



Solar panels on a farm, Mali
Photo: © Curt Carnemark / World Bank

Scaling Innovation at the Energy-Agriculture Nexus in East Africa

Sectoral Business Condition Brief



Executive Summary

With rising global demand for food, there is an urgent need to find climate-smart ways to intensify agricultural production. As the population expands, agribusinesses not only need to fight food losses but also produce and process at least 70% more food on the same amount of agricultural land to feed the world.¹ Identifying means by which clean energy technology can be used to intensify agricultural production and facilitate processing will be crucial in meeting this demand.²

Investing in the promotion of green energy solutions for sustainable agriculture has multiple benefits for the economy and population in Kenya and Uganda.

Agriculture is the backbone and major driver of both countries' economies and is already a hub for innovation.³ Investing in green energy solutions will boost economic growth and create decent jobs in a sustainable industry. It also addresses critical development challenges and contributes to achieving various Sustainable Development Goals (SDGs) including food security, employment and enterprise creation, and climate action, which are also focus areas of the Kenyan government.⁴

In the 10 years of the SEED Awards, we have seen a trend towards innovation at the nexus between energy and agriculture in East Africa.

East Africa is among the regions where most technological solutions at the nexus are developed and applied.^{5 6} Eco-enterprises develop and adopt diverse low-cost solutions such as solar pumping, heating, drying, cooling and chilling, biogas production and biomass powered milling, pressing and grinding for smallholder farmers and Small, Medium and Micro-sized Enterprises (SMMEs) to power their agriculture, or generate clean energy. These technologies can lead to increased agricultural productivity and strengthen smallholders through direct access to markets.

Technology application is still in its infancy. Several barriers prevent solutions at the nexus from reaching scale, including relatively high technology costs, limited awareness on the benefits of using green energy solu-

tions, lack of reliable policy incentives, as well as limited access to finance for both technology innovators and customers.

Policy makers can catalyse development of the sector through four key actions:

- 1 Provide consistent policy strategy and coordinate sector activities
- 2 Invest in research and development of appropriate technologies at the local level
- 3 Incentivise the application of technologies at the nexus; and
- 4 Facilitate access to finance

To this end, policy makers can collaborate with and support other ecosystem actors, including development partners, financing institutions, local implementation partners and academia. To fully unleash the potential of green energy solutions for agriculture and create a thriving and competitive industry, policy makers in East Africa need to mainstream a holistic and integrated nexus thinking in the key policy frameworks affecting energy and agriculture. As a first step, ministries responsible for agriculture, energy, water and environment, economic development and finance need to coordinate and identify who in their local context is best placed to address the barriers outlined above and how the government can best support innovators in this space.

¹ FAO. How to Feed the World in 2050, p.4. http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf, Accessed: July 11, 2016.

² PAEGC, 2015. Annual Report, p.2. https://poweringag.org/sites/default/files/PAEGC_Annual_Report_2015b.pdf, Accessed: July 11, 2016.

³ Salami, Adeleke; Kamara, Abdul B.; Brixiova, Zuzana, 2010. Smallholder Agriculture in East Africa: Trends, Constraints and Opportunities, Working Papers Series N° 105, African Development Bank, Tunis, Tunisia, p.8. <http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/WORKING%20105%20%20PDF%20d.pdf>, Accessed: July 11, 2016.

⁴ The Star, 2016. Kenya to focus on 5 sustainable development goals at UN summit. http://www.the-star.co.ke/news/2015/09/22/kenya-to-focus-on-5-sustainable-development-goals-at-un-summit_c1208434, Accessed: July 11, 2016.

⁵ PAEGC, 2015. Annual Report, p.10f. https://poweringag.org/sites/default/files/PAEGC_Annual_Report_2015b.pdf, Accessed: July 11, 2016.

⁶ Interview with representative of development organisation, May 12, 2016.

Green Energy Solutions can Drive Sustainable Agriculture

Energy and agriculture form a nexus. On one hand, energy can be generated by using crops, agricultural residues and livestock waste. On the other hand, substantial amounts of energy are required along the agricultural and food processing value chain, accounting for around 30 % of the global energy consumption.⁷

Energy is key for increasing agricultural productivity and food security. The use of energy in agriculture has a significant impact on the productivity of the sector. Energy-powered mechanisation can increase yields through improved irrigation, planting, weeding and harvesting technologies and reduce post-harvest losses through improved cooling, chilling and drying solutions. In addition, farmers can generate additional income through value-added processing. However, currently the agriculture sector in East Africa is highly dependent on fossil fuels with the most commonly-used energy source being expensive diesel generators. As a result, most smallholder farmers (who manage over 80 % of the agricultural land in the region) suffer from energy poverty and are trapped in a poverty cycle as they cannot afford the relatively high running costs for fuels.⁸

Smallholder Farmers

There is no universally accepted definition of a smallholder farmer. We define smallholders as farmers that operate less than a threshold size of 2 hectares. In this report the terms smallholder and smallholder farmers are used interchangeably.

Renewable technologies can make the sector not only more productive but also climate-smart. Decentralised, green energy solutions are well suited for smallholder farmers and Small, Medium and Micro-sized Enterprises (SMMEs) because they provide access to electricity in remote areas and are more cost-effective and reliable than traditional diesel solutions.⁹ They also provide farmers in grid connected areas with affordable backup solutions. Larger installations like biomass gasification systems can produce enough power to electrify several villages and power agricultural processing plants like rice mills or wheat flour shops. Renewable technologies can also improve the environmental sustainability of a sector that currently produces over 20 % of global greenhouse gas emissions and is a major contributor to climate change.¹⁰ Countries like Kenya or Uganda can leapfrog emissions-intensive technology and make their agricultural sectors sustainable and ready for the future.

