Evaluation of **renewable energy resources** in Africa

Daniel Ayuk Mbi Egbe

Linz Institute for Organic Solar Cells, Johannes Kepler University Linz, Altenbergerstr. 69, 4040 Linz, Austria. daniel_ayuk_mbi.egbe@jku.at

ANSOLE e.V., Ebertstr.14, 07743 Jena, Germany
daniel.egbe@ansole.org/daniel_ayuk_mbi.egbe@jku.at
Goals of ANSOLE

Fosters technical and vocational education and training (TVET) in renewable energies at various skill levels (*capacity building*).

Fosters research activities in renewable energy among African scientists and non-African scientists who are directly involved in the education of African students and experts (*capacity building*).

Promotes and encourages the use of renewable energy in Africa (*sustainable development, environmental protection, business mediation, etc*).
ANSOLE has more than 850 members based in:


26 non African Countries: Albania, Austria, Belgium, Britain, Canada, China, Denmark, Estonia, France, Germany, India, Ireland, Italy, Jordan, Luxembourg, Malaysia, Holland, Palestine, Portugal, Russian Federation, Scotland, Sweden, Switzerland, Taiwan, Turkey and USA.

Logos of Institutional Members

UPPSALA UNIVERSITY

DSTC TECHNOLOGIES

FOM

NEXT ENERGY

ISP

BioTherm Energy

SECCCO

Solar Energy Consulting and Construction Company (SECCCO)
Activities

1) Organisation of RE conferences, symposia, workshops & summer schools

2) Assisting in organization of non-ANSOLE RE related events worldwide

3) Training, Education & Research
   • „Sur-Place“ scholarships to selected 3rd year Bachelor students
   • „Sur-Place“ scholarships to selected Masters and PhD students
     • Mobility scholarships to Masters & PhD students (Intra-African Exchange, INEX, Africa-North Exchange, ANEX, & Africa-Latin America Exchange, ALAMEX)
     • Mediation of students & researchers from Africa, Europe, USA with own funding to African & non-African RE laboratories
     • Implementation of vocational training and education programs in RE at existing training institutions (First initiative planned 2016 in Cameroon)
   • E-learning (looking for partners!)
4) RE public education & awareness raising in Africa:
   • radio & TV, print media, open-air events, popular theater („No Bill with the Sun“)
     ANSOLE website, ANSOLE News (ANSOLE e-Magazine)

5) Business mediation

6) ANSOLE websites (www.ansole.org/www.ansole.com)
   • information about RE events, job, training, funding opportunities, e-learning

7) ANSOLE e-Magazine (ANSOLE News)
   • country specific detailed RE information; ANSOLE reports, RE events reports,
     Events calendar, life stories, etc

8) ANSOLE mailing list
   • Rapid information dissemination to members, who forward the information thru
     own mailing lists

9) Bridging Africa, Latin America and Europe on Water and Renewable Energies
    Applications (BALEWARE)-www.baleware.org
    → will be launched in december 2016 in Arusha Tanzania
Energy Situation in Africa

- Extremely low levels of modern energy supply and access

**Electricity**

- Low Generation Capacity
  - Total capacity about 140 GW, South Africa accounts for 36%, North Africa (39%), other Sub-Saharan Africa (25%)

- Low Access to Electricity
  - Only about 31% of the Sub-Saharan African population has access to electricity, Contrast with N. Africa – 99% access
  - Electrification rates as low as 9 – 20% in many Sub-Saharan African countries

- Inefficient Transmission and Distribution System
  - Distribution losses as high as 20% in Ghana and Senegal to 55% in Botswana

- Highly unstable and unreliable electricity supply from the grid
Energy Situation Africa

- High Generation costs
  - Over 80% of electricity generation in Africa is from fossil fuels
    - Highly vulnerable to price shocks
  - Average tariffs are US$0.14 per kWh compared to US$0.04 and US$0.07 per kWh in South and East Asia, respectively

- Low Electricity Consumption
  - Per capita electricity consumption of 571 kWh in Africa is 5 times less than world average

Other forms of energy

- About 80% of SSA population depends on biomass for cooking with very low efficiency in heat conversion of traditional stoves (10 – 15% efficiency)
  - Serious impacts on health and mortality (mostly affecting women and children)
- Huge dependence on animal and human labor for productive activities especially in rural areas
### The Opportunity: Energy Resources Potential of Africa

