0. Small Scale Renewable Energy overview

Energy solutions consist of one or more of the following functions:

- Energy generation (e.g. solar panels, wood burning chamber)
- Energy storage (e.g. battery), transportation (e.g. electricity-grid), or metering (e.g. smart meter).
- Energy use (e.g. cooking, lighting, charging a mobile phone).
Each function can be deployed at a different scale level. In Western energy systems, generation, storage and transportation are generally centralized (e.g. a coal power plant supplies electricity through the grid). In developing countries centralized energy infrastructure is only accessible for a part of the population, leaving a large need for off-grid energy solutions. In this overview the focus in on small scale application of the different energy functions. Small scale is defined as individual, household or community application. We focus specifically on energy solutions that are accessible and appropriate for those living in poverty.

Renewable or non-renewable fuels can be used to generate energy. In this overview the focus in on renewable energy sources, such as wind, water, solar and biomass. This document is based on information being available in 2013.

Key takeaways are noted in the boxed sections.

1. Market demand

1.1. Market description

- Energy is the second largest BoP market, after food, worth >500 billion USD per year.
- A large market for off-grid electricity solutions emerges, focused on rural Africa.

The market for small scale renewable energy solutions for developing countries can roughly be divided into a market for cooking or heating solutions, a market for lighting and a market for electricity, with a focus on phone charging.

- The 4 billion poorest people in the world spend >500 billion USD a year on energy, making energy the second largest BoP market, after food.
- Nearly 3 billion people use open fires or rudimentary stoves for cooking or heating, mostly using wood or charcoal as a fuel.
- The 4 billion poorest people in the world annually spend > US$ 250 billion on cooking fuels.
- 1.2 billion people have no access to the electricity grid.
- 900 million inefficient off-grid lighting points were in use, such as kerosene lamps, candles or flashlights with disposable batteries.
- Annual global spending for these inefficient off-grid lighting products is:
  - US 23 billion on kerosene for lighting
  - US 7 billion on candles

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1. See appendix 5
- $US 2.5 billion on disposable batteries\(^7\)
- An unknown amount of diesel generators and second-hand car batteries are used to supply electricity to off grid regions

- Mobile phone penetration rate has increased rapidly to 89% in developing countries, and 63% for the whole African continent, versus 128% for the developed world.
- 600 million mobile phone subscribers live in off-grid areas, predominantly in Sub-Saharan Africa and South Asia.\(^8\)
- Annual spending on off-grid mobile phone charging is estimated at US$ 3 billion\(^9\)
- While electrification in Asia and South America is progressing steadily, 90 million rural African households will not be connected to the grid by 2030\(^10\), making Africa the biggest future market for rural off-grid electricity solutions.

### 1.2. Impact description

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<td>Air pollution, caused by poor energy solutions, is recently recognized as one of the largest global killers</td>
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<td>The growing need for energy leads to massive environmental damage on a local and global scale</td>
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Not having access to affordable energy, or prolonged use of rudimentary solutions in combination with non-renewable and polluting fuels leads to a series of issues, both short and long term:

- **Health:**
  - Indoor air pollution leads to an estimated 3.5 million premature deaths, and is recently being recognized as one of the biggest global health issues\(^11\).
  - Continuous exposure to indoor air pollution causes chronic and acute health effects such as lung cancer, respiratory tract infections, low birth-weight in children.
  - Open fire poses the risk of severe burning
  - Women and young children suffer the worst health consequences\(^12\), because they come the most in contact with fires or fuels.
  - Children run the risk of deadly poisoning after kerosene ingestion, as liquid fuel is often sold in recycled drink bottles

- **Environment:**
  - The massive scale collection of firewood and production of charcoal leads to deforestation, mudslides and watershed issues.
  - The burning of non-renewable fuels leads to increased CO2 emissions and other greenhouse gasses which are linked to global warming.