By promoting green energy solutions in agriculture, policy makers in East Africa will address critical development challenges and achieve various SDGs. The Sustainable Development Goals provide an overarching framework that calls for cross-sectoral collaboration and partnerships to end poverty and protect the planet. Integrating green energy into the agricultural sector would contribute to achieving the SDGs such as ending poverty (SDG 1) and ensuring food security (SDG 2). Using green and climate-smart solutions instead of fossil fuels would further contribute to achieving affordable and clean energy (SDG 7) promoting industry, innovation and

⁷ FAO, 2011. Energy-smart food for people and climate. Issue paper. Food and Agriculture Organization of the United Nations, Rome, Italy, III. <http://www.fao.org/docrep/014/i2454e/i2454e00.pdf>, Accessed: July 11, 2016.

⁸ FAO, 2012. Smallholders and Family Farmers. Factsheet Sustainability Pathways, p. 1. http://www.fao.org/fileadmin/templates/nr/sustainability_pathways/docs/Factsheet_SMALLHOLDERS.pdf, Accessed: July 11, 2016.

⁹ Solar Electric Light Fund (SELF), 2008. A cost and reliability comparison between Solar and Diesel powered pumps, p. 8ff. http://www.self.org/SELF_White_Paper_-_Solar_vs_Diesel.pdf, Accessed: July 11, 2016.

¹⁰ FAO, 2011. Energy-smart food for people and climate. Issue paper. Food and Agriculture Organization of the United Nations, Rome, Italy, p. III. <http://www.fao.org/docrep/014/i2454e/i2454e00.pdf>, Accessed: July 11, 2016.

infrastructure (SDG 9) and climate action (SDG 13). Policy makers could potentially increase food production whilst at the same time decreasing CO₂ emissions. Kenya, for example, picked five key areas from the 17 SDGs to guide its development for the next 15 years, including agriculture and food security, employment and enterprise, and environment among them.¹¹

This brief is of particular relevance for policy makers from Kenya, Uganda and other East African countries that have identified agriculture and energy as priority sectors. It provides recommendations on how to support this promising development and create a dynamic industry that can be a strong driver of growth, both for the region and beyond.

Critical questions discussed in the brief include:

- What are the crucial drivers for policy makers from Kenya and Uganda to promote green energy solutions for sustainable agriculture?
- Which barriers in East Africa are currently slowing down the growth of the sector and how can energy-agriculture solutions reach scale?
- Which stakeholders can support innovation and growth at the energy-agriculture nexus?
- How can policy makers in Kenya and Uganda catalyse development of the sector?

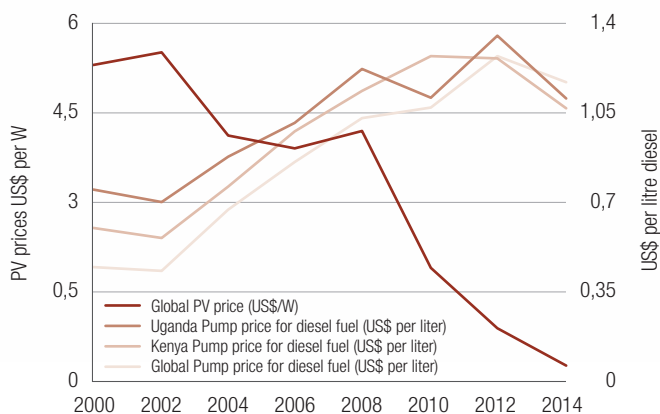
The insights and recommendations of this brief are based on desk research and interviews with key ecosystem stakeholders, including SMMEs, government officials, development organisations, impact investors and academia.

Breaking with the Traditional Agricultural Growth Trajectory

Green energy solutions challenge the traditional agricultural growth trajectory of industrialised economies that was based on the premise that having more energy intense, large-scale farms was the best way to increase productivity. By leapfrogging emissions-intensive technologies and instead applying small-scale, cost-effective renewable energy solutions, farms can be both small with lower GHG emissions and still highly productive.

The example of solar-powered irrigation pumps shows that green energy solutions are more cost-effective than traditional diesel powered pumps despite their higher initial investment costs. While global prices for fuel remain high, prices for PV modules are rapidly falling.

Cost comparison of Solar PV and diesel in US\$



Source: Own compilation based on World Bank Data and African Solar Designs (ASD)¹²

Comparing the costs of photo-voltaic pumping with diesel pumping shows that even in a best case scenario for diesel the costs per kWh of a solar powered pump are four times lower than that of a diesel pump. Despite the higher initial investment costs of solar PV pumps, they typically break even after 2.5 years and out-compete traditional diesel pumps for the remaining life cycle of 20 plus years.¹³

	Initial Capital	Operating cost/year	Total Net Present Cost	\$ per kWh
Photo-Voltaic Pumping	\$12,300	\$355	\$16,472	\$0.66
Diesel Pumping (best case)	\$2,000	\$4,854	\$62,494	\$2.48
Diesel Pumping (worst case)	\$2,000	\$12,525	\$158,094	\$6.27

Note: Best case: US\$ 1.2 per litre and 0.3 litres per kilowatt generated; worst case: US\$ 1.7 per litre and 0.7 litres per kilowatt generated.¹⁴ Source: Solar Electric Light Fund (2008)¹⁵

¹² ASD, 2014. RE Trends East Africa, p. 4. http://africansolardesigns.com/asddocumentation/Newsletter/ASD_Q3_14_Newsletter.pdf, Accessed: July 11, 2016.

¹³ Solar Electric Light Fund (SELF), 2008. A cost and reliability comparison between Solar and Diesel powered pumps, p. 4. http://www.self.org/SELF_White_Paper_-_Solar_vs_Diesel.pdf, Accessed: July 11, 2016.

¹⁴ In 2014 the price for 1 litre of diesel in Uganda was \$1.11 and in Kenya \$1.07 (World Bank Data), Accessed: July 11, 2016.

