhouse-gas emissions.”

18. Appliance Energy Efficiency and Wattage

The section discussing lamps contains a **technical issue that should be corrected**.

The manuscript states:

“The higher the lamp's wattage, the more power it consumes...”

and recommends households prioritize low-wattage lamps.

While higher wattage generally means higher instantaneous power consumption, **wattage alone does not determine energy efficiency**.

For lamps, the relevant efficiency indicator is **luminous efficacy (lumens per watt)**.

Two lamps can have different wattages but also different light outputs.

Therefore, the authors should emphasize:

lumens per watt, rather than simply low wattage, when discussing lighting efficiency. This is particularly important because the manuscript itself correctly identifies luminous efficacy as a primary indicator but then emphasizes wattage in the practical recommendation.

19. Energy-Label Classification

The energy-label discussion contains potentially confusing information.

The manuscript first presents an **A–G** classification and then refers to an **A+++ to D** scale.

These labeling systems should not be mixed without explanation.

The authors should clearly state:

- which labeling system applies in Benin;
- which appliances use it;
- whether the displayed label is current;
- what authority regulates it;
- whether A–G or A+++–D is being discussed.

The figure should be revised accordingly.

20. Figure 1 and SWOT-Type Assessment

Table 1 presents strengths, weaknesses, opportunities and threats related to energy-efficiency promotion in Benin.

However, the methodology does not explain how this SWOT assessment was generated.

The authors should state:

- who generated the SWOT categories;
- whether they came from interviews;
- whether they were researcher-derived;
- number of stakeholders involved;

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- criteria used to classify factors as strengths, weaknesses, opportunities or threats.

Figure 1 then presents a “diagnosis and proposed response,” but the pathway from empirical data to this framework is not adequately documented.

21. Market Claims

The manuscript makes strong statements concerning the Beninese appliance market, including claims that:

- large numbers of energy-intensive appliances enter through porous borders;
- imported appliances often have poor energy performance;
- equipment from Nigeria, Europe and Asia is frequently inefficient;
- counterfeit products are widespread.

These claims are important but require robust evidence.

The authors should distinguish:

- findings from their household survey;
- observations from market visits;
- stakeholder opinions;
- information obtained from government/project reports.

If market-level data were not systematically collected, these statements should be presented as **reported perceptions or observations**, rather than generalized facts.

22. Freon-22 Statement

The manuscript states that some air conditioners imported from Asia use **Freon-22**, described as a known greenhouse gas.

This statement requires more precise scientific and regulatory context.

The authors should clarify:

- whether the statement refers specifically to R-22;
- whether it is being discussed because of ozone-depletion potential, global-warming potential, or both;
- whether the cited evidence concerns products actually observed in Benin;
- what national or international regulation is being referenced.

The phrase “fails to meet international standards regarding the use of greenhouse gases” is too broad without specifying the relevant standard or regulatory framework.

23. Consumer Behavior Analysis

The manuscript identifies several potentially useful behaviors:

- turning off lights;
- avoiding standby mode;
- using power strips;
- refrigerator maintenance;
- keeping refrigerators away from heat sources;
- maintaining air conditioners;
- setting air-conditioning temperature between 24–25°C.

However, the study does not clearly quantify the prevalence of each behavior.

If these practices were assessed through the survey, the authors should provide a table such as:

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Energy-saving practice Tankpè (%) Zopah (%) p-value

Turns appliances off

Avoids standby

Uses efficient lamps

Maintains refrigerator

Maintains AC

This would directly address the second research objective.

24. Second Hypothesis

The manuscript concludes that the second hypothesis is **not validated** because Zopah residents, despite buying new appliances, do not always adopt energy-saving behaviors.

This conclusion is actually interesting, but the analytical basis is insufficient.

The authors should define:

- what constitutes “knowledge”;
- what constitutes “poor practices”;
- how knowledge was scored;
- how behavior was scored;
- how knowledge and behavior were statistically compared.

A correlation or regression analysis could be useful.

The authors should avoid treating anecdotal observations as hypothesis testing.

25. Causality

Several statements imply causal relationships that the study design cannot establish.

For example:

poverty → purchase of energy-intensive appliances → high electricity bills

and:

lack of awareness → poor energy behavior.

These pathways are plausible, but the cross-sectional design can establish associations rather than causality.

The authors should use terms such as:

- “associated with”;
- “may contribute to”;
- “is consistent with.”

They should avoid repeatedly using:

- “explains”;
- “causes”;
- “is responsible for”

unless supported by appropriate statistical analysis.

26. Discussion

The Discussion contains useful observations but frequently repeats the Results.

A stronger Discussion should be organized around the principal research questions:

1. Socioeconomic factors and appliance choice

2. Consumer awareness and energy-label use

3. Energy-saving behaviors

4. Appliance-market conditions

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5. Policy implications

6. Limitations

This would make the manuscript more analytical and less descriptive.

27. Policy Recommendations

The manuscript recommends:

- consumer education;
- energy-efficiency awareness;
- adoption of good energy-saving habits;
- stronger market regulation;
- banning unlabeled appliances.