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\(^7\) ibid  
\(^9\) ibid  
• Safety/livelihood
  o Especially women in refugee camps are vulnerable to attack when collecting firewood
  o Open fires pose risks of house fires, which can have especially devastating effects in dense urban slums.
  o A lack of firewood is an increasing source of conflict between communities

• Economic/educational
  o Having light in the home or workplace, or having access to a (charged) mobile phone increases people’s economic opportunities
  o Having light in the home, or spending less time on the collection of firewood, increases the learning potential of children

Even in electrified areas, access to the grid for the poorest is not a given. A grid connection is often unreliable, unaffordable, or unobtainable because a formal address, ID or bank account is required.

Experts indicate that in recent years, a shift in global attention (and subsequently funding) can be observed from a focus on environmental impact to a focus on individual health impacts.

1.3. End-user behavior trends

The trends below affect the uptake and development of the renewable energy market.

• Rapid urbanization:
  o Fuels are becoming increasingly expensive or scarce in urban areas.
  o Many of the poor do not benefit from urban electrification.

• Uptake of the mobile phone:
  o Mobile phones require regular charging, adding a new customer need – and a wide variety of formal and informal charging solutions - to the market place.
  o Feature phones are being replaced by smartphones, which are expected to replace certain consumer products, e.g. television and radio.

• Experts indicated increased exposure to global mass media (e.g. television, internet) leads to customer needs becoming more ‘aspirational’: people strive to have solutions that are similar in quality, look and feel to the solutions being portrayed in the media.
2. Market supply

2.1. Product landscape

- Product competition is strongest in sectors that have a high degree of mass production, such as solar lanterns, solar home systems or cookstoves. Opportunities exist for mass produced biogas, micro-wind and micro-hydro systems.
- Hybrid energy solutions are emerging, combining multiple fuels or multiple energy outputs.

The product landscape of small scale renewable energy technologies consists of a set of solutions for three major needs: cooking, lighting and electricity. The actual amounts of products installed is hard to quantify, because of the informal character of the market and of many products. Market surveys typically cover 1 product category in 1 country.

The main product categories for clean and efficient cooking are improved solid biofuel cookstoves and to a smaller extent biogas systems.

For off-grid electricity, solar systems are the dominant product category, either in the form of solar lanterns for individual lighting purposes, or solar home systems for household or community use. Cellphone charging is becoming a main feature in most of those solutions. Other common solutions for renewable energy generation are small scale wind and water turbines.

Solar cookers use direct solar radiation for cooking, while solar heaters use the sun’s rays to heat water, mainly for washing or water purification needs.

A series of hybrid systems exist. Biogas systems can be equipped with a gas-burning lamp. Larger scale biogas systems can be used to power an electricity generator. A new product category that is coming into play is cookstoves or biogas systems with integrated thermo-electrical generators that generate sufficient electricity for cell phone charging. Biogas systems are also often linked to sanitation (connecting toilets) or agriculture (bioslurry as fertilizer).

2.2. Supply chain

- China and India are emerging as new players in product design
- Focus is shifting away from product specs to last-mile distribution as a main differentiating factor

As the industry is maturing, the structure of the supply chains is becoming adapted to the level of mass production that is optimal for a product category, as well as to the unique distribution challenges posed by developing countries

- R&D: although Western research still dominates the field, recently industrialized countries such as China and India are increasingly active in renewable energy research
- Design: For items that are mass producible (notably solar) the design capabilities are shifting from the West to recently industrialized countries such as India and China. Artisanal designs still dominate in cookstove and biogas system design, but increasingly mass-producible
solutions (e.g. plastic or glass fiber biogas digesters) are being designed in recently industrialized countries such as China, India, Vietnam, Bangladesh.