¹⁵ Solar Electric Light Fund (SELF), 2008. A cost and reliability comparison between Solar and Diesel powered pumps, p. 3. http://www.self.org/SELF_White_Paper_-_Solar_vs_Diesel.pdf, Accessed: July 11, 2016.

¹¹ The Star, 2015. Kenya to focus on 5 sustainable development goals at UN summit. http://www.the-star.co.ke/news/2015/09/22/kenya-to-focus-on-5-sustainable-development-goals-at-un-summit_c1208434, Accessed: July 11, 2016.

East African Eco-Entrepreneurs and Policy Makers can Lead the Way

East Africa has the potential to be at the forefront of green agribusiness innovation. Its entrepreneurial culture, its leading role in the solar energy market in Africa¹⁶ and the importance of agriculture for the region all foster the development of cutting-edge solutions for the energy-agriculture nexus.¹⁷ The multi-donor initiative Powering Agriculture that funds sustainable approaches at the nexus received 871 applications for its last Global Innovation Call Round in 2014/2015. Over a third of these came from companies incorporated in Africa. In particular, East African countries were strongly represented: Together, firms based in Kenya, Tanzania and Uganda submitted 125 proposals (14%). Of the 24 winners currently supported by the initiative, 39% are incorporated in Africa and 61% implement their projects there.¹⁸

Innovation is mainly driven by early-stage for-profit SMMEs. Companies that develop and deploy sustainable business models such as solar irrigation kits, biogas milk chillers or biomass-powered thermal processing are often for-profit SMMEs.¹⁹ An example for such a company is the East Africa Fruit Farm and Company in Tanzania. The

2015 SEED Africa Winner significantly reduces post-harvest losses from 48% down to 10% by cold storage, and powers all processing activities with renewable energies.²⁰ Technologies that address multiple energy needs offer further potential: SunDanzer's cooling system for instance can also be used for food storage and has a mobile phone charging station in Kenya.²¹

Good practice policies are emerging, although they are at an initial stage. Policy makers in Kenya and Uganda have started to develop frameworks that link the food and the energy challenge. Uganda's National Agriculture Policy (2013), for example, clearly lays out that strategies for agricultural mechanisation and value addition require investment in affordable and reliable energy sources.²² Kenya's Draft National Irrigation Policy (2015) stresses the importance of promoting increased use of renewable energy to improve irrigation technology and mitigate effects of climate change.²³ Promoting green energy solutions for sustainable agriculture also fits well into the national strategies to achieve the SDGs.

¹⁶ Teri, 2015. Policy Brief. Solar PV for Enhancing Electricity Access in Kenya: What Policies are Required? p. 2. <http://www.teriin.org/policybrief/files/SolarPV/index.html#p=3>, Accessed: July 11, 2016.

¹⁷ PAEGC, 2015. Annual Report, p. 2f. https://poweringag.org/sites/default/files/PAEGC_Annual_Report_2015b.pdf, Accessed: July 11, 2016.

¹⁸ PAEGC, 2015. Global Innovation Call Round 2 (GICR2) Application Results. Document available upon request from PAEGC.

¹⁹ Interview with representative of development organisation, May 12, 2016.

²⁰ SEED, 2015. East African Fruit and Company, Tanzania, p. 1. <https://www.seed.uno/images/documents/1822/2857fruitfarmflyer150820screen.pdf>, Accessed: July 11, 2016.

²¹ Interview with representative of development organisation, May 12, 2016.

²² Government of Uganda, 2013. National Agriculture Policy http://www.agriculture.go.ug/userfiles/National%20Agriculture%20Policy_booklet_A5_option-web%20version.pdf, Accessed: July 11, 2016.

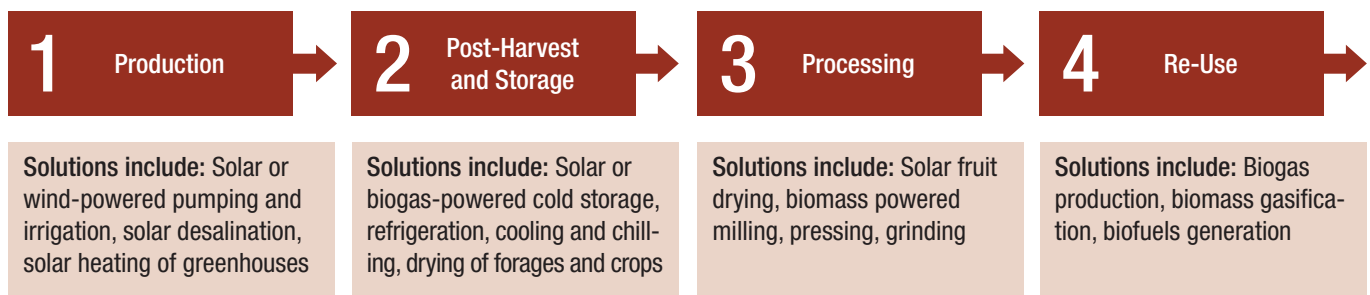
²³ Government of Kenya, 2015. Draft National Irrigation Policy. <http://www.kilimo.go.ke/wp-content/uploads/2015/06/National-Irrigation-Policy-draft.pdf>, Accessed: July 11, 2016.

Examples of Innovative Solutions at the Energy-Agriculture Nexus in East Africa

Companies in East Africa are already showing that it is possible to reduce poverty and protect the planet at the same time. They have developed cost-effective energy solutions for SMMEs and smallholder farmers that can be applied along the agricultural value chain in a circular

economy, from production, post-harvest storage and processing to reusing agricultural and livestock waste as a source of energy through gasification and thermal processing.

