Workshop agenda

- Net metering assessment findings
- Net metering draft regulations
- Proposed net metering procedures
  
  Tea break

- Proposed grid connection study procedures & ToR
- Feasibility study template
  
  Closure and lunch
Background

- Net metering
- FIT policy
- 2013 Ministry/ERC request to EUEI-PDF
Net metering assessment findings and proposed mechanism

Andrew Tipping, ECA
Matthew Woods, CA

Nairobi, 28 February 2014
Presentation overview

- Objectives of the study
- Why net metering?
- Market potential
- Case study projects
- Economic impact on the utility
- Impact on government revenue
- Recommendations
What is net metering?

Diagram showing:
1. Direct solar PV consumption
2. Excess solar PV production
3. Grid consumption

Time:
00:00 - 24:00
Net metering study objectives

- Assess the likely **technical and economic impacts** of the adoption of a net metering programme

- Where needed, identify measures that could be implemented to **address issues that may arise**

- Findings are intended to inform the design and implementation of **net metering regulations**
<table>
<thead>
<tr>
<th>High income</th>
<th>Upper middle income</th>
<th>Lower middle income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbados</td>
<td>Brazil</td>
<td>Cape Verde</td>
</tr>
<tr>
<td>Belgium</td>
<td>Chile</td>
<td>Egypt</td>
</tr>
<tr>
<td>Canada</td>
<td>Costa Rica</td>
<td>Guatemala</td>
</tr>
<tr>
<td>Cyprus</td>
<td>Dominican Republic</td>
<td>India</td>
</tr>
<tr>
<td>Denmark</td>
<td>Grenada</td>
<td>Lesotho</td>
</tr>
<tr>
<td>Italy</td>
<td>Jamaica</td>
<td>Micronesia</td>
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<tr>
<td>Japan</td>
<td>Jordon</td>
<td>Pakistan</td>
</tr>
<tr>
<td>Malta</td>
<td>Lebanon</td>
<td>Philippines</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Mexico</td>
<td>Sri Lanka</td>
</tr>
<tr>
<td>New Zealand</td>
<td>Morocco</td>
<td>Syria</td>
</tr>
<tr>
<td>Portugal</td>
<td>Panama</td>
<td>Tunisia</td>
</tr>
<tr>
<td>Singapore</td>
<td>South Africa</td>
<td></td>
</tr>
<tr>
<td>South Korea</td>
<td>St. Lucia</td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>Uruguay</td>
<td></td>
</tr>
<tr>
<td>United States of America</td>
<td>Thailand</td>
<td></td>
</tr>
</tbody>
</table>
Why net metering?

Top 5 reasons cited:

- **Renewable energy** promotion, **power generation**
- Facilitation of **economic development**, technology innovation, local industry and job creation
- **Local ownership and customer participation** in energy services
- **Energy security**, diversification and self-sufficiency
- Reduce **greenhouse gas emissions**
<table>
<thead>
<tr>
<th>Country</th>
<th>Examples of economic and development benefits</th>
</tr>
</thead>
</table>
| Sri Lanka | Utility meter manufacturing facility (500,000 unit capacity)  
-> **diversification of utility business model**                              |
| Tunisia   | Emergence of **30 new solar PV installation companies** on the basis of 739 net metering customers           |
| Tunisia   | **Domestic solar PV module manufacturing** with capacity of 25 MWp                                         |
| USA       | **120,000 solar worker jobs**                                                                               |
| California| **Enhanced resilience** to supply interruptions and **avoidance of new capacity**                          |
| Kenya?    | 633 **new PV installation companies** creating **almost 1,600 jobs** in a 100 MWp uptake scenario            |
Net metering market potential in Kenya