- **Production**: Production in the West is limited, often only for early low-volume batches. Mass production items are generally coming from low-wage production countries such as China, Bangladesh or India, while many social businesses focus on local production as a means to generate social impact (jobs).
- **Assembly**: some developing countries offer tax cuts for organizations which do local assembly of imported mass produced components, which can make local assembly a more viable option.
- **Distribution**: the power balance in the sector is shifting from companies who are strong in design and manufacturing to companies who are strong in last-mile distribution, which distribute commodity energy solutions from low-wage production countries.
- **Training**: NGO’s are dominant in training, awareness creation and local capacity building. The focus is on training of entrepreneurs.
- **End-of-life**: Especially solar lanterns and solar home systems threaten to create a future e-waste problem, for which so far little attention is generated.

### 2.3. Revenue models

- **Energy is a sector with strong opportunities for commercially viable business models**
- **Fee-for-service models are emerging, instead of direct product purchases**

- Renewable energy solutions that require little investment (solar lanterns, cookstoves) are being sold based on a very short payback period for end-users (ex. less charcoal used for cooking, not having to pay for phone charging at charge kiosk)
- Micro-finance is the preferred option for products that require large investment, such as solar home systems or biogas systems
- Carbon finance, where investment in clean energy projects was paid for by trading future carbon reduction rights. suffered greatly from the decline in the global carbon credit prices.
- For community scale electricity solutions, smart metering and mobile phone payments are the keys to new fee-for-service models, where consumers do not own the electricity generation equipment, but only pay for the used electricity. Electrical appliances (televisions, refrigerator) can also be leased in a similar fee-for-use model
- New cookstove business models focus on generating revenues from selling pelletized solid biomass cooking fuels, often from agricultural waste, allowing a discount on the purchase price of a compatible cookstove.
- Revenues from related off-grid products aimed at the Western consumers, (ex. off-grid charging solutions for outdoor activities) are used to subsidize products for developing countries. A term often used is buy-one-give-one (BOGO). The effects of such discount models are questioned as disturbing local market initiatives.

### 2.4. Market leaders
The dominant players in the solar home and solar lantern market are typically SME-size companies who offer a series of solar home products in a number of developing countries, such as BBOXX\textsuperscript{13} or D-light\textsuperscript{14}. Typically, these companies have some form of Western design, capital and management, although Indian and Chinese entrepreneurs are emerging, such as Thrive Solar\textsuperscript{15}.

For cookstoves, the market is dominated by local artisanal cookstoves producers, often backed-up by support from Western NGO’s or funding, such as Toyola in Ghana\textsuperscript{16}, supported by the former E+Co\textsuperscript{17}. Western Social enterprises are distributing mass produced cookstoves, such as the Envirot\textsuperscript{18} stove. More advanced cookstoves with electrical components are brought to the market by companies such as Biolite\textsuperscript{19} or African Clean Energy\textsuperscript{20} together with consumer electronics multinational Philips.

For biogas systems, the market leaders are traditional masons, although an industry changing move to plastic digesters is expected. Several Western and Asian companies are currently developing mass production systems for these plastic digesters, as well as efficient distribution channels, such as Simgas\textsuperscript{21}.

Pico-hydro and micro-wind systems are mostly installed with some form of NGO or government involvement.

For all sectors, once the market has reached sufficient sales volume, a consolidation of market players is expected, as well as market entry by multinational corporations.

3. Knowledge state

\textsuperscript{13} http://bboxx.co.uk/
\textsuperscript{14} http://www.dlightdesign.com/
\textsuperscript{15} http://thriveenergy.co.in/
\textsuperscript{16} http://www.toyolaenergy.com/
\textsuperscript{17} http://www.compete-bioafrica.net/events/events2/Dakar/3-3-COMPETE-Conference-Dakar-Wurster.pdf
\textsuperscript{18} http://www.envirofit.org/
\textsuperscript{19} http://www.biolitestove.com/homestove/overview/
\textsuperscript{20} http://www.ace.co.ls/technology.php
\textsuperscript{21} http://www.simgas.com/
3.1. R&D Intensity

- Most research dedicated to developing countries is done on biomass and solar.
- There is an evident gap in research related to biogas and micro-hydro. Opportunity exists to conduct and publish high impact research as these are the most development-specific technologies.