Opportunities for clean energy technologies along the agricultural value chain



Innovations

<p>Solar-powered irrigation, Kenya</p> <p>SunCulture sells irrigation kits that combine cost-efficient solar pumping technology with high-efficiency drip irrigation systems achieving yield increases of up to 300% and water savings of up to 80%. It also pilots a pay-as-you-go to make technology more affordable for smallholders.</p>	<p>Solar-powered refrigeration, Kenya</p> <p>SunDanzer developed a small-scale portable cooling system for the dairy market, which is made up of a PV refrigerator powered by solar energy. The improved milk quality led to a 20% production increase 40 more units will be installed in 2016.</p>	<p>Clean fruits and vegetable processing, Tanzania</p> <p>East Africa Fruit Farm and Company buys fruits and vegetables from smallholder farmers and processes them with green energy solutions. It also applies solar power and bio-diesel in irrigation and greenhouses, cooling and transportation.</p>	<p>Biomass and solar photovoltaic minigrids, India, Tanzania and Ghana</p> <p>Husk Power Systems developed a hybrid plant using solar and biomass that generates clean energy for domestic and agricultural needs. In India over 250,000 customers are served already, the solution is now launched in Africa.</p>
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Photo: SunCulture



Photo: Winrock International / SunDanzer



Photo: EAFFC



Photo: Husk Power Systems

Barriers to Scale Solutions at the Energy-Agriculture Nexus

East African eco-entrepreneurs and SMMEs might be heading the movement to connect energy and agriculture but they still face numerous challenges. Most companies are still in the pilot or early growth phase and in the process of developing viable business models.²⁴ The relatively high costs of technologies make financing difficult and most applications fall between the cracks of energy and agriculture, making it harder to attract sector specific investments. In addition, little public knowledge and awareness exists on the benefits of green energy solutions for sustainable agriculture.

- **High investment costs for green energy technologies:**

The current technical solutions are often expensive and barely affordable for smallholder farmers. Companies have to charge high prices due to their low volume of turnover and face high distribution and service costs in remote rural areas.²⁵ For example, a solar-powered cooling system from SunDanzer that can cool up to 24 litres of fresh milk currently costs around US\$ 2,000 in Kenya.²⁶ Initial costs for a solar-powered irrigation pump with 1900 watts is around US\$ 12,000, six times higher than a comparable 4 kW diesel powered pump.²⁷

- **Limited access to finance to afford technologies:**

Smallholders and smaller companies often do not have the means to cover high initial investment costs associated with clean energy upgrades.²⁸ Commercial banks require high amounts of collateral and a long accounting track-record that most early-stage businesses cannot deliver. For micro-finance institutes (MFIs), savings groups or informal lenders, financing requirements are often too high. In general, traditional financiers have a limited understanding of how green energy solutions increase agricultural productivity and income, making access to

capital extremely difficult.²⁹ None of the companies interviewed for this study has accessed commercial loans due to high interest rates in East African countries.

- **Lack of reliable policy incentives for solutions at the nexus:**

In East Africa, progressive policies already promote renewable energies and agricultural development through subsidies and VAT-exemptions. Under the East African Community External Tariff of 2007, for example, solar products are classified to attract 0% import duty.³⁰ However, companies that work at the nexus often have difficulties to benefit from subsidies for agricultural development because they cannot always prove that the technology components will be applied in the sector.³¹ In countries like Tanzania, VAT-exemptions are completely missing for specific technologies like biomass gasification.³² In addition, as has happened in Ghana or Tanzania, promises made to attract political support during election cycles such as extending the grid or creating diesel subsidies can undermine the development of a green economy by providing conflicting signals to the market and undermining investor confidence.^{33 34}

- **Lack of awareness on benefits of technology:**

Most clean energy solutions are still new and farmers are not aware of the variety of applications and how they can improve their lives and pay-off over the medium and long run.³⁵ Smallholders are often risk averse and unlikely to invest in a technical solution they have not seen paying off.³⁶ In addition, farmers and SMMEs have limited access to distributors for purchasing technologies, installation and maintenance.³⁷

²⁴ Interview with research institute, May 18, 2016.

²⁵ Interview with representative of development organisation, May 12, 2016.

²⁶ Interview with social enterprise, May 10, 2016.

²⁷ Solar Electric Light Fund (SELF), 2008. A cost and reliability comparison between Solar and Diesel powered pumps, p. 2f. http://www.self.org/SELF_White_Paper_-_Solar_vs_Diesel.pdf, Accessed: July 11, 2016.

²⁸ PAEGC, 2015. Annual Report, p. 2. https://poweringag.org/sites/default/files/PAEGC_Annual_Report_2015b.pdf, Accessed: July 11, 2016.

²⁹ Interview with investor, July 6, 2016.

³⁰ Kenya Climate Innovation. <http://www.kenyacic.org/sites/default/files/TAX%20REGULATIONS%20ON%20SOLAR%20PRODUCTS-%20FACT%20SHEET.pdf>, Accessed: July 11, 2016.

³¹ Interview with social enterprise, May 10, 2016.

³² Interview with social enterprise, June 2, 2016.

³³ Interview with academic expert, June 10, 2016.

³⁴ Interview with social enterprise, June 2, 2016.

³⁵ PAEGC, 2015. Annual Report, p. 2. https://poweringag.org/sites/default/files/PAEGC_Annual_Report_2015b.pdf, Accessed: July 11, 2016.

³⁶ BMZ, 2012. Growing Business with Smallholders. A Guide to Inclusive Agribusiness, p. 26.

³⁷ <https://www.giz.de/fachexpertise/downloads/giz2012-0304en-growing-business-smallholder.pdf>, Accessed: July 11, 2016.

³⁸ PAEGC, 2015. Annual Report., p. 2. https://poweringag.org/sites/default/files/PAEGC_Annual_Report_2015b.pdf, Accessed: July 11, 2016.

