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End-use energy utilization efficiency of Nigerian residential sector

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Abstract

In this paper, the end-use efficiencies of the different energy carriers and the overall energy efficiency in the Nigerian residential sector (NRS) were estimated using energy and exergy analysis. The energy and exergy flows were considered from 2006 to 2011. The overall energy efficiency ranges from 19.15% in 2006 to 20.19% in 2011 with a mean of $(19.96 \pm 0.23)\%$ while the overall exergy efficiency ranges from 4.34% in 2006 to 4.40% in 2011 with a mean of $(4.31 \pm 0.059)\%$. The energy and exergy efficiency margin was 15.58% with a marginal improvement of 0.07% and 0.02%, respectively when compared with previous results. The contribution of the energy carriers to the total energy and exergy inputs were 1.45% and 1.43% for electricity, 1.95% and 3% for fossil fuel and 96.6% and 95.57% for bio-fuel. The result shows that approximately 65% of the residence use wood and biomass for domestic cooking and heating, and only a fraction of the residence have access to electricity. LPG was found to be the most efficient while kerosene, charcoal, wood and other biomass the least in this order. Electricity utilization exergy efficiency is affected by vapor-compression air conditioning application apart from low potential energy applications. In addition, this paper has suggested alternatives in the end-use application and has demonstrated the relevance of exergy analysis in enhancing sustainable energy policies and management and improved integration techniques.

Keywords

end-use energy exergy efficiency residential sector Nigeria

References

1. 1.
Utlu Z, Hepbasli A. A review and assessment of the energy utilization efficiency in the Turkish industrial sector using energy and exergy analysis method. *Renewable & Sustainable Energy Reviews*, 2007, 11(7): 1438–1459 [CrossRef](#) [Google Scholar](#)
2. 2.
Hasanuzzaman M, Rashid N A, Hosenuzzama M, Saidur R, Mahbubul I M, Rashid M M. Energy savings in the combustion based process heating in industrial sector. *Renewable & Sustainable Energy Reviews*, 2012, 16(7): 4527–4536 [CrossRef](#) [Google Scholar](#)
3. 3.

Nigeria National Bureau of Statistics (NNBS). Distribution of household by type of fuel. 2012-10-08, <http://www.nigerianstat.gov.ng>

4. 4.

Obadote D J. Energy crisis in Nigeria: technical issues and solutions. Power Sector Prayer Conference. Abuja, Nigeria, 2009: 1–9 [Google Scholar](#)

5. 5.

Dincer I, Hussain M M, Al-Zaharnah I. Energy and exergy utilization in transportation sector of Saudi Arabia. Applied Thermal Engineering, 2004, 24(4): 525–538 [CrossRefGoogle Scholar](#)

6. 6.

Dincer I. On energetic, exergetic and environmental aspects of drying systems. International Journal of Energy Research, 2002, 26(8): 717–727 [CrossRefGoogle Scholar](#)

7. 7.

Rosen M A, Dincer I. Sectorial energy and exergy modeling of Turkey. Journal of Energy Resources Technology, 1997, 119(3): 200–204 [CrossRefGoogle Scholar](#)

8. 8.

Reistad G M. Available energy conversion and utilization in the United States. Journal of Engineering for Power, 1975, 97(3): 429–434 [CrossRefGoogle Scholar](#)

9. 9.

Rosen M A. Evaluation of energy utilization efficiency in Canada using energy and exergy analyses. Energy, 1992, 17(4): 339–350 [CrossRefGoogle Scholar](#)

10. 10.

Wall G. Exergy conversion in the Japanese society. Energy, 1990, 15(5): 435–444 doi:10.1016/0360-5442(90)90040-9 [CrossRefGoogle Scholar](#)

11. 11.

Wall G, Sciubba E, Naso V. Exergy use in the Italian society. Energy, 1994, 19(12): 1267–1274 [CrossRefGoogle Scholar](#)

12. 12.

Utlu Z, Hepbasli A. A study on the evaluation of energy utilisation efficiency in the turkish residential-commercial sector using energy and exergy analyses. Energy and Building, 2003, 35(11): 1145–1153 [CrossRefGoogle Scholar](#)

13. 13.

Saidur R, Masjuki H H, Jamaluddin M Y. An application of energy and exergy analysis in residential sector of Malaysia. *Energy Policy*, 2007, 35(2): 1050–1063 [CrossRefGoogle Scholar](#)

14. 14.

Ayres R U, Ayres L W, Warr B. Exergy, power and work in the US economy, 1900–1998. *Energy*, 2003, 28(3): 219–273 [CrossRefGoogle Scholar](#)

15. 15.

Hammond G P, Stapleton A J. Exergy analysis of the United Kingdom energy system. *Journal of Power and Energy*, 2001, 215(2): 141–162 [CrossRefGoogle Scholar](#)

16. 16.

