Mapping of PV and Wind markets in Kenya: Current state and trends

Selected highlights from the report and ideas for further reserach

Ulrich Elmer Hansen, IREK workshop, Eldoret, Jan-Feb, 2017

Presentation

- Background
- Research questions
- Theory and methods
- Main findings
- Ideas for further research.

Background of the report

- The expansion of renewable energy sources, especially wind and solar power, has been given high priority in national policies in Kenya
- Updated information on the development and diffusion of wind and solar technologies in Kenya is currently lacking
- Report take stock of the markets for wind and solar PV in Kenya
- Provide a common reference document for other tasks in IREK.

Research questions

- How do wind and solar markets in Kenya differ in terms of development and organization?
- What are the current status and trends (across PV and wind) mini-grids and large-scale (grid-connected) market segments?
- What are the key drivers and barriers for the observed market trends?

Theory and methods

Sectoral Innovation System (SIS) perspective:

- Innovation dynamics depend on the specific characteristics of a given sector or industry
- SIS differs in terms of: knowledge bases, users, producers, investors, actors, prices, scale, R&D-intensity, value chains, technical characteristics

Three main elements:

- Knowledge and technologies: tacit/codified, knowledge bases,..
- Actors and networks: linkages, input-output structures, value chains,..
- Institutions: regulatory set-up, policy, incentive structures, social norms,..

Method/Data: Review of documentary material, webpages, journal papers, prior research, discussions with Phd and master students.

Analysis of four distinctive wind and solar SIS

- Large-scale power plants:
  - Grid-connected plants owned by utilities and/or private operators with installed capacities above 15 MW
- Small-scale (mini-grids):
  - Off-grid power generation assets and distribution, capacity between 0.2 kW-2 MW to two or more individual households

	Wind	Solar
Large	Grid-connected wind power plants	Grid-connected solar power plants
Small	Mini-grids using small scale wind turbines	Solar-powered mini-grids

Research question #1

How do wind and solar markets in Kenya differ in terms of development and organization?

	Wind mini-grids	Large-scale Wind	Solar mini-grids	Large-scale solar
Knowledge and technologies	Domestic wind turbine industry characterized by: • **Small-scale** and **simple** wind turbines • **Informal** learning and knowledge • Local **craftsmen** and engineers • **Limited knowledge** in wind-powered mini-grids • **Absence of formalized R&D** activities carried out at universities in small-scale wind turbines • **Import** of higher standard wind turbines	• **Formalized R&D** in large-scale wind turbines • Technical and engineering-based disciplines • **Complex** and **capital-intensive** capital goods • Experience in **EPC** contracting and planning of large-scale plants • Expertise in **PPA** contract negotiation and legal aspects • **Design of project** tailored to local conditions	• **Engineering**-based knowledge • **Telecom expertise** (mobile payment schemes, **PAYG** models) • **Smart metering** and monitoring systems • Data management and **software** optimization tools • Consultancy and donor experience	• **Engineering**-based knowledge • Experience in **turnkey** contacting • Experience in **EPC** contracting and planning of large-scale plants • Knowledge System design integration and operation

	Wind mini-grids	Large-scale Wind	Solar mini-grids	Large-scale solar
Actors and networks	• **Donors, NGOs**, local manufacturers involved in small-scale development projects • Actors embedded in **local and regional supply chains** and distribution networks • Universities involved in **practical** and **hands-on** applied research in specific projects • Absence of private suppliers of wind-powered mini-grids • Importers of foreign wind turbines	• Industry **lead firms**, such as **Vestas and General Electric** • **International investors,** including development banks, donors and pension funds • National policy makers and key government agencies (e.g. via direct negotiation with project developers) • Local community groups (opposing projects)	• **European turnkey contractors** • Local engineering and consultancy firms • **Private suppliers** of mini-grids owned by **foreign expatriates** • **Foreign investors** (direct plant investments and equity investments) • **Foreign component suppliers** • Examples of cooperatives and community-based solar mini girds	• International EPC contractors • Technology suppliers • International investors, including development banks and donors • Industrial users

	Wind mini-grids	Large-scale Wind	Solar mini-grids	Large-scale solar
Institutions	• **State and donor** support for **hybridization** of the existing diesel-fired mini-grids	• **Feed-in tariff** for wind power projects	• **State and donor** support for **hybridization** of the existing diesel-fired mini-grids	• **Feed-in tariff** for wind power projects

Summary

Are the differences/similarities in SIS characteristics greatest between (a) solar vs wind or (b) large vs. small? (RL):

- High similarity between large-scale wind and solar projects:
  - Scientific knowledge (R&D), capital intensive, EPC experience, turnkey contracting, PPA negotiation, management of large scale projects, foreign technology and expertise, foreign investors
- Large-scale wind and solar differs from small-scale wind and solar mini-grids:
  - Mini-grids are decentral, dependent of tariff structures, cross-subsidies, rural electrification domain, grid-extension, donor-driven hybridisation,
- But: significant differences between wind and solar mini-grids:
  - Wind mini-grids: informal knowledge, simple technology, local craftsmen, local supply chains, individual donor projects, hybrids in existing plants
  - Solar mini-grids: hybrids as well as private operators, foreign expertise and technology, highly specialised, telecom, BoP business models,

Research question #2

What are the current status and trends (across PV and wind) mini-grids and large-scale (grid-connected) market segments?