Strategies to Catalyse Development of the Energy-Agriculture Nexus

Government, development partners, finance institutions, academia and many others in East Africa can support entrepreneurs to develop and sell green energy solutions and to enable smallholder farmers and agribusinesses to afford and use them. They can create a conducive business environment by designing targeted policies and regulations, filling knowledge gaps and providing financial and technical support.

- **Incentivise application of green energy solutions through targeted regulations:** Governments can create transparent import subsidies and tax regulations that specifically target green technologies like solar-powered cold storage or irrigation. In Kenya, for example, solar water heaters and deep cycle-sealed batteries which exclusively use or store solar power, are tax exempt supplies.³⁸ Net metering regulations and feed-in tariffs would incentivise grid-connected farmers and SMMEs to apply green energy solutions because they could generate their own electricity.³⁹ In off-grid areas, larger solar pumps or biogas systems would become more attractive for end users because they could act as independent power producers.⁴¹
- **Improve codes and standards for technologies:** To protect customers, improve product quality and decrease risk adversity of smallholders, governments in collaboration with other stakeholders should define product standard guidelines for proven and new tech-

nological solutions like solar PV or biomass gasification systems.⁴² The multi-donor initiative Lighting Africa successfully developed a series of quality standards and testing methods for lighting products, and could thus serve as an example.⁴³ Certifications increase trust in new technologies and give credibility to companies that comply with high product standards.

- **Create one-stop-shop solutions for smallholders:** To make application of their technologies more convenient for farmers, innovative SMMEs can provide comprehensive solutions that include in-house financing, training and access to inputs or markets. The Kenyan social enterprise SunCulture, for example, is developing a pay-as-you-go payment solution that significantly decreases the upfront capital expenses of their solar-powered irrigation technology and offers farmers training on good agricultural practices, installation and maintenance of technologies.⁴⁴
- **Provide patient capital to local SMMEs:** SMMEs that work at the nexus are often in the early or growth stage and in need of patient capital.⁴⁵ Agricultural impact investors can offer support by lending such capital to promising and growing SMMEs. The Kenyan impact investor Root Capital, for example, provides loans and equity to small and growing agriculture businesses that use climate friendly technologies.⁴⁶ Governments, Development Finance Institutions (DFIs) and

³⁸Kenya Climate Innovation. <http://www.kenyacic.org/sites/default/files/TAX%20REGULATIONS%20ON%20SOLAR%20PRODUCTS-%20FACT%20SHEET.pdf>, Accessed: July 11, 2016.

³⁹Interview with research institute, May 18, 2016.

⁴⁰Interview with representative of development organization, May 19, 2016.

⁴¹Interview with representative of development organization, May 12, 2016.

⁴²Interview with social enterprise, May 10, 2016.

⁴³Lighting Africa, 2016. Website. <https://www.lightingafrica.org/what-we-do/>, Accessed: July 11, 2016.

⁴⁴Interview with social enterprise, May 27, 2016.

⁴⁵Interview with investor, July 6, 2016.

⁴⁶Root Capital, 2016. Website. <https://www.rootcapital.org/our-approach/publication/scaling-climate-smart-agriculture-financing-small-and-growing-businesses>, Accessed: July 11, 2016.

donors can facilitate such forms of finance by making loan guarantees or by providing preferential finance low-interest loans and patient capital. Any form of de-risking will help to reveal more capital in the sector.⁴⁷

- **Create awareness and educate farmers:** Agricultural ministries and local non-governmental organisations (NGOs) often have a deep reach into rural communities. They could use their distribution channels and public extension services to educate smallholders, especially women, on the benefits and effective usage of green energy technologies. For example, a national campaign could educate farmers about the benefits of using solar-powered irrigation technologies or of using livestock and agricultural waste for biogas production.⁴⁸ They should also provide information on where technologies can be purchased and how farmers can access finance.

⁴⁷Interview with investor, July 6, 2016.

⁴⁸Interview with research institute, May 18, 2016.

Many Actors can Support Innovation at the Energy-Agriculture Nexus

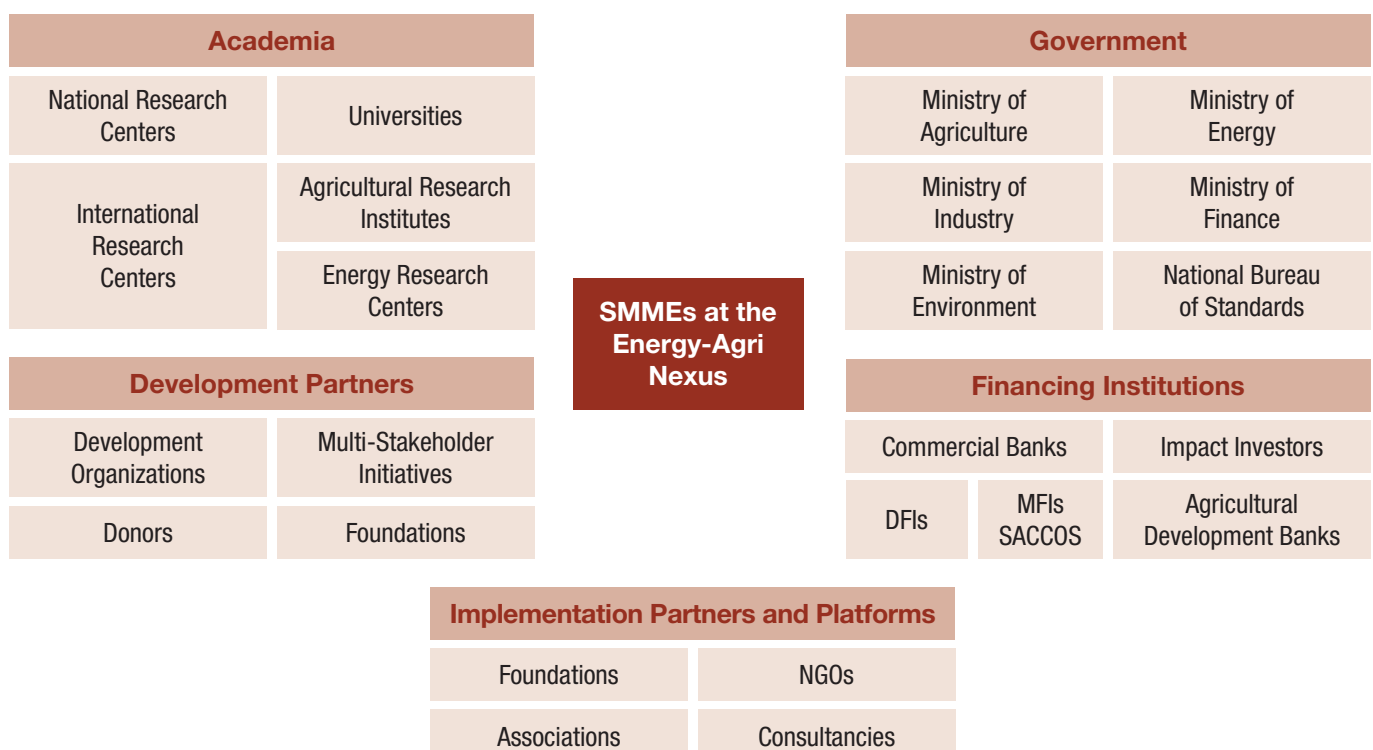
National governments play an indispensable role in promoting green energy solutions for sustainable agriculture. But they do not stand alone. There is an entire ecosystem of stakeholders that can support SMMEs and smallholder farmers to overcome the challenges previously outlined.