Having analyzed the annual amount of scholarly and popular articles published in the Scopus database that focus on renewable energy technologies for developing countries, the following conclusions can be drawn from the data:

- A relatively large amount of articles on energy technologies is published in the energy sector due to its heavy focus on engineering.

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22 See appendix, paragraph 5 for detailed description of search database and keywords.
23 http://www.scopus.com/
• In generic renewable energy R&D, most scholarly articles are published on biomass, with solar catching up. Most popular scientific articles published address solar and wind technologies.
• Out of those articles, roughly 4% focuses specifically on developing countries.
• In R&D specifically aimed at developing countries, biomass is the dominant topic, followed at roughly half the intensity by solar.
• There is an evident gap in research related to biogas and micro-hydro. Opportunity exists to conduct and publish high impact research as these are the most development-specific technologies.

3.2. R&D centers, Journals and Conferences

• Newly industrialized countries, especially India, are upcoming R&D centers on research into small scale energy solutions
• There is continuing tension between scholars and practitioners about the pros and cons of development-specific research, journals or conferences.

The following universities and R&D centers have published the highest number of articles on small scale renewable energy technologies specifically focused on developing countries (2011 – 2013):

• Indian Institute of Technology, Delhi, India
• University of Ibadan, Ibadan, Nigeria
• UC Berkeley, Berkeley, USA
• Anna University, Chennai, India
• University of Malaya, Kuala Lumpur, Malaysia
• Indian Institute of Science, Bangalore, India
• The energy and Resources institute, New Delhi, India
• Indian institute for tropical meteorology, Pune, India
• Bangladesh University of Engineering and Technology, Dhaka, Bangladesh
• Indian Institute of Technology Roorkee, Roorkee, India
• Tsinghua University, Beijing, China
• Covenant University, Ota, Nigeria
• Wageningen University and Research Center, Wageningen, the Netherlands
• Norges Teknisk-Naturvitenskapelig, Trondheim, Norway
• Centre National de Recherche Scientific, Paris, France
• University of Ghana, Accra, Ghana
• National University of Singapore, Singapore, Singapore
• Georgia Institute of Technology, Atlanta, USA
• University of Maryland, Washington D.C., USA
• University of Nigeria, Nsukka, Nigeria

The following journals contain the highest number of articles on small scale renewable energy technologies for developing countries (2011 – 2013):
The following academic conferences yield the highest number of articles on small scale renewable energy technologies for developing countries (2011 – 2013):

- International Conference on the Developments in Renewable Energy Technology ICDRET
- World Renewable Energy Forum WREF and World Renewable Energy Congress WREC
- Solar World Congress SWC
- IEEE Power and Energy Society General Meeting
- IEEE Global Humanitarian Technology Conference GHTC
- American Institute of Physics Conference AIP
- American Institute of Chemical Engineers Annual Meeting Conference Proceedings AICHE
- International Conference on Electrical and Computer Engineering ICECE
- International Conference on Energy Efficient Technologies for Sustainability ICEETS
- International Renewable and Sustainable Energy Conference IRSEC
- International Conference and Utility Exhibition on Power and Energy Systems Issues and Prospects for Asia ICUE
- Institute of Engineering and Technology conference IET

Next to academic conferences which focus on researchers, conferences focusing on practitioners are widespread. These conferences tend to be based on specific problems or needs (deforestation), specific solutions (solar) or a specific geography (sub-Saharan Africa).

- Local universities in developing countries (especially India) are publishing an increasing share of research in small scale energy technologies. Measured in the amount of scientific articles produced, ‘Western’ universities are losing their previous dominance on this subject.
There is ongoing debate about the general quality of articles published in developing countries. Vanity publication and plagiarism are often mentioned occurrences in underdeveloped academic ecosystems. (The above list is created using the Scopus scientific index by Elsevier, which imposes certain quality controls). Other aspects that impact perceived quality can be a poor command of the English language, or unfamiliarity with the ‘Western’ scientific culture and traditions.