Wind-powered mini-grids

Mini-grid	Type	Nominal Capacity	Effective Capacity	Customers
Baragoi	Diesel	248 kW	138 kW	230
Eldas	Diesel	184 kW	184 kW	80
Elwak	Hybrid Solar	740 kW	610 kW	802
Habaswein	Hybrid Solar and Wind	760 kW	542 kW	1,015
Hola	Hybrid Solar	1,220 kW	660 kW	1,956
Lodwar	Hybrid Solar	2,740 kW	1,480 kW	2,380
Lokichoggio	Diesel	680 kW	500 kW	166
Mandera	Hybrid Solar	2,350 kW	1,480 kW	4,000
Marsabit	Hybrid Wind	2,900 kW	2,800 kW	3,300
Merti	Hybrid Solar	250 kW	170 kW	436
Mfangano	Hybrid Solar	520 kW	390 kW	120
Mpeketoni	Diesel	1,285 kW	950 kW	1,503
Rhamu	Diesel	184 kW	184 kW	2,132
Takaba	Hybrid Solar	244 kW	244 kW	300
Wajir	Diesel	3,400 kW	3,130 kW	4,100
TOTAL		**17,705 KW**	**13,462 KW**	**20,598**

Large-scale, grid-connected wind power projects

- 1 Plant in operation: (25.5 MW) Ngong Power Station, owned by KenGen
- 4 plants under development:

Name	Status
Lake Turkana project (310 MW)	Planned start: June 2017
Kipeto Energy Wind Park (100 MW)	PPA signed with KPLC, but not approved by ERC (under evaluation)
Kinangop Wind Park (60 MW)	Cancelled in early 2016
Baharini Electra Wind Farm project (90 MW)	Financial closure and PPA have not been agreed

- 236 applications submitted under the FIT, but none have signed PPA's.

Solar-powered mini-grids

- 8 state-owned, hybrid mini-grid stations are currently in operation
- 15 state-owned, solar mini-grids are currently under construction
- DFID's Kitoyni mini-grid (solar-diesel hybrid, 13.5 kWp)
- UNIDO's Olosho Oibor mini-grid (solar-wind-diesel hybrid, 10 kWp)
- REA's call for tenders for 25 new solar mini-grids in 2016
- 26 solar mini-grids under develpoment by the KfW and GIZ
- 5 solar mini-grids by the Spanish Development Agency
- 20-30 solar-powered mini-grids (1.4-10 kW) by private operators (Powerhive, PowerGen, SteamaCo and Talek)
- Private operators currently upscaling their businesses.

Large-scale, grid-connected solar power projects

- 5 grid-connected solar power plants in operation:
  - Rooftop (575 kWp) PV system UN compound, Nairobi
  - SOS Children's village in Nairobi (60 kWp)
  - 72 kWp system installed at a flower farm
  - 1 MWp plant at a tea-processing facility
  - Strathmore University rooftop system (0.6 MW)
- 7 new grid-connected plants under development under the FIT:
  - Samburu project (40 MW)
  - Garissa project (50 MW)
  - Greenmillenia Energy project (40 MW)
  - Nakuru project (50 MW),
  - Kopere Solar Park project (17 MW),
  - Witu Solar Power project (40 MW), and
  - Alten Kenya Solarfarm project (40 MW)
- Not reached financial closure and signed PPA's (Garissa?).

Summary

Wind:

- The market for small-scale wind-based mini-grids is not moving: very few existing and planned hybrids and no private suppliers of mini-grids
- The market for large-scale wind projects is moving to some extent, driven by a limited number of very large-scale projects, especially Lake Turkana

Solar:

- The market for small-scale solar-based mini-grids is booming: both private mini-grid operators and many donors in existing and planned hybrid and greenfield mini-grids
- The market for large-scale solar projects is not moving on the ground (existing projects only small scale, most at planning stage)

→ Observed trends: indicators of the relative strength of the four SIS? (RL)

Research question #3

What are the key drivers and barriers for the observed market trends?

