No Longer a Triangle
(“all of the above” is difficult)
“Energy is Eternal Delight”

William Blake, The Marriage of Heaven and Hell, 1793

• Lighting
• Heating/cooling
• Refrigeration
• Pumping
• Transport
• Motors

We mostly take these for granted or assume their availability in wealthy countries.
It is a very different situation in poor countries.
Energy and development: “The golden thread”

A basis for *security*: migration, urbanization, equality

Impacts on *environment*: air pollution (indoor and outdoor), climate change

A foundation for *economic* activity across the economy

*Essential for social development: public health, education, food security, water services*

+Imminently “doable”: the physics in New York and Paris, the same as in Dhaka and Addis.
Ensure access to affordable, reliable, sustainable and modern energy for all

**TARGETS**

7.1 By 2030, ensure universal access to affordable, reliable and modern energy services

7.2 By 2030, increase substantially the share of renewable energy in the global energy mix

7.3 By 2030, double the global rate of improvement in energy efficiency

7.a By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology

7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support
UN Sustainable Energy for All initiative

One Goal: Achieving Sustainable Energy for All by 2030

Three Targets:

- Ensuring universal access to modern energy services.
- Doubling the global rate of improvement in energy efficiency.
- Doubling the share of renewable energy in the global energy mix.
• Roughly 600m without access in SSA now: projected to be 700m in 2030 (IEA). Only region going up in absolute terms.

• Without South Africa, the total SSA capacity is a mere 34 GW, equivalent to the installed capacity of Argentina.

• Manufacturing enterprises experience power outages on an average of 56 days per year; costs 6-16% of GDP.
Energy moving to Developing Economies

Total power system investment 2012-2035 is estimated at USD 16.9 trillion. Non-OECD countries account for 60% of cumulative investment.

As China slows, then India, Southeast Asia, the Middle East and parts of Africa & Latin America take over as the engines of global energy demand growth.
Non-linear growth needed
(more than a light – big markets)
## Multi-tier Framework

### Attributes

<table>
<thead>
<tr>
<th>Tier</th>
<th>Tier-1</th>
<th>Tier-2</th>
<th>Tier-3</th>
<th>Tier-4</th>
<th>Tier-5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Peak capacity</strong></td>
<td>Power</td>
<td>V. Low Power Min 3 W</td>
<td>Low Power Min 50 W</td>
<td>Medium Power Min 200 W</td>
<td>High power Min 800 W</td>
</tr>
<tr>
<td>AND Daily capacity</td>
<td>Min 12 Wh</td>
<td>Min 200 Wh</td>
<td>Min 1.0 kWh</td>
<td>Min 3.4 kWh</td>
<td>Min 8.2 kWh</td>
</tr>
<tr>
<td>OR, Services</td>
<td>Lighting of 1000 lm/hr/day</td>
<td>Electrical lighting, Air circulation, Television, and Phone charging are possible</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2. Duration</strong></td>
<td>Hours per day</td>
<td>Min 4 hrs</td>
<td>Min 4 hrs</td>
<td>Min 8 hrs</td>
<td>Min 16 hrs</td>
</tr>
<tr>
<td>Hours per evening</td>
<td>Min 1 hrs</td>
<td>Min 2 hrs</td>
<td></td>
<td>Min 3 hrs</td>
<td>Min 4 hrs</td>
</tr>
<tr>
<td><strong>4. Affordability</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Cost of a standard consumption package of 365 kWh per annum is less than 5% of household income</td>
</tr>
<tr>
<td><strong>3. Reliability</strong></td>
<td></td>
<td></td>
<td>Max 14 disruptions per week</td>
<td>Max 3 disruptions per week of total duration &lt; 2 hours</td>
<td></td>
</tr>
<tr>
<td><strong>5. Legality</strong></td>
<td></td>
<td></td>
<td>Bill is paid to the utility / pre-paid card seller / authorized representative</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>6. Health and Safety</strong></td>
<td></td>
<td></td>
<td>Absence of past accidents and perception of high risk in the future</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>7. Quality</strong></td>
<td></td>
<td></td>
<td>Voltage problems do not affect use of desired appliances</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Additional frameworks for access to energy for:
- Household cooking
- Productive engagements
- Community Infrastructure
In Kinshasa DRC, conventional access is 90%, but adjusting for service deficiencies score drops to 30%
Precedent of household electrification

In Nigeria, higher population density favours on-grid supply.
Low population density in Ethiopia means show mini- and off-grid solutions.
Environmental Trade-offs?

