Energy Efficiency as an engine for development in countries characterized by energy poverty: a review

R. F. Rallo, M. Casazza, S. Viglia, S. Ulgiati

*renatof.rallo@uniparthenope.it
General Hypotheses

• HP1: reducing gaps between countries is the only way to universal, more effective mechanisms to face climate change, resource consumption’s reduction

• HP2: Energy efficiency is an engine for development, and development is an engine for energy efficiency and environmental protection
What is development: subsistence / wellbeing / opulence? Arguable, but we cannot leave people underdeveloped in name of possible, future sustainability issues. Emergency is now.
United Nations - SDGs: There is no strict ranking in SDGs, but Climate Action is just one, and can not counterbalance all the other ones.
Poverty
Share of population living on less than 2011 PPP $1.90 a day, 2013 (%)

- Less than 2.0
- 2.0–9.9
- 10.0–24.9
- 25.0–49.9
- 50.0 or higher
- No data
Energy efficiency entails development by definition

• Having free, available energy pushes economies to do more things.
• Direction of causality is still under debate, but in the case of developing countries it’s not important. «Correlation is enough»
• Rebound effect in developed countries is very often below 100%, thus not generating any Jevons Paradox
• In developing countries, anyways, we do want Jevons Paradox to take place and boost economy and all related wellbeing, health, wealth indicators.
Life expectancy, 2013

Shown is period life expectancy at birth. This corresponds to an estimate of the average number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.

Source: Clio-Infra estimates until 1949; UN Population Division from 1950 to 2015

OurWorldInData.org/life-expectancy-how-is-it-calculated-and-how-should-it-be-interpreted/ • CC BY-SA
Life expectancy globally and by world regions since 1770

Source: Life expectancy – James Riley for data 1990 and earlier; WHO and World Bank for later data (by Max Roser)
OurWorldInData.org/life-expectancy/ • CC BY-SA
IEA

- 1.18 billion people (16% of the worldwide population) lack access to electricity
- 2.74 billion (40% of the global population) rely on traditional cooking methods
- 80% of energy poor people live in rural areas
- almost four million people die every year from indoor air pollution due to the use of traditional cooking fuels and stoves, and this is also a problem of en. Eff.
- emissions from cooking stoves are well over 50% of anthropogenic sources (Bond et al., 2013)
# REBOUND: DIRECT EFFECTS

ROUGHLY 10-30% FOR CONSUMERS IN RICH NATIONS

## TABLE 2.1:
Scale of Direct Rebound for Consumer Energy Services in Developed Nations – Summary

<table>
<thead>
<tr>
<th>Energy Service</th>
<th>Range of Estimates</th>
<th>Best Guess</th>
<th>Degree of Confidence (Notes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive transport</td>
<td>5-87%</td>
<td>10-30%</td>
<td><strong>HIGH</strong> (Unmeasured in these studies are changes in automotive attributes, particularly heavier vehicles and more powerful engines.)</td>
</tr>
<tr>
<td>Space heating</td>
<td>1.4-60%</td>
<td>10-30%</td>
<td><strong>MEDIUM</strong> (Unmeasured in these studies are increases in the space heated and an increase in thermal comfort.)</td>
</tr>
<tr>
<td>Space cooling</td>
<td>0-50%</td>
<td>1-26%</td>
<td><strong>LOW</strong> (Unmeasured in these studies are increases in the space cooled and an increase in thermal comfort.)</td>
</tr>
<tr>
<td>Water heating</td>
<td>&lt; 10-40%</td>
<td>?</td>
<td><strong>VERY LOW</strong> (Unmeasured in these studies are reports of increased shower length or purchase of larger water heating unit.)</td>
</tr>
<tr>
<td>Other consumer energy services</td>
<td>0-49%</td>
<td>&lt;20%</td>
<td><strong>LOW</strong></td>
</tr>
</tbody>
</table>
REBOUND: DIRECT EFFECTS

MUCH LARGER IN DEVELOPING NATIONS

(40-80%?)