Wind-powered mini-grids

	Drivers (enabling conditions)	Barriers (disenabling conditions)
Knowledge and technologies	• The increasing costs of competing technologies and practices, especially diesel • Generally decreasing costs of wind turbines globally • Good wind resources and possibilities for competitive wind-powered mini-grids in a number of locations	• Very limited domestic expertise in larger scale (15-100kW) stand-alone, wind mini-grids • Lack of local reference plants, proven technical concepts and business models • The technology used in large-scale wind-turbine systems are not compatible with smaller scale-systems • General trend in the global wind industry involves focusing development efforts on developing larger and more efficient turbines and not for small-scale plants
Actors and networks		• Local providers of wind turbines increasingly shifted their focus toward the emerging market for solar PV • Absence of local suppliers of wind-powered mini grids on a commercial basis • Global lead firms not active on the local market for small-scale wind turbines and wind-powered mini-grids in Kenya
Institutions	• State and donor support for the development of wind-diesel hybrids	• Wind-powered mini-grids appears under-prioritized by the state and donors in comparison with solar

Grid-connected wind power projects

	Drivers (enabling conditions)	Barriers (disenabling conditions)
Knowledge and technologies	• Alignment between the demand for large-scale wind power projects and the competences and strategic orientation of lead firms • Decreasing costs of wind turbines globally • Good wind resources in a number of locations	• The inclusion of wind power into the existing grid is challenging from a technical perspective
Actors and networks	• Involvement of foreign expertise in the design, construction and management of large-scale wind power projects (EPC contractors, construction companies and consultancy firms) • Involvement of globally-leading wind turbine suppliers (well-proven technological concepts)	• Local communities and interest groups opposing against the development of wind power projects
Institutions	• Financial and advisory support from international donors and development banks • Feed-in tariff for wind power projects	• Lengthy approval process • Difficulties in securing sufficient funding from foreign investors and reaching financial closure • Lack of a comprehensive plan and detailed regulatory framework

Solar-powered mini-grids

	Drivers (enabling conditions)	Barriers (disenabling conditions)
Knowledge and technologies	• Expertise in business start-up, engineering consultancy, telecommunications • Introduction of smart metering and monitoring technologies, mobile payment schemes • Widespread use of mobile phones (enabling the emergence of PAYG business models) • The increasing costs of diesel • Price/performance improvements in core technology components (panels, batteries, BoS)	
Actors and networks	• Highly specialized foreign-owned companies • Rural consumers able to purchase electricity on a daily basis depending on need	• KPLC have objected to new license applications
Institutions	• State and donor support for hybridisation of existing diesel-fired mini-grids with solar • Significant funding provided from foreign investors to private suppliers of mini-grids • GIZ directly involved in promoting mini-grids in Kenya through the company Talek • Private suppliers of solar-powered mini-grids promoting regulatory changes in favour of commercial mini-grids (license and tariff system)	• Business models of private mini-grid suppliers dependent on securing continued funding and project orders • Lack of regulatory framework and clear policy concerning tariffs for commercial mini-grids (lengthy negotiation and approval process) • Lack of framework for future integration with national grid should it arrive at a mini-grid site

Grid-connected solar power projects

	Drivers (enabling conditions)	Barriers (disenabling conditions)
Knowledge and technologies	• Decreasing costs of solar panels globally • Solar radiation offer favorable conditions for solar power in a number locations • Tested and well-proven technology globally only requiring minor adaptation (short project cycle)	
Actors and networks	• Local presence of a number of renowned European technology suppliers and contractors • Local labor used during construction and operation (reducing investment and operational costs)	
Institutions	• Financial support from international donors and development banks • Feed-in tariff for solar power projects	• Difficulties in securing sufficient funding from foreign investors and reaching financial closure • Uncertainties concerning future policy framework

Summary

Communalities across the four SIS:

Drivers:

- Decreasing cost of core technology components
- Increasing cost of existing technologies, diesel and HFO
- Donor support and foreign investors
- Expertise and proven technology from abroad
- Favourable solar and wind conditions in specific locations

Barriers:

- Sufficient financing (direct project investments) to reach closure
- Lengthy PPA negotiation and approval process
- Uncertainty about future regulatory framework
- Tariff negotiations ongoing.

Ideas for further reserach

The domestic wind turbine industry:

- Role of Chinese actors and products
- Domestic capabilities in manufacturing of key components

Large-scale solar and mini-grids:

- More info on status and development of specific projects
- Linkages to domestic SHS industry (battery suppliers, panel importers, technicians,)
- How do the market for solar Pico products relate to SHS and mini-grids, grid extension

Politics and governance:

- From FIT to competitive bidding (Anton Eberhard, Wikus Krüger from Uni. of Cape Town) experience from South Africa - policy change in Kenya (Newell, Lakshmi)

Foreign vs. local involvement:

- Report only looks at presence/non-presence of foreign (EU/China) and local actors
- Analysis of the effect (e.g. on capability/industry development) of foreign or local involvement