International Energy Agency (IEA): “Universal modern energy access does not have any significant impact on energy or climate security”

It depends...cookstoves or modern ovens and dishwashers...
Sustainable Energy for All initiative

One Goal: Achieving Sustainable Energy for All by 2030

Three Targets:
Investment flows need to triple to achieve the necessary pace of progress

<table>
<thead>
<tr>
<th>Annual investment</th>
<th>Universal access to modern energy services</th>
<th>Universal access to modern energy services</th>
<th>Doubling the global rate of improvement in energy efficiency</th>
<th>Doubling the share of renewable energy in the global mix</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Electrification</td>
<td>Cooking</td>
<td>Energy efficiency</td>
<td>Renewable energy</td>
<td>Total</td>
</tr>
<tr>
<td>Actual for 2012b</td>
<td>9</td>
<td>0.1</td>
<td>130</td>
<td>258</td>
<td>397</td>
</tr>
<tr>
<td>Required to 2030c</td>
<td>45</td>
<td>4.4</td>
<td>560</td>
<td>442–650</td>
<td>1,051–1,259</td>
</tr>
<tr>
<td>Gap</td>
<td>36</td>
<td>4.3</td>
<td>430</td>
<td>184–392</td>
<td>654–862</td>
</tr>
</tbody>
</table>
Our new estimates

Our medium estimate is roughly equivalent to other literature, including the World Energy Outlook 2012. The large disparity between our high scenario and the available literature is mostly due to the significantly higher assumption on per capita electricity use. That “high” per capita electricity use assumption is still roughly half of the average of today’s North African demand – so still nearly an order of magnitude lower than an OECD average.
Current flows are not being utilised entirely

Fig. 2. Analysis of aid disbursed over aid scheduled: data from OECD CRS database.
Readiness for Investment
The wrong image
Nearly 50% of sub-Saharan African companies own or share a generator.
10 Hotspots

1. Onshore Algeria/Tunisia
2. Angola
3. East Africa deepwater
4. Ethiopia
5. Gabon
6. Kenya
7. Mozambique
8. Tanzania
9. Uganda
10. Offshore West Africa

Proved reserves
- Oil (million bbls)
- Gas (bcf)

- Algeria: 12,200, 159,054
- Libya: 48,470, 54,701
- Egypt: 4,400, 77,200
- Nigeria: 37,140, 180,737
- Angola: 9,060, 9,711
- Mozambique: 0, 100,000

Majority of reserves and production remain concentrated in six countries:
- Nigeria
- Libya
- Algeria
- Egypt (gas)
- Mozambique (gas)
- Angola (oil)

Widespread reform has contributed to a doubling of economic output over the past decade.

2000: 138 active rotary rigs - highest in over 20 years

Source: E&Y, 2014
Oil, Governance, Aid, and Access
(an evolving story)

The $18 billion needed for access to electricity and to clean cooking stoves and cylinders, is a mere 0.4% of the government take from oil and gas export revenues in 2006-2030.
Flaring and planning

About 140 billion cubic meters annually

Enough to produce 750 billion kWh power

More than the entire power consumption on the African continent currently
Natural gas and Africa

Optimal transmission pipeline network and gas cost at city gate for the baseline scenario. Based on the estimated gas demand for 2050 and a gas production cost of $3/MMBtu. It is assumed that 1300 Bcf/year is exported from Matola (Southern Mozambique) to South Africa. The required investment is estimated at $56.7 Billion.

Estimated potential natural gas demand in sub-Saharan Africa by 2050.
Security and Geopolitics as Impetus and Lens

Providing energy services in the poorest countries can lower the risk of internal unrest and reduce the movement of people across borders.
Towards a research agenda

1. How do we link energy and development issues firmly with governance and security issues?

2. How to improve power planning methodologies, especially in fragile and conflict states under deep uncertainty?

3. How to respond to the challenges related to linkages with other sectors such as water and food security?

4. How to best understand links to natural gas and energy access?

5. How are the world’s financial institutions investing in the energy sector in developing countries, under what rules, and what rule-making?
Thank you

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Related references


Tawney, L., Miller, M, Bazilian, M. 2013. Innovation for sustainable energy from a pro-poor perspective. Climate Policy.