«Energy Emergence. Rebound and Backfire»
J. Jenkins
## SCALE OF TOTAL, ECONOMY-WIDE REBOUND?

### Table 3.1: Survey of CGE Simulations of Economy-wide Rebound Effect

<table>
<thead>
<tr>
<th>Study</th>
<th>Country/Region</th>
<th>Projected Economy-wide Rebound</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semboja (1994)</td>
<td>Kenya</td>
<td>170-350%</td>
<td>Two scenarios: 1% improvement in economy-wide energy production efficiency and end-use energy efficiency.</td>
</tr>
<tr>
<td>Dufournaud et al. (1994)</td>
<td>Sudan</td>
<td>47-77%</td>
<td></td>
</tr>
<tr>
<td>Van Es et al. (1998)</td>
<td>Holland</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>Vikstrom (2004)</td>
<td>Sweden</td>
<td>50-60%</td>
<td></td>
</tr>
<tr>
<td>Washida (2004)</td>
<td>Japan</td>
<td>35-70% (53% in central scenario)</td>
<td></td>
</tr>
<tr>
<td>Grepperud and Rasmussen (2004)</td>
<td>Norway</td>
<td>Small for oil use but &gt;100% for electricity</td>
<td></td>
</tr>
<tr>
<td>Glomsrod and Wei (2005)</td>
<td>China</td>
<td>&gt;100%</td>
<td></td>
</tr>
<tr>
<td>Hanley et al. (2005)</td>
<td>Scotland</td>
<td>120%</td>
<td></td>
</tr>
</tbody>
</table>

«Energy Emergence. Rebound and Backfire»
J. Jenkins
Three types of jobs can be created:
1) **Direct**: Workers hired for implementation of the desired efficiency measures
2) **Indirect**: Materials purchased from other companies thus creating new jobs
3) **Induced**: Direct and indirect workers spend their salaries in the local economy, creating induced jobs

Therefore, diverting investments from “business as usual” spending patterns to high labor intensity construction and manufacturing industries would support more jobs.

It’s not easy to reassess the impact of EE investment from mature economies to developing countries...

But it’s intuitive to recognise that the same amount of money will have much bigger impact on generating jobs, improving energy access and performances
Promoting renewable energy and energy efficiency in Africa: a framework to evaluate employment generation and cost effectiveness

Nicola Cantore, Patrick Nussbaumer, Max Wei and Daniel M Kammen

1 UNIDO, Austria
2 Lawrence Berkeley National Laboratory, United States of America
3 Energy and Resources Group, University of California, United States of America
4 Goldman School of Public Policy, University of California, United States of America

E-mail: pnussbaumer@unido.org

Keywords: renewable energy, employment, energy efficiency, Africa

---

**Figure 3.** Jobs in different scenarios (jobs/year, vertical axis, year horizontal axis).
Cantore 2017: energy savings and the conversion of the electricity supply mix to renewable energy generates employment compared to a reference scenario. It also concludes that the costs per additional job created tend to decrease with increasing levels of both EE adoption and RE shares.
Cantore 2017: energy savings and the conversion of the electricity supply mix to renewable energy generates employment compared to a reference scenario. It also concludes that the costs per additional job created tend to decrease with increasing levels of both EE adoption and RE shares.

Table 3. Share of jobs across sources of energy.