These recommendations are potentially valuable.

However, the recommendation to **ban unlabeled appliances** requires consideration of:

- existing Beninese regulations;
- enforcement capacity;
- affordability;
- informal markets;
- consumer access;
- testing and certification infrastructure.

The recommendations should therefore be linked explicitly to the study findings and existing policy frameworks.

28. Practical Energy-Saving Recommendations

The practical recommendations are useful, but some should be technically refined.

For example:

- “lower wattage” should not be used as the primary definition of efficient lighting;
- appliance efficiency should be considered relative to the service delivered;
- refrigerator advice should distinguish old and modern technologies;
- air-conditioner recommendations should consider climate, insulation and equipment efficiency.

The recommendations should preferably be based on authoritative energy-efficiency standards or documented evidence.

29. Figures

The manuscript includes photographs of lamp packaging and refrigerator rating plates.

These figures are potentially useful educational illustrations.

However:

- image quality should be improved;
- labels should be legible;
- figure numbers should be consistent;
- captions should be complete;
- arrows/circles should clearly identify the relevant information;
- figures should be directly connected to the survey findings.

At present, the figures look more like educational material than scientific research figures.

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30. References

The reference list is relatively short and includes sources on energy efficiency, energy policy and energy labeling.

However, the references require substantial improvement.

Specific issues include:

1. Some references lack complete bibliographic information.
2. Reference formatting is inconsistent.
3. Institutional reports should include organization, title, year and publication details consistently.
4. Some sources appear to be presentations rather than peer-reviewed publications.
5. The reference list is relatively limited for a study making broad claims about energy efficiency, greenhouse gases and appliance markets.
6. Recent literature on household energy consumption and energy-efficient appliance adoption in Africa should be considered.

The authors should ensure that every important technical claim is supported by an appropriate source.

31. Language and Editorial Quality

The manuscript requires **considerable English-language and editorial revision**.

Examples include:

- “theBenin”;
- “householdincome”;
- “theand”;
- inconsistent capitalization;
- inconsistent hyphenation;
- French terms embedded in English text;
- inconsistent formatting of references;
- punctuation problems.

There are also awkward expressions such as:

“spongy borders of Benin”

which is not appropriate scientific English. The intended meaning appears to be **porous borders**.

Similarly, phrases such as:

“pollute the environment”

should be replaced with more precise scientific terminology where possible.

Professional English editing is strongly recommended.

32. Minor Internal Inconsistencies

Several internal inconsistencies require correction:

A. Sample size

The manuscript states both a target of more than 5,000 houses and 60 households per neighborhood, but later says the total population was estimated at 60 households per neighborhood.

B. Percentages

The reported **37.44%** and **86.36%** figures require verification and denominators.

C. Hypothesis testing

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The manuscript describes the first hypothesis as “confirmed” without presenting a statistical test.

D. Energy labels

A–G and A+++–D classification systems are presented together without sufficient explanation.

E. Study objective versus measurements

The title emphasizes electricity bills and greenhouse-gas emissions, but these outcomes are not directly measured.

These inconsistencies should be resolved before publication.

Strengths of the Manuscript

The manuscript has several positive features:

1. **Important and timely topic** related to energy efficiency and household welfare.
2. Focus on Benin, where evidence on consumer energy-efficiency behavior is valuable.
3. Comparison of two contrasting urban neighborhoods.
4. Combination of questionnaire and interview approaches.
5. Clear identification of consumer awareness as an important issue.
6. Useful discussion of second-hand appliance markets.
7. Attention to energy labeling.
8. Practical recommendations for household energy-saving behaviors.
9. Discussion of national energy-efficiency initiatives.
10. Potential policy relevance for consumer education and appliance-market regulation.
11. The manuscript identifies a potentially important disconnect between appliance purchasing behavior and actual energy-saving practices.

Overall Recommendation

The manuscript addresses a **relevant and potentially publishable topic**, particularly in relation to household awareness, appliance purchasing behavior and energy-efficiency policy in Benin. The comparison between Tankpè and Zopah and the attention to consumer awareness and energy labels provide a useful foundation for the study.

However, the current manuscript does not yet provide sufficient evidence to support its strongest claims. The most important issue is the **mismatch between the title/objectives and the actual measurements**: the manuscript claims to demonstrate reductions in household electricity bills and greenhouse-gas emissions, while the reported study primarily assesses appliance purchasing behavior, perceptions and awareness.

The sampling methodology also needs clarification, particularly the apparent contradiction concerning the total household population. The socioeconomic comparison between Tankpè and Zopah needs objective indicators, and the hypotheses require proper statistical testing. Technical explanations concerning appliance efficiency and energy labels also require correction.

With substantial revision, clearer quantitative analysis, improved methodological reporting, more cautious interpretation, and comprehensive language editing, the

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manuscript could become a useful contribution to the literature on household energy efficiency in Benin.

Recommendation: Minor Revision

Final Decision: MINOR REVISION