While every stakeholder in the ecosystem has its particular role to play, collaboration is important to achieve the transformation to a sustainable agricultural sector that is powered by cost-effective renewable energy solutions. Public research institutions facilitate access to technical expertise, financing institutions support access to customer finance and implementation partners assist to open up new delivery channels. SunDanzer in Kenya, for example, partners with the experienced non-profit organisation Winrock International to reach their target group in remote rural areas and with various Saving and Credit Cooperatives (SACCOS) to provide suitable financing arrangements to make products affordable,

even for smallholders.⁴⁹ Winrock has over 25 years of experience in this region and can make use of its established relationships.

Governments can play a critical role in coordinating sector activities, and designing and implementing helpful policies and regulations for companies that innovate at the nexus of green energy and agriculture. In addition, they can promote R&D by investing in public research centres, and they can create awareness and educate farmers through public extension services. They can also support enterprises directly through subsidies and grant finance schemes and incentivise private investment through pooled financing solutions and risk guarantee funds. The most relevant government stakeholders at the nexus include the ministries responsible for agriculture, energy, water and environment, economic development and finance.

⁴⁹Interview with social enterprise, May 10, 2016.



Development partners can assist with technical support to strengthen local expertise and also support national governments in shaping their environmental frameworks. In addition, they can provide grants or loans to companies at the nexus. The international donor initiative Powering Agriculture, for example, provides grants to enterprises to develop, test and scale new technologies at the nexus. The initiative also works with banks to ensure that financial intermediaries have the capital and capacity to lend to farmers and farm-related businesses.⁵⁰ Together with Family Bank and SNV, GIZ created a Risk Guarantee Fund in Kenya for biogas applications with agricultural and food processing use.⁵¹ SEED, the multi-donor funded partnership, supports eco-inclusive enterprises with technical and financial assistance, with several of them working at the energy-agriculture nexus.⁵²

Financing institutions can provide SMMEs at the nexus with grants, loans and equity. Banks, for example, can offer commercial loans and microfinance products. Social impact investors that operate in East Africa like Acumen, responsAbility or Root Capital can provide smaller companies with patient capital and equity finance and also offer technical assistance to improve managerial capacities of early stage businesses. DFIs like the World Bank offer large ticket sizes of over US\$5 million of patient capital to selected companies with a proven business model. Through collaboration with international donors or national governments, pooled financing solutions can be created, including loan guarantees and low-interest loans that de-risk investment in the nexus.

National research centres, universities and independent institutes can support the development, testing and application of new technologies. Investment in R&D is critical to develop and promote a high-value manufacturing

industry in East Africa that is at the forefront of innovation, creating well-paid jobs and boosting economic development of the region. National research institutions can set quality standards and help make the case that green energy solutions are cost-effective in the medium and long-term, are sustainable and should be mainstreamed in the agricultural sector.⁵³ In Kenya, first steps in this direction are already in place. Since 2012, the Strathmore Energy Research Centre (SERC) has carried out high quality research and technical training on how to test, install and maintain renewable energy solutions in Kenya.⁵⁴ To date, more than 300 engineers have been trained at their solar laboratory.⁵⁵ SERC also offers consultancy services to the public and private sector to design, develop and implement renewable energy projects. The Centre for Research in Energy and Energy Conservation (CREEC) in Uganda also conducts comprehensive research on solar PV and bioenergy solutions.⁵⁶

Implementation partners not only provide support through consumer education and last-mile distribution, but also through networking and advocacy. NGOs and non-profits often have well-established distribution channels and business associations that can support their company members in articulating policy needs by providing a platform for joint advocacy. Futurepump Ltd sells solar pumps to low-income smallholders in Kenya. The company was developed in partnership by the non-profits IDE and PRACTICA Foundation, each of which has a depth of expertise in developing and testing solar pumps for smallholders. Both organisations remain closely involved in the project by providing strategic guidance as members of the company's board.⁵⁷ NGOs like Techno-Serve or Practical Action that work in East Africa support entrepreneurs to develop inclusive business models around the nexus.