<table>
<thead>
<tr>
<th></th>
<th>CURRENT_POLICIES</th>
<th>NEW_POLICIES</th>
<th>450_ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy efficiency net of induced jobs</td>
<td>0.00</td>
<td>4.98</td>
<td>9.59</td>
</tr>
<tr>
<td>Induced jobs</td>
<td>0.00</td>
<td>2.13</td>
<td>4.11</td>
</tr>
<tr>
<td>Renewable energy</td>
<td>36.93</td>
<td>36.52</td>
<td>42.18</td>
</tr>
<tr>
<td>Fossil fuels</td>
<td>60.78</td>
<td>53.35</td>
<td>40.50</td>
</tr>
<tr>
<td>Nuclear</td>
<td>2.30</td>
<td>3.02</td>
<td>3.63</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy efficiency net of induced jobs</td>
<td>0.00</td>
<td>6.61</td>
<td>12.08</td>
</tr>
<tr>
<td>Induced jobs</td>
<td>0.00</td>
<td>2.83</td>
<td>5.18</td>
</tr>
<tr>
<td>Renewable energy</td>
<td>43.16</td>
<td>43.82</td>
<td>51.99</td>
</tr>
<tr>
<td>Fossil fuels</td>
<td>54.50</td>
<td>43.09</td>
<td>26.21</td>
</tr>
<tr>
<td>Nuclear</td>
<td>2.34</td>
<td>3.49</td>
<td>4.54</td>
</tr>
</tbody>
</table>
Cantore 2017: energy savings and the conversion of the electricity supply mix to renewable energy generates employment compared to a reference scenario. It also concludes that the costs per additional job created tend to decrease with increasing levels of both EE adoption and RE shares.

![Figure 5. Generation cost per worker (1000 2011 USD per jobs/year).](image)
Cantore 2017: energy savings and the conversion of the electricity supply mix to renewable energy generates employment compared to a reference scenario. It also concludes that the costs per additional job created tend to decrease with increasing levels of both EE adoption and RE shares.

Figure 6. Zoom on 2030. Generation cost per created job per year (vertical axis) vs number of created jobs per year.
A market transformation from inefficient and polluting fuel-based lighting to solar-LED systems is well underway across the developing world, but the extent of net job creation has not previously been defined. The current employment associated with fuel-based lighting represents approximately 150,000 jobs. New jobs will accompany the replacement technologies. A survey of major solar-LED lighting companies finds that 38 such jobs are created for each 10,000 people living off-grid for whom stand-alone solar-LED lights are suitable.

Applying this metric, the number of new jobs already created from the current uptake of solar-LED lighting has matched that of fuel-based lighting and foreshadows the potential creation of 2 million new jobs to fully serve the 112 million households globally that currently lack electricity access, are unlikely to be connected to the major grid, micro-grids, or are able to afford more extensive solar systems.
Barriers to energy access

• Lack of funding
• Large scale infrastructure geared towards export of energy to industrialised countries.
• Lack of business models sustainable in the long run
• Climate change agenda, often put above the energy poor.
Suggestions for policy / 1

• Recognising the right to energy, and the right to reduce the gap between and within continents and countries.

• Political willingness and stability from local governments

• Allowance of greenhouse gas emissions to provide energy access for the poor.

• Alternative climate change mechanisms, regularly being assessed against their real impact in addressing energy poverty
Suggestions for policy / 2

• Introduction of efficient, effective and equitable subsidies.

• An adequate and effective implementing agency, with high-degree of operating autonomy (particularly from possible political pressure) and accountability in the targets to reach.

• Adequate expansion plans, which consider the actual needs and possibilities of communities, ensure financial viability and economic impact: premature rural electrification may miss the objective of contributing to sustainable community development (https://www.feem.it/m/publications_pages/2-feem-energy-poverty-alleviation-low1.pdf)

• Right and adequate tariff policy, considering customers’ realistic ability to pay.

• Blended finance through Public Private Partnership
Tackling energy poverty is key for

- Reducing poverty
- Creating jobs
- Decreasing energy intensity
- Reducing deforestation, fuelwood consumption, land degradation
- Deploying global mechanism applicable to all, thus making them finally useful
  (Cap & Trade, etc.)
THANK YOU!

Renato F. Rallo
Parthenope University of Naples, Italy
Department of Science and Technology
renatof.rallo@uniparthenope.it