Addressing Energy Constraints in Off-farm Dairy Segments is Critical to Inclusive Growth in Africa

**WHERE IS ENERGY USED?**

<table>
<thead>
<tr>
<th>MILKING</th>
<th>TRANSPORT</th>
<th>PROCESSING</th>
<th>PACKAGING/DISTRIBUTION</th>
<th>END-USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>Bio-diesel transport</td>
<td>Pasteurization, thermization, sterilization</td>
<td>Cold chain</td>
<td>Storing</td>
</tr>
<tr>
<td>Fuel for mechanization</td>
<td>Energy efficient trucking</td>
<td>Drying and cooling</td>
<td>Sanitation &amp; cleaning-in-place</td>
<td>Cooking</td>
</tr>
<tr>
<td>Improved roads</td>
<td></td>
<td></td>
<td></td>
<td>Consumption</td>
</tr>
</tbody>
</table>

**BUSINESS IMPLICATIONS** *(field work findings)*

**Reliability**
- 28% rural SENEGAL access to electricity
- 3-5x /week KENYA power outages in dairies

**Expense**
- Electricity consumes 20-40% of operating costs in Kenyan small-scale dairies

**Value addition & market access**
- Yogurt, cheese, & butter require energy to chill and/or heat products
- Tight delivery times restrict rural market access, divert fresh into fermented milk

**Employment**
- Power outages reduced hiring
- 24% SMEs, 15% large enterprises in SENEGAL
- High energy operating costs are a major factor limiting business growth, hiring, or diversification
- Energy cost savings would go to increased wages
- 2/3 of dairies in KENYA

**Long-term competitiveness**
- Kenya’s dairy sector is formalizing for food safety—energy is required all along this shift. Without it, small operations will struggle to remain competitive.

**Hidden Impacts**
Energy’s hidden impact is on business growth, food safety, and value addition. This affects farm-gate prices and demand for producers, employment, and retail prices and product availability for consumers.

**The Time is Ripe for Energy-Fueled Agricultural Transformation**

**MARKET-BASED OPPORTUNITIES TO INCREASE UPTAKE OF CLEAN ENERGY**

- **Small-scale solar chillers** extend delivery windows from farm to collection center & refrigerate transport by bicycle, bus or donkey
- **Solar minigrids** increase rural electricity access off-grid and minimize costs and power disruption for those on-grid
- **Energy efficiency audits** for SMEs identify tailored options (e.g. blended solar and on-grid energy models)
- **Private and impact capital investments** can fill renewable energy financing gap left by commercial banks—key due to high upfront RE costs
- **Infrastructure**: Well-maintained, networked roads reduce travel time and fuel use. Access to electricity and potable water reduces spoilage
- **Waste heat recovery** is a relatively simple, inexpensive process that uses pumps, pipes, and heat exchangers to recover waste heat from the chilling process, using it to reduce energy in pasteurization and sterilization. WHR can reduce total energy use by up to 19%.

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**Hidden Impacts**
- Many solar products have oversized inverters and batteries, affecting product efficiencies and lifespan.
- Outages increase operating costs by: (1) requiring dairies to invest in backup power systems; (2) increasing wear and tear on equipment through frequent stops and starts; and (3) spills and jams on packing lines, with wasted product and labor clean up costs.

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**SME SNAPSHOT**

- **USA**: 3 of 5 dairies in KENYA
- **Wisconsin**: 24% SMEs, 15% large enterprises in SENEGAL
- **Energy cost savings would go to increased wages**

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**Key Findings from the Energy for Agriculture and Food Security Project**

- **Solar minigrids** increase rural electricity access off-grid and minimize costs and power disruption for those on-grid
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**Clean and Renewable Energy for Productive Use: Spotlight On Dairy**

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**Before vs. After**

- **$1,000/mo**
- **$4,000/mo**

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**SME Snapshot**

- **USA**: Kenyan dairies in Wisconsin USA
- **10,000L/day**: 3 of 5 dairies in KENYA
- **$100,000**: invested in a 100kWh solar array for $100,000