⁵⁰ PAEGC, 2015. Annual Report, p. iii. https://poweringag.org/sites/default/files/PAEGC_Annual_Report_2015b.pdf, Accessed: July 11, 2016.

⁵¹ Interview with representative of development organisation, May 25, 2016.

⁵² SEED, 2016. Website. <https://www.seed.uno/about/work.html>, Accessed: July 11, 2016.

⁵³ Interview with research institute, May 18, 2016.

⁵⁴ Interview with representative development organisation, May 25, 2016.

⁵⁵ Strathmore University, 2016. Website. <https://serc.strathmore.edu/about-serc/about-us>, Accessed: July 11, 2016.

⁵⁶ Centre for Research in Energy and Energy Conservation, 2016. Website. <http://creec.or.ug/our-departments/bioenergy/>, Accessed: July 11, 2016.

⁵⁷ Futurepump, 2016. Website. <http://futurepump.com/about/>, Accessed: July 11, 2016.

Government can Catalyse Scale of Green Energy Solutions

East African countries like Kenya and Uganda have **critical positions in promoting innovative business solutions** that tackle sustainable development challenges, and have shown willingness to further expand their roles.⁵⁸ Broader ecosystem conditions are also conducive to supporting the sector's development in the region, such as the widespread use of mobile payment systems and a lively support network of investors and intermediaries.⁵⁹ East African governments should use these favourable conditions to **create a thriving and competitive industry** for sustainable energy solutions for agriculture. **Policy makers can catalyse development of the sector through four key actions.**

1) Provide consistent policy strategy and coordinate sector activities

In Kenya and Uganda the ministries responsible for agriculture and renewable energies should take a proactive role, establish intersectoral working groups and start aligning their policy frameworks and key performance indicators (KPIs) to create a consistent policy strategy and policy incentives. As examples from Rwanda and Tanzania show, consistent policy strategies are key to encourage private sector investment in sectors that are still in a nascent stage. Ministries responsible for energy can also support businesses directly by providing relevant market contacts and information on their electrification plans.

East African governments should also take a leading role in coordinating activities in the sector and be a central resource for international donors, companies and investors. To fully understand the specific needs of the private sector and how civil society organisations (CSOs) and academia can support the ecosystem, key stakeholders should be included in multi-stakeholder dialogues. Development partners can provide support here: UNDP's Private Sector Unit, for example, is currently supporting ministries in Uganda, Senegal and Lesotho to set-up multi-stakeholder platforms and coordinate support activities for social enterprises.

Good practice policy example

Consistent policy strategies: In Rwanda the Electricity Development Strategy 2011-2017 clearly outlines priority areas for grid extension as well as areas where the focus should be on mini-grid or off-grid solutions to encourage private sector investment. The government of Rwanda proactively shares its grid extension strategy, grid maps and contacts at the village level with off-grid energy providers to guarantee effective electrification coverage. Concessions over 10 plus years and exit possibilities also allow social enterprises to invest in training facilities, and enable operations for a long-term perspective. Tanzania, for example, has a framework on mini-grids that clearly lays out a buy-out possibility for companies in case an area gets connected to the main grid.

⁵⁸UNDP, 2012. Realizing Africa's Wealth, p. 8. <http://www.undp.org/content/undp/en/home/librarypage/poverty-reduction/realizing-africa-s-wealth--building-inclusive-businesses-for-sha.html>, Accessed: July 11, 2016.

⁵⁹UNDP, 2012. Realizing Africa's Wealth, p. 16, 26. <http://www.undp.org/content/undp/en/home/librarypage/poverty-reduction/realizing-africa-s-wealth--building-inclusive-businesses-for-sha.html>, Accessed: July 11, 2016.

2) Invest in research and development of appropriate technologies at the local level

Ministries responsible for renewable energies should take a leading role in R&D and support companies in the costly process of developing promising green energy technologies for agriculture. As the example of URC in Kenya shows, public research institutions and universities can be incentivised to develop, test and apply new technologies and transfer knowledge from universities into businesses. Research should be conducted on solutions that are still in their infancies but show high potential for the local market, including green refrigeration and cooling technologies and hybrid solutions that combine solar and biomass or biogas.⁶⁰ Start-up grants, start-up competitions and entrepreneurship centres can also support entrepreneurs with working space, access to expert advice, and funding.⁶¹

In collaboration with existing business incubators, the Kenyan Climate Innovation Centre in Nairobi could become a hub for innovation and knowledge transfer in East Africa. National Energy Research Centres like the SERC in Kenya and the CREEC in Uganda could build on their expertise of small scale renewable energy technologies and expand research on green energy solutions for agriculture.

Good practice policy example

Innovation of new technologies: The University Research Chairs Programme (URC) in Kenya aims at supporting the uptake and application of research for economic and social development. The programme mainly focuses on innovation and production of new technologies, with an emphasis on uptake to solve pressing social-economic problems by closely involving government and industry actors. The program is implemented by the National Commission for Science, Technology and Innovation (NACOSTI). So far, focus areas of the program have been health systems and manufacturing.

3) Incentivise the application of technologies at the nexus

Agricultural ministries in East Africa should take a leading role in incentivising the application of technologies at the nexus by promoting campaigns and using their public agricultural extension service. This could further be done by incentivising private extension services to educate smallholders, especially women, and SMMEs on the economic, social and ecological benefits as well as on the effective usage of green energy solutions in agriculture.

To make products more affordable, ministries responsible for agriculture and renewable energies in Kenya and Uganda could engage the Ministry of Finance to create targeted time-bound subsidies and VAT exemptions for technologies at the nexus, including for refrigeration and cooling solutions. The authorities in Tanzania could create VAT exemptions for biomass gasification systems. Ministries responsible for renewable energies should also engage with the National Bureaus of Standards and development partners like World Bank or IFC to create codes and product standards for technologies at the nexus.