Eligible technologies

- Could apply to all types of distributed renewable energy generation

- Demand expected to come mostly from solar PV
## Attractiveness for customer

<table>
<thead>
<tr>
<th>Customer category</th>
<th>DC &lt;1500</th>
<th>DC &gt;1500</th>
<th>SC</th>
<th>CI1</th>
<th>CI2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System size</strong> kWp</td>
<td>5.7</td>
<td>18.8</td>
<td>58.8</td>
<td>364.5</td>
<td>2525.1</td>
</tr>
<tr>
<td>Capacity factor %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generation (year 1) kWh</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System degradation %/year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital cost USD/kWp</td>
<td>2,821</td>
<td>2,821</td>
<td>2,565</td>
<td>2,180</td>
<td>2,180</td>
</tr>
<tr>
<td>Total capital cost USD</td>
<td>16,103</td>
<td>53,055</td>
<td>150,779</td>
<td>794,570</td>
<td>5,504,718</td>
</tr>
<tr>
<td>O&amp;M costs % of CAPEX</td>
<td>0.50%</td>
<td>0.50%</td>
<td>0.40%</td>
<td>0.30%</td>
<td>0.30%</td>
</tr>
<tr>
<td>Annual O&amp;M costs/kWp USD/kWp</td>
<td>14</td>
<td>14</td>
<td>10</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Total annual O&amp;M USD</td>
<td>81</td>
<td>265</td>
<td>603</td>
<td>2,384</td>
<td>16,514</td>
</tr>
<tr>
<td>Equipment replacement (year 10) % of CAPEX</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>Equipment replacement cost USD</td>
<td>3,221</td>
<td>10,611</td>
<td>30,156</td>
<td>158,914</td>
<td>1,100,944</td>
</tr>
<tr>
<td>Discount rate %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project lifetime Years</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td><strong>LCOE 2013</strong> USD/kWh</td>
<td>0.1996</td>
<td>0.1996</td>
<td>0.1799</td>
<td>0.1517</td>
<td>0.1517</td>
</tr>
<tr>
<td>Capital cost reduction factor %/year</td>
<td>2.50</td>
<td>2.50</td>
<td>2.50</td>
<td>2.50</td>
<td>2.50</td>
</tr>
<tr>
<td><strong>LCOE 2018</strong> USD/kWh</td>
<td>0.1759</td>
<td>0.1759</td>
<td>0.1585</td>
<td>0.1336</td>
<td>0.1336</td>
</tr>
</tbody>
</table>
Attractiveness for the customer - Cl1 example

Cash flow for a hypothetical 365kWp solar PV system Cl1 customer category

Project IRR of 10.7%
(Scenario 1)

Consumption:
- 67% internal
- 33% exported
Estimated market size – maximum uptake

![Graph showing estimated market size and maximum uptake over years 2013 to 2018. The y-axis represents NEM capacity (MWP) from 0 to 120, and the x-axis represents years from 2013 to 2018. The graph includes a trend line and bars for each year, indicating growth in NEM capacity and percentage of peak load.](image-url)
## Market segmentation – maximum uptake

<table>
<thead>
<tr>
<th>Customer category</th>
<th>Nr of customers</th>
<th>Avg energy per customer (kWh/a)</th>
<th>Avg solar PV system size (kWp)</th>
<th>Uptake (%)</th>
<th>Uptake capacity (MWp)</th>
<th>NEM share</th>
<th>Nr of NEM projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC</td>
<td>1,656,586</td>
<td>1,127</td>
<td>0.6</td>
<td></td>
<td>0.0%</td>
<td>0.0</td>
<td>0%</td>
</tr>
<tr>
<td>0-50</td>
<td>903,581</td>
<td>219</td>
<td>0.1</td>
<td>0.0%</td>
<td>0.0</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>50-1500</td>
<td>749,213</td>
<td>2,062</td>
<td>1.2</td>
<td>1.0%</td>
<td>8.8</td>
<td>9%</td>
<td>7,492</td>
</tr>
<tr>
<td>&gt;1500</td>
<td>3,792</td>
<td>32,947</td>
<td>18.8</td>
<td>8.0%</td>
<td>5.7</td>
<td>6%</td>
<td>303</td>
</tr>
<tr>
<td>SC</td>
<td>200,616</td>
<td>6,098</td>
<td>3.5</td>
<td>4.0%</td>
<td>27.9</td>
<td>28%</td>
<td>8,025</td>
</tr>
<tr>
<td>CI1</td>
<td>2,775</td>
<td>638,561</td>
<td>364.5</td>
<td>4.0%</td>
<td>40.5</td>
<td>40%</td>
<td>111</td>
</tr>
<tr>
<td>CI2</td>
<td>305</td>
<td>4,423,899</td>
<td>2,525.1</td>
<td>2.0%</td>
<td>15.4</td>
<td>15%</td>
<td>6</td>
</tr>
<tr>
<td>CI3</td>
<td>31</td>
<td>10,210,317</td>
<td>5,827.8</td>
<td>1.0%</td>
<td>1.8</td>
<td>2%</td>
<td>0</td>
</tr>
<tr>
<td>CI4</td>
<td>21</td>
<td>22,743,016</td>
<td>12,981.2</td>
<td>0.0%</td>
<td>0.0</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>CI5</td>
<td>24</td>
<td>8,940,157</td>
<td>5,102.8</td>
<td>0.0%</td>
<td>0.0</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>15,938</strong></td>
<td></td>
<td></td>
<td><strong>100.1</strong></td>
<td><strong>100%</strong></td>
<td><strong>15,938</strong></td>
<td></td>
</tr>
</tbody>
</table>
Market potential – key messages