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**Energy’s impact**

- **Electricity consumes 20-40% of operating costs in Kenyan small-scale dairies**
- **Power outages reduced hiring**
- **High energy operating costs are a major factor limiting business growth, hiring, or diversification**
- **Energy cost savings would go to increased wages**
- **3 of 5 dairies in KENYA**
Empowering Women Through Energy in Dairy? A Complex Reality

**ENERGY SOLUTIONS CAN:**

- Reduce women’s time poverty
- Address women’s mobility constraints i.e. solar-powered chilling on motorized transport enables collection at farm gate
- Trigger male takeover of functions and income as milk becomes more commercial and value-added

**Clean and Renewable Energy Can Reduce Greenhouse Gases and Contribute to Low Emission Development**

**RENEWABLES INCREASINGLY BEAT FOSSIL FUELS ON COST**

Change in average cost of utility-scale renewables ($/kWh)

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost ($/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>0.36</td>
</tr>
<tr>
<td>2017</td>
<td>0.05</td>
</tr>
</tbody>
</table>

**CONTINUE TO INVEST IN IMPROVED GHG DATA FOR TRANSPORT, PROCESSING, AND RETAIL**

Energy consumption data post-harvest is often lacking; better quantifying energy savings and GHG emissions and reductions can inform future policy and illustrate policy impacts.

**CONTEXT MATTERS**

- **Kenya**: 27% fossil fuel in power generation mix
- **Senegal**: 84% fossil fuel in power generation mix

Off-set high fossil fuels by targeting on-grid, larger dairies. In off-grid areas, dairy is currently highly informal and therefore does not use significant energy.

**Policy and Partnership Opportunities**

1. **Embrace a systems approach to analysis and design**
   - Exciting ideas can fail to have systemic impact; many energy opportunities struggle with widescale adoption and market penetration. Systems approaches help us understand the broader ecosystem, social and economic dynamics that will influence impact, and design smarter policies and programs.

2. **Leverage partnerships** with solar and energy innovators and programs to synergize investments, support scale-up and commercialization, and apply lessons learned. E.g., PoweringAg, USAID’s Photovoltaics for Sustainable Milk for Africa through Refrigeration Technology (PV-SMART) project; Strathmore Univ’s Energy Research Centre in Kenya.

3. **Net metering** incentivizes distributed storage and increases total supply of RE.

4. **Reduce or eliminate tariffs on solar products** (as in Kenya) and provide subsidies (guarantees, subsidized debt interest, tax incentives) to spur investment, adoption and reduce user costs.

5. **Support user education campaigns** on energy efficient best practices.

6. **Strengthen the solar energy ecosystem** e.g.
   - Installation and maintenance: strengthen vocational and enterprise skills, alternative delivery models (e.g. layered service onto rural agent networks)
   - Support alternative financing and directed investment for companies and end customers to minimize upfront costs. (e.g. alternative collateral, bundled investments, business accelerators)
   - Expand access and availability of appropriately sized inverters, batteries, and chargers
   - Build industry platforms for collaboration, advocacy and co-creation.

Interested in more? Visit [www.agrilinks.org/post/clean-energy-productive-use-post-harvest-value-chains-integrated-literature-review-field-work](http://www.agrilinks.org/post/clean-energy-productive-use-post-harvest-value-chains-integrated-literature-review-field-work) for more E4Ag resources, including briefs on solar thermal and solar PV for small scale dairies; single to three phase electrical conversion; and energy-sensitive value chain development design, plus a series of gender-focused blogs.

The Energy Opportunities for Agricultural Systems and Food Security Project (E4AS) expands and focuses information on how clean energy and energy efficiency can strengthen post-harvest value chains and reduce loss in sub-Saharan Africa, while also contributing to LED goals and incorporating gender considerations. E4AS is funded by USAID’s Africa Bureau and implemented by Green Powered Technology in partnership with ACDI/Voca.