Most articles related to renewable energy in developing countries are published in generic journals in a wide variety of fields (physics, chemistry, environmental sciences, monitoring and evaluation studies, health).

Academic journals and conferences are often mono-disciplinary, focusing on a single scientific field (Physics, Chemistry, Environmental Sciences, Monitoring and Evaluation studies), while solutions for developing countries often involve a multidisciplinary approach.

Journals or conferences specifically focusing on technology for developing countries are scarce. There is ongoing debate in the scientific and practitioner community about the pros and cons of development-specific scientific journals

- Pro:
  - More focus on and understanding of specific local situation which has high impact on solutions/interventions/observations
  - Lower barrier to publish for local researchers from developing countries

- Con:
  - Potentially lower academic quality and rigor
  - Risk of disconnect from the generic field of science

Medical or health related journals or conferences are absent in the top-20, even though the topic of indoor air pollution from woodstove cooking / kerosene lighting and its relation to mortality and morbidity came out as a trend among practitioners.

### 3.3. Technology related trends

- **People in developing countries are directly affected by major global energy technology trends, such as price decreases for solar panels, or increased demand for biofuels.**

Key trends at the intersection of renewable energy technology and energy products that directly affect consumers at the base of the pyramid are:

- Further price decreases and efficiency increases in mass produced electronic components (LED, PV panels, Li-Ion batteries) ensure the continued competitiveness of small scale solar lighting and electricity products.
- Further efficiency increase in consumer electronics leads to affordable and energy efficient consumer electronic devices (televisions, radios, routers) suited for low voltage off grid electricity systems.
- Rapid adoption of smartphones in developing countries, opening up new uses and demands:
  - Demand for charging will outgrow demand for lighting
  - Smartphones will partly replace certain consumer devices (TV, radio, camera, wifi-router)
• Increasing understanding of and focus on health impact of indoor air pollution related to burning of biomass will lead to cleaner cooking solutions
  o Nano particles
  o Removing sulphur from biogas
• Global market demand for biofuels will impact the BoP. A balance needs to be found between lowering carbon emissions and preventing increased pressure on agricultural land and vulnerable communities
• The packaging of solar (lighting, electricity) and biomass (cooking) products into a single energy offering makes energy solutions more accessible and affordable.
• Better understanding of local cooking habits leads to a new range of cooking devices
  o Purpose or region specific cookstoves and cookware
  o Combination of biogas systems and improved cookstoves into one offering for different cooking needs

3.4. Standardization and test centers

- Standardization for solar products and cookstoves is solidifying, while standardization for biogas, small wind and micro-hydro is still in a premature state.
- Formulating, implementing and enforcing standardization continues to be problematic in many developing countries

Standardisation for different product categories is in different phases of maturity:

• Cookstoves
  o The Clean Cooking Catalog by the Clean Cookstove Alliance24 shows tested cookstoves, a global listing of test centers and published detailed test results.
  o ISO Technical Committee 28525 on Clean Cookstoves and Clean Cooking Solutions is being prepared
  o In the meantime, the interim IWA 11:2012 framework26 for rating cookstoves on several performance criteria is adopted, focusing on fuel efficiency, in/outdoor carbon and particulate matter emissions and safety.

• Biogas
  o standardisation is most often seen on a national biogas program level, and often manifest itself in the form of training manuals27. New biogas countries will typically copy and adapt best practices from an early biogas country. Most burner designs for instance can be traced back to an original burner used in the Cambodia National Biogas program. Standardisation is often focused on locally built brick dome digesters.
  o The Kenya Bureau of Standards is currently designing standards for brick dome and plastic biogas digesters, biogas lamps and biogas stoves, which are expected to be

24 http://catalog.cleancookstoves.org/
26 http://www.iso.org/iso/catalogue_detail?csnumber=61975
used as input for ISO Technical Committee 255\textsuperscript{28} to make a uniform standard for developing countries.