<table>
<thead>
<tr>
<th>Energy Type</th>
<th>Reserves</th>
<th>Regional Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-renewable</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crude oil</td>
<td>132.1 billion barrels</td>
<td>Northern Africa: 53.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Western Africa: 28.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Central Africa: 16.9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other Africa: 1.7%</td>
</tr>
<tr>
<td>Natural gas</td>
<td>14.7 trillion $m^3$</td>
<td>Northern Africa: 55.8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Western Africa: 36.1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other Africa: 8.2%</td>
</tr>
<tr>
<td>Coal</td>
<td>31.696 billion tones</td>
<td>Southern Africa: 95.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other Africa: 4.8%</td>
</tr>
<tr>
<td>Nuclear</td>
<td>Reasonably assured resources: 663,400 tonnes</td>
<td>Northern Africa: 2.9%</td>
</tr>
<tr>
<td></td>
<td>Inferred resources: 286,300 tonnes</td>
<td>Western Africa: 36.7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Central Africa: 2.7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eastern Africa: 4.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Southern Africa: 53.5%</td>
</tr>
<tr>
<td><strong>Renewable</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydro</td>
<td>1,834 TWh/yr</td>
<td>Central Africa: 57%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eastern Africa: 32%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other Africa: 11%</td>
</tr>
<tr>
<td>Biomass</td>
<td>Woody biomass: 70 billion tonnes</td>
<td>All regions</td>
</tr>
<tr>
<td>Solar</td>
<td>$^1$Solar insolation: 1800 – 2850 kWh/m².a</td>
<td>Most of Africa</td>
</tr>
<tr>
<td>Wind</td>
<td>$^1$Wind speeds:</td>
<td>Most attractive sites in the Northern</td>
</tr>
<tr>
<td></td>
<td>Southern Africa (6 – 8 m/s)</td>
<td>and Southern coasts</td>
</tr>
<tr>
<td></td>
<td>$^2$Northern Africa (5 – 8.5 m/s)</td>
<td></td>
</tr>
<tr>
<td>Geothermal</td>
<td>15,000 MW</td>
<td>Eastern Africa</td>
</tr>
</tbody>
</table>
# Energy context in Africa

Africa: the lowest electrification rate of the world

**SOURCE:** IEA, World Energy Outlook 2012

## Electricity access in 2010 - Regional aggregates

<table>
<thead>
<tr>
<th>Region</th>
<th>Population without electricity (millions)</th>
<th>Electrification rate (%)</th>
<th>Urban electrification rate (%)</th>
<th>Rural electrification rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing countries</td>
<td>1 265</td>
<td>76.1</td>
<td>92.1</td>
<td>63.7</td>
</tr>
<tr>
<td>Africa</td>
<td>590</td>
<td>43</td>
<td>72</td>
<td>24</td>
</tr>
<tr>
<td>North Africa</td>
<td>1</td>
<td>99</td>
<td>100</td>
<td>99</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>589</td>
<td>32</td>
<td>64</td>
<td>13</td>
</tr>
<tr>
<td>Developing Asia</td>
<td>628</td>
<td>83</td>
<td>96</td>
<td>74</td>
</tr>
<tr>
<td>China &amp; East Asia</td>
<td>157</td>
<td>92</td>
<td>98</td>
<td>88</td>
</tr>
<tr>
<td>South Asia</td>
<td>471</td>
<td>70</td>
<td>92</td>
<td>61</td>
</tr>
<tr>
<td>Latin America</td>
<td>29</td>
<td>94</td>
<td>98</td>
<td>76</td>
</tr>
<tr>
<td>Middle East</td>
<td>18</td>
<td>91</td>
<td>99</td>
<td>75</td>
</tr>
<tr>
<td>Transition economies &amp; OECD</td>
<td>2</td>
<td>99.8</td>
<td>100.0</td>
<td>99.5</td>
</tr>
<tr>
<td>World</td>
<td>1 267</td>
<td>81.5</td>
<td>94.7</td>
<td>68.0</td>
</tr>
</tbody>
</table>
Energy resources in Africa

Energy potentials: renewable energy resources (geothermal)

Geothermal energy

More concentrated in Eastern Africa
Energy resources in Africa

Energy potentials: renewable energy resources (biomass energy)

Biomass energy
25% of the global biomass reserves
Energy resources in Africa

Energy potentials: renewable energy resources (biomass energy)

Biomass density in the Africa continent (left) and total area used to produce sugarcane and oil palm in Africa in 2009
21. Int. Solarkochertagung: Ms Regula Ochsner, CEO of the swiss organisation ADES (Association pour le Développement de L´Énergie Solaire) presenting the successful implementation of solar cookers in Madagascar. www.adesolaire.org
TriesteNext, Trieste, Italy 26-28 September 2014

Public Educational Mission of ANSOLE

UNESCO World Science Day, 10 Nov. 2014, UCLAN, Westlakes, Britain
Technical and Vocational Education and Training as from 2016

New training programs: Solar cookers, solar photovoltaics, solar lamps, wood saving stoves, and solar heaters

Partners: ANSOLE, Full Gospel Mission in Cameroon, Liebe in Aktion e.V., EG Solar e.V., Performing Arts and Cinematography Section at the Faculty of Arts and Letters of the University of Yaounde I and Prof Tahar ACHOUR
Energy resources in Africa

Energy potentials: renewable energy resources (wind energy)