- Net metering may have **wider benefits**
- **Uptake will depend on a financial attractiveness**, which is based on many variables
- Net metering **more interesting for certain customer categories** than others
- **100 MW maximum uptake scenario not likely** to be achieved by 2018
## Case studies

<table>
<thead>
<tr>
<th>Project</th>
<th>Size (kW)</th>
<th>Year Installed</th>
<th>Source of funds/ rationale of investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNEP Nairobi</td>
<td>515</td>
<td>2011</td>
<td>Donor funded (grant). Primarily demonstration value.</td>
</tr>
<tr>
<td>SOS Children’s Village Mombasa</td>
<td>60</td>
<td>2011</td>
<td>Donor funded (grant). Primary objective was to reduce operating expenses for the facility.</td>
</tr>
<tr>
<td>Uhuru Flowers</td>
<td>72</td>
<td>2013</td>
<td>Privately funded, commercial venture.</td>
</tr>
</tbody>
</table>
SOS Mombasa – energy balance

Energy consumption/production (MWh/a)

Total consumption
Solar energy production

Import from grid
Export to grid
Solar energy direct consumption
SOS Mombasa – load profile (Dec 2012)
UNEP Nairobi – power output

- Primarily for own consumption
- Some spillage on weekends
Main parameters and assumptions:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment</td>
<td>1.38 million USD</td>
</tr>
<tr>
<td>O&amp;M expenses</td>
<td>0.3% of capex</td>
</tr>
<tr>
<td>Replacement of parts</td>
<td>Inverters in year 10</td>
</tr>
<tr>
<td>System output</td>
<td>762 MWh/a (degradation 0.5%/a)</td>
</tr>
<tr>
<td>Offset tariff</td>
<td>14c/kWh escalating to 18c/Kwh</td>
</tr>
<tr>
<td>IRR</td>
<td>5.0%</td>
</tr>
</tbody>
</table>

Accumulated cash flows (in USD ’000)

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>-1380</td>
</tr>
<tr>
<td>2013</td>
<td>-1000</td>
</tr>
<tr>
<td>2015</td>
<td>500</td>
</tr>
<tr>
<td>2017</td>
<td>750</td>
</tr>
<tr>
<td>2019</td>
<td>1000</td>
</tr>
<tr>
<td>2021</td>
<td>1250</td>
</tr>
<tr>
<td>2023</td>
<td>1500</td>
</tr>
<tr>
<td>2025</td>
<td>1750</td>
</tr>
<tr>
<td>2027</td>
<td>2000</td>
</tr>
<tr>
<td>2029</td>
<td>2250</td>
</tr>
<tr>
<td>2031</td>
<td>2500</td>
</tr>
</tbody>
</table>

- Project investment in 2011
- Same project with 2013 prices would have an IRR of 7.2% and 5%
- Net metering less attractive for CI2 customers than others (e.g. DC and SC)
Uhuru Timau – power output

- February 2013 installation
- Almost entire production consumed on-site
Reduced solar PV prices reflect in financial performance

Impact of net metering on IRR minor due to ~95% consumption on site

However, project may have been sized differently with net metering

### Main parameters and assumptions:

| **Investment:** | 177 kUSD |
| **O&M expenses:** | 0.