- **Solar lanterns**
  - Due to a significant push by World Bank and IFC’s Lighting Global initiative, standards and test centers specifically aiming at solar lanterns have emerged. Lighting Global offers minimum quality standards\textsuperscript{29}, test methods\textsuperscript{30}, links to test centers\textsuperscript{31}, and awards outstanding products\textsuperscript{32}

- **Solar home systems**
  - International standardization for solar home solutions is advanced, building on generic solar standardization from IEC, ISO, IEEE, ASTM and others.
  - For developing countries, IEC has formulated Technical Specification 62257, “Recommendations for small renewable energy and hybrid systems for rural electrification”\textsuperscript{33}. IEC, WorldBank and the UN agreed that stakeholders from developing countries can access these specifications for a discounted price.

- **Wind:**
  - No international consensus exists on the definition of pico, micro or mini wind. IEC standards exist for small wind, which is defined as a turbine having a <200m\textsuperscript{2} rotor area, which typically produces up to 50 kW of output, therefore a much larger scale than home or community use.
  - Experts typically borrow from Canadian standards\textsuperscript{34} for mini-wind (0.3-1 kW) or UK standards\textsuperscript{35} for micro-wind (0-1.5kW) for small scale solutions for developing countries

- **Micro-hydro**
  - The IEC’s technical committee TC 4 – Hydraulic turbines – published standards for water energy, however most of these standards are for large scale applications.
  - Nepal has established a micro-to-pico Turbine Test Center\textsuperscript{36} aiming at developing new solutions and standardization for small scale hydro turbine technology.

- **Developing countries face a large number of difficulties in formulating, implementing and enforcing process and product standards related to medical devices. Reasons are:**
  - Inadequate institutional infrastructure and capabilities
  - Insufficient knowhow in standards development processes

\textsuperscript{28}http://www.iso.org/iso/home/standards_development/list_of_iso_technical_committees/iso_technical_committee.htm?commid=617083
\textsuperscript{29}http://lightingglobal.org/activities/qa/standards
\textsuperscript{30}http://lightingglobal.org/activities/qa/testmethods
\textsuperscript{31}http://lightingglobal.org/activities/qa/testing
\textsuperscript{32}http://lightingglobal.org/activities/outstanding-product-awards
\textsuperscript{33}http://webstore.iec.ch/Webstore/webstore.nsf/ArtNum_PK/48704?opendocument&preview=1
\textsuperscript{34}http://www.canwea.ca/swe/certification.php?id=68
\textsuperscript{35}http://www.microgenerationcertification.org/mcs-standards/product-standards
\textsuperscript{36}http://www.ku.edu.np/mech/water_power_laboratory/Turbine%20Testing%20Laboratory.htm
- Little awareness and little access to information on standardization
- Limited participation in international standard setting
- Poor coordination among agencies responsible for technical regulations
- Inadequate funding
- Inadequate stakeholder participation
- Corruption

- The International Renewable Energy Agency IRENA has published a document summarizing local and international standardization and gaps for renewable energy technologies.

### 4. Support ecosystem

#### 4.1. Funding and financing

- **Funding for R&D for energy solutions in developing countries is shifting away from government institutions towards charities**
- **Project funding by NGO’s is being replaced by impact investment, with government agencies starting to fund the “pioneer gap” between R&D and commercialization.**

The following trends can be observed in 3 types of funding that are relevant for energy products in developing countries.

- **R&D funding: fundamental and applied scientific research**
  - both US and EU national research agendas have a strong focus on national energy issues, and leave little room for funding development-specific energy research.
  - A growing majority of global R&D is financed by private, mostly multinational enterprises, which are increasingly focusing on energy solutions for developing countries. Examples are Philips and Panasonic who are developing consumer energy products, Total which is growing its fuel distribution network, and Schneider which supplies B2B energy solutions. Multinationals are often partnering with universities and NGO’s for developing and testing innovative concepts.
  - Charities such as the Bill & Melinda Gates foundation are increasingly funding fundamental R&D specifically aimed at pressing issues in developing countries that get little attention in the West, such as sanitation, malaria and clean cooking.