Ertesvåg I S. Society exergy analysis: a comparison of different societies. *Energy*, 2001, 26(3): 253–270 [CrossRefGoogle Scholar](#)

17. 17.

Dincer I, Hussain M M, Al-Zaharnah I. Energy and exergy use in public and private sector of Saudi Arabia. *Energy Policy*, 2004, 32(14): 1615–1624 [CrossRefGoogle Scholar](#)

18. 18.

Jaber J O, Al-Ghandoor A, Sawalha S A. Energy analysis and exergy utilization in the transportation sector of Jordan. *Energy Policy*, 2008, 36(8): 2995–3000 [CrossRefGoogle Scholar](#)

19. 19.

Saidur R, Sattar M A, Masjuki H H, Ahmed S, Hashim S U. An estimation of the energy and exergy efficiencies for the energy resources consumption in the transportation sector in Malaysia. *Energy Policy*, 2007, 35(8): 4018–4026 [CrossRefGoogle Scholar](#)

20. 20.

Utlu Z, Hepbasli A. Assessment of the energy utilization efficiency in the Turkish transportation sector between 2000 and 2020 using energy and exergy analysis method. *Energy Policy*, 2006, 34(13): 1611–1618 [CrossRefGoogle Scholar](#)

21. 21.

Koroneos C J, Nanaki E A, Xydis G. Exergy analysis of the energy use in Greece. *Energy Policy*, 2011, 39(5): 2475–2481 [CrossRefGoogle Scholar](#)

22. 22.

Kumiko K. Energy and exergy utilization efficiencies in the Japanese residential/commercial sectors. *Energy Policy*, 2009, 37(9): 3475–3483 [CrossRefGoogle Scholar](#)

23. 23.

Dincer I, Hussain M M, Al-Zaharnah I. I. Energy and exergy utilization in agricultural sector of Saudi Arabia. *Energy Policy*, 2005, 33(11): 1461–1467 [CrossRefGoogle Scholar](#)

24. 24.

Ahamed J U, Saidur R, Masjuki H H, Mekhilef S, Ali M B, Furqon M H. An application of energy and exergy analysis in agricultural sector of Malaysia. *Energy Policy*, 2011, 39(12): 7922–7929 [CrossRefGoogle Scholar](#)

25. 25.

Utlu Z, Hepbasli A. Analysis of energy and exergy use of the Turkish residential-commercial sector. *Building and Environment*, 2005, 40(5): 641–655 [CrossRefGoogle Scholar](#)

26. 26.

Badmus I, Osunleke A S. Application of energy and exergy analyses for efficient energy utilisation in the Nigerian residential sector. *International Journal of Exergy*, 2010, 7(3): 352–368 [CrossRefGoogle Scholar](#)

27. 27.

Energy Commission of Nigeria. The National energy policy of Nigeria. 2013-09-04, http://wacee.net/getattachment/21cca4e4-ef1b-4c59-8501-98b3e8624b88/National_Energy_Policy_Nigeria.pdf.aspx

28. 28.

National Population Commission (NPC). Report of Nigeria's National Population Commission on the 2006 Census. 2007-03-01, <http://www.jstor.org/stable/25434601>

29. 29.

Anozie A N, Bakare A R, Sonibare J A, Oyebisi T O. Evaluation of cooking energy cost, efficiency, impact on air pollution and policy in Nigeria. *Energy*, 2007, 32(7): 1283–1290 [CrossRefGoogle Scholar](#)

30. 30.

Kotas T J. The Exergy Method of Thermal Plant Analysis. London: Egergon Publishing Company UK Ltd, 2012 [Google Scholar](#)

31. 31.

Dincer I, Hussain M M, Al-Zaharnah I. Analysis of sectoral energy and exergy use of Saudi Arabia. International Journal of Energy Research, 2004, 28(3): 205–243 [CrossRefGoogle Scholar](#)

32. 32.

Chen B, Chen G Q. Exergy analysis for resource conversion of the Chinese society 1993 under the material product system. Energy Policy, 2006, 31(8–9): 1115–1150 [Google Scholar](#)

33. 33.

Ertesvag I S. Energy, exergy and extended-exergy analysis of the Norwegian society 2000. Energy, 2005, 30(5): 649–675 [CrossRefGoogle Scholar](#)

34. 34.

Gabar B. Demand side management and efficient lighting initiatives in Nigeria. 2009-06-30, http://www.worldenergy.org/documents/ethiopia_june_30_vi_garba_nigeria.pdf

35. 35.

Central Intelligence Agency. CIA world factbook, Nigeria. 2013-09-12, <http://www.cia.gov/library/publications/the-world-factbook/geos/ni.html>

36. 36.

National Bureau of Statistics. World Bank and BP Statistical Review of World Energy 2012. 2013-09-12, <http://www.bp.com/en/global/corporate/about-bp/statistical-review-of-world-energy-2012.html>

37. 37.

Sambo A S. Renewable Energy Development in Nigeria. 2010-06,