The recently signed Climate Change Act in Kenya created a momentum that could be used to push for the implementation of net metering regulations and the revision of feed-in tariffs as well as for targeted subsidies and VAT exemptions for low carbon economy.⁶²

Good practice policy example

Targeted time-bound subsidies for solutions at the nexus: Examples from India or China show that targeted time-bound subsidies can help establish a market. In India, for example, the Solar Pumping Programme for Irrigation and Drinking Water aims at supporting the deployment of 1 million solar pumps by 2020. A recent World Bank paper that has analysed the impacts of SHS subsidies in Bangladesh concluded that while the subsidy has been declining over time, the demand for SHS has seen rapid growth, mostly because of technological developments that have made the systems increasingly more affordable.

⁶⁰ Interview with research institute, May 18, 2016.

⁶¹ EXIST, 2016. University-Based Business Start-Ups. Website. <http://www.exist.de/EN/Programme/About-EXIST/content.html>, Accessed: July 11, 2016.

4) Facilitate access to finance

Ministries responsible for agriculture and renewable energy in East Africa should engage their Ministry of Finance, development partners, DFIs and impact investors to develop financing solutions for companies and farmers at the nexus and de-risk private investment in the relatively new sector through loan guarantees and preferential finance. As the example of IDCOL in Bangladesh shows, governments can provide financing directly through their own finance institutions, start-up grants, low-interest loans, loan guarantees, or technical assistance funds.

Together with development partners like Powering Agriculture, Ministries of Finance should strengthen the capacity of local financial institutions, especially commercial banks, to facilitate a better understanding of lending requirements for agribusinesses. This also includes a better understanding of how green energy solutions can influence the business cycle and improve the agricultural productivity of businesses.

Good practice policy example

Proactive Financing: In 1997, the Government of Bangladesh established the Infrastructure Development Company Limited (IDCOL) as a non-bank financial institution. IDCOL plays a major role in bridging the financing gap for developing renewable energy projects by providing companies with equity, low-interest debt and grant finance. IDCOL's investment in solar PV technologies led to the development of a local supply chain with more than three Bangladesh-based solar panel producers, more than five local battery producers and several local LED producers. Together with the quality standards set by the government, this led the way for the successful expansion of Grameen Shakti. Since 2006, IDCOL has several low carbon initiatives, including programmes to promote domestic biogas, solar irrigation, solar mini-grids and biomass/biogas based power projects.

⁶²Interview with research institute, May 18, 2016.

Call to Action

Kenya and Uganda are in an excellent position to become global market leaders for sustainable energy solutions for agriculture. The entrepreneurial energy in the region combined with its leading role in the solar energy market in Africa and the importance of the agricultural sector in both countries altogether create great potential for cutting-edge solutions at the energy-agriculture nexus. Strong and well targeted governmental support could unleash this potential and create a marketplace that encourages investment in the nascent sector.

By implementing the four key actions outlined in this brief – firstly, to provide consistent policy strategy and coordinate sector activities, secondly, to invest in research and development of appropriate technologies at the local level, thirdly, to incentivise the application of technologies at the nexus and fourthly, to facilitate improved access to finance – policy makers can support promising social enterprises at the energy-agriculture nexus to overcome market barriers and further drive the development of the sector.

Through collaboration with international and local partners, governments in Kenya and Uganda could leverage technical and financial resources and lay the basis for the development of a local high-tech manufacturing industry that can lift smallholders out of poverty and boost economic development in the region.

Acronyms

CO₂ emissions – Carbon dioxide emissions
CREEC – Centre for Research in Energy and Energy Conservation
CSOs – Civil Society Organisations
DFIs – Development Finance Institutions
GHG emissions – Greenhouse gas emissions
IFC – International Finance Corporation
KPIs – Key Performance Indicators
kWh – Kilowatt hour
MFIs – Micro-Finance Institutes
NGOs – Non-governmental Organisations
PV modules – Photovoltaic modules
R&D – Research and Development
SACCOs – Saving and Credit Cooperatives
SDGs – Sustainable Development Goals
SERC – Strathmore Energy Research Centre
SMMEs – Small Medium and Micro Enterprises
UNDP – United Nations Development Organization
VAT – Value-added tax

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About SEED

SEED is a global partnership for action on sustainable development and the green economy. Founded by the United Nations Environment Programme (UNEP), the United Nations Development Programme (UNDP) and IUCN (International Union for Conservation of Nature) at the 2002 World Summit on Sustainable Development in Johannesburg, SEED supports innovative small scale and locally driven enterprises around the globe which integrate social and environmental benefits into their business model. SEED is hosted by adelphi research gGmbH, based in Berlin, Germany. adelphi research is a leading think tank for policy analysis and strategy consulting. The institution offers creative solutions and services regarding global environment and development challenges for policy, business, and civil society communities.

About Endeava

Endeava's mission is to inspire and support enterprise solutions to the world's most pressing problems: making poverty a thing of the past and preserving ecosystems for the future. In our projects, we build, share, and apply knowledge to develop, implement and grow inclusive business models. As an independent institute, we work closely with partners from all sectors. The people at Endeava share a passion for positive change and inspiring collaboration.

About SWITCH Africa Green

The overall objective of SWITCH Africa Green (SAG) is to support 6 countries in Africa to achieve sustainable development by engaging in transition towards an inclusive green economy, based on sustainable consumption and production patterns, while generating growth, creating decent jobs and reducing poverty. The objective will be achieved through support to private sector led inclusive green growth. The overall objective of SEED's multi-country project under SAG "Promoting Eco-Entrepreneurship in Africa" is to potentiate and accelerate a green and inclusive economy and foster an enabling environment for eco-entrepreneurship and sustainable consumption and production so as to provide a SWITCH Africa Green response to Africa's goal of sustainable development.



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