- **Project funding: projects aiming for impact without commercial objectives.**
  - With the energy sector being quite commercial in nature, mostly humanitarian or disaster relief projects are supported by this kind of funding.
  - Funding comes from national programs (e.g. USAID) or through fundraising by NGO’s and charities. In many countries in the West, government funding of NGO’s is under pressure.
  - Donor organizations generally prefer funding projects implementing proven technologies, leaving little room for technological or product innovation.

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• Social business funding: businesses that combine a focus on reaching social or environmental impact with financial sustainability
  
  o Impact investors (venture capitalist who aim for both social/environmental as well as financial impact) are increasingly interested in funding start-up or scaling-up activities for renewable energy business with a sustainable business model. Examples are Acumen Fund38, Omidyar39, Bamboo Finance40, or Calvert Foundation41. Rabobank42 in the Netherlands has set up an Inclusive Business Fund, aiming at similar impact investments. DFID’s Impact Fund43 will invest 75 million GBP through impact investors.
  
  o Micro-credit institutions such as Grameenbank44 finance very small loans so consumers can invest in improved energy solutions
  
  o For the development of innovative products and business, the “Pioneer Gap” is poses an obstacle. R&D funding and some grant money can finance the first stages of development of a social business, but the output of such projects (a proof of concept, demo, small scale pilot) is still too risky for impact investors to invest in. Some national development agencies are making funding available to bridge this Pioneer Gap, such as SIDA’s Innovations Against Poverty45, and USAID DIV46 program.
  
  o The U.S. African Development Foundation (USADF), which is part of the Power Africa Initiative will launch a $2 million Off-Grid Energy Challenge to provide grants of up to $100,000 to African-owned and operated enterprises to develop or expand the use of proven technologies for off-grid electricity benefitting rural and marginal populations47.
  
Several innovation hubs are being created that offer a holistic service portfolio. An energy specific hub is InfoDev’s Climate Innovation Centers48, which offers market intelligence, business advisory and training, government advisory, and venture finance.

38 http://acumen.org/sectors/energy/
39 http://www.omidyar.com/portfolio
40 http://www.bamboofinance.com/?s=energy
41 http://www.calvertfoundation.org/impact/issues/environment
43 http://asenetwork.org/2013/01/28/dfid-impact-fund-proposals-request/
45 http://www.sida.se/English/Partners/Private-sector/Collaboration-opportunities/Challenge-Funds/Innovations-against-poverty/
46 http://www.usaid.gov/div/apply
47 http://www.usadf.gov/USADFOffGridChallenge.html
48 http://www.infodev.org/climate
4.2. Political and institutional support

- Policy focus is shifting from environmental to health effects
- The US policy is guided by the 7 billion USD Power Africa Initiative

- Global institutional support for renewable energy is strong. However, the financial crisis is seen as a factor limiting countries priority to invest in clean technologies.
  - The UNDP\textsuperscript{49} sees global access to clean, reliable and affordable energy as a central requirement for sustainable development and poverty reduction, which is a basic precondition to meet all 8 Millennium Development Goals. The United Nations is initiator of the Alliance for Clean Cookstoves
  - The Worldbank\textsuperscript{50} focuses on the economic and environmental effects of access to energy, both in terms of economic development as related to the negative effects of CO2 related climate change. Together with IFC, Worldbank initiated the Lighting Global program.
- The United States pledged 7 billion USD to the Power Africa initiative\textsuperscript{51}, of which the Off-grid Energy Challenge is specifically relevant.
- The Clean Development Mechanism\textsuperscript{52}, one of the schemes of the Kyoto protocol and its predecessors, provides the basis to offset pollution in developed countries by preventing carbon emissions in developing countries. The recent implosion of the carbon credit market has greatly limited the possibilities to use carbon financing to set up renewable energy projects.
- Instead of a focus on environmental issues, health issues related to poor energy solutions are being put higher on the agenda.
- The uptake of renewable energy is heavily dependent on national policies. The Renewable Energy Policy Network has created an overview\textsuperscript{53} of national policies worldwide. Although most developing countries have adopted or are adopting policies stimulating renewable energy, at the same time policies that hinder the rapid adoption of renewable energy products are in place. Examples are the absence of feed-in tariffs, incumbent national energy monopolies that are threatened by decentralized energy generation, import-taxes or the subsidization of non-renewable energy to stimulate the local economy.