Wind energy
20% of global energy

More concentrated in northern and southern parts of the continent
# Energy resources in Africa

Energy potentials: renewable energy resources (wind energy)

<table>
<thead>
<tr>
<th>Country</th>
<th>Potential (m/s)</th>
<th>Number of Wind Pumps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botswana</td>
<td>2-3</td>
<td>200</td>
</tr>
<tr>
<td>Burundi</td>
<td>&gt;6</td>
<td>1</td>
</tr>
<tr>
<td>Djibouti</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Eritrea</td>
<td>3-8</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Kenya</td>
<td>3</td>
<td>272</td>
</tr>
<tr>
<td>Morocco</td>
<td>&gt;10</td>
<td>-</td>
</tr>
<tr>
<td>Mozambique</td>
<td>0.7-2.6</td>
<td>50</td>
</tr>
<tr>
<td>Namibia</td>
<td>-</td>
<td>30,000</td>
</tr>
<tr>
<td>Rwanda</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Seychelles</td>
<td>3.62-6.34</td>
<td>-</td>
</tr>
<tr>
<td>South Africa</td>
<td>7.29-9.7</td>
<td>300,000</td>
</tr>
<tr>
<td>Sudan</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Tanzania</td>
<td>3</td>
<td>58</td>
</tr>
<tr>
<td>Uganda</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Zambia</td>
<td>2.5</td>
<td>100</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>3-4</td>
<td>650</td>
</tr>
</tbody>
</table>
Energy resources in Africa

Energy potentials: renewable energy resources (hydro energy)

Hydro production potential of 1440 TWh/year
Solar Panels to ring the Moon
How the moon could provide for our energy

News and Trends, January 8, 2014

11000 Km solar panels around the moon equator and transmission of energy to Earth via microwave (Japanese project 2035)
Energy resources in Africa

Energy potentials: renewable energy resources (solar energy)

Solar energy: 74% of the continent receives more than 1900 kWh/m²/year
Energy resources in Africa

Energy potentials: renewable energy resources (solar energy)
Example of an adaptable and affordable technology

Easy transportation of a rolled up 135 W panel on a motorbike

Solamander 36 W photovoltaic panel mounted on a corrugated roof and held in place with nails

Solamander 135 W photovoltaic panel mounted on a corrugated roof
SOLAR PARABOLA For WATER HEATING
Mirela Alushllari, Alfred Alushllari
Institute of Applied Nuclear Physics, University of Tirana, Albania
(looking for investors)
Founder of the „Solarbier“ concept: Hubert Brandl
FELSEN BRÄU

Umweltbilanz pro Flasche Bier
Felsenbräu
Normale Produktion
2 g CO₂
73 g CO₂

98 % weniger Umweltbelastung
Felsenbräu: drink green!

Schmeckt gut. Jeder Schluck ein Beitrag
zum Umweltschutz. Prost!

DIE UMWELTBRAUEREI
FELSEN BRÄU
Frische aus Franken. Das Beste am Tag.
Solar Food Concept

Certification institutions:

www.solar-food.com
• Only about 30% of population in sub-Saharan Africa has access to electricity
• The present yearly economic growth of Africa is ~5.5%, despite of lack of sufficient energy and infrastructure.
• However, Africa cannot embark on the same path as Europe, USA and China for its development by relying only or strongly on environmental non-friendly energy sources. This is imperative in order to keep the predicted overall world temperature rise below 2% due to climate change.
• The appropriate use of the abundant solar energy can be regarded as a solution of the African energy problem
• Appropriate, adaptable, efficient and affordable electrical energy solutions are necessary
Energy resources in Africa

Energy potentials: Energy Efficiency and energy conservation

Status of Energy Efficiency in Africa
• Compared to renewables, very little done on energy efficiency
• Energy efficiency programmes largely absent
  • No evaluation of the real potential
  • Lack of information on energy efficiency
Energy resources in Africa

Energy potentials: Renewables and Energy Efficiency

Renewables and Energy Efficiency Policies in Africa

- Underdeveloped renewables and energy efficiency is reflection of energy policies

- Focus on conventional energy systems

- Lack of implementation plans for renewables and energy efficiency

- Rationale for promoting renewables and energy efficiency not well argued:
  - Leads to focus on conventional energy systems
  - Does not attract significant budgetary allocations
Energy resources in Africa

Energy potentials: Renewables and Energy Efficiency

Why should Africa promote Renewables?
• Significant energy resource potential exists
• Increasingly unreliable conventional energy supply
• Lowering the risk profile of energy sector
• Enhance competitiveness of agro-industries
• Minimise high oil import bills
• Job creation potential
• Decentralized energy supply

Why should Africa promote Energy Efficiency?
• Reduction in the cost of energy supply
  – Tunisia: Switch to SWH to reduce electricity cost by 20%
• Job creation potential
• Can attract CDM-related financing
• Industry: Reduction in the cost of production