4.3. Awards and recognition

- Industry status is achieved by working with the right partners
- Awards are being pursued for status, the financial gains are often limited

Apart from criteria such as the actual achieved impact, or scientific recognition via publications, awards and recognition come in many forms.

\textsuperscript{49} http://www.undp.org/content/undp/en/home/ourwork/environmentandenergy/focus_areas/sustainable-energy.html
\textsuperscript{50} http://www.worldbank.org/en/topic/energy
\textsuperscript{51} http://www.whitehouse.gov/the-press-office/2013/06/30/fact-sheet-power-africa
\textsuperscript{52} http://cdm.unfccc.int/
\textsuperscript{53} http://www.ren21.net/REN21Activities/GlobalStatusReport.aspx
• Fellowships such as Ashoka: Innovators for the Public\textsuperscript{54}
• Awards such as the Ashden Award\textsuperscript{55}, or Siemens Stiftung Empowering People Award\textsuperscript{56}. Companies enter for the publicity, not for the prize money, which is generally low in comparison to the amount of effort required to participate (i.e. compared to applying for grants).
• Working with the right partners: A certain status within the industry can be derived from working with top funders such as the Bill&Melinda Gates Foundation, renowned universities such as MIT or large NGO’s .

\textsuperscript{54} https://www.ashoka.org/fellows
5. Poverty definition

Poverty can be defined economically as those living below a certain income threshold, typically less than 1.25 or 2 USD a day (at 2005 Purchasing Price Parity)\textsuperscript{57}. Such quantitative definitions are often criticized for not taking into account price differences between regions, excluding non-monetary income (e.g. produce from subsistence farming), or ignoring that poverty is a continuum with different levels of hardship. We follow the qualitative definition of the UN, which describes poverty in broader terms as a “lack of income and productive resources to ensure sustainable livelihoods; hunger and malnutrition; ill health; limited or lack of access to education and other basic services; increased morbidity and mortality from illness, homelessness and inadequate housing; unsafe environments and social discrimination and exclusion”\textsuperscript{58}

6. Acknowledgement

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7. Background on R&D state search methodology

7.1. Search Database

The database used for these analytics is Scopus, the world’s largest online database of peer-reviewed articles and abstracts, by Elsevier. Scopus covers over 50 million records from 21,000 journal titles by 5,000 publishers.

Scopus also offers advanced online search tools, covering ‘popular scientific’ publications outside of the Scopus database. Those publications include scientists’ homepages, courseware, patents, institutional repositories as well as selected web content such as reports from World Bank, OECD etc.

(note: at the moment Scopus uses both the instrumentation from LexisNexis and Scirius for its online search tooling. Scirius will stop its activities after Q2 2014. We have been in contact with the people from Elsevier who ensured us they will have comparable online search capabilities after Q2 2014 in place for Scopus.)

\textsuperscript{57} \url{http://go.worldbank.org/77LE4ON4V0}
\textsuperscript{58} \url{http://www.un.org/esa/socdev/unyin/documents/ydiDavidGordon_poverty.pdf}
7.2. Search Queries

The search queries that have been used to yield the data on which this analysis is built consists of combinations of 3 search terms:

1. A search term describing the field of ‘Energy’
3. A search term describing ‘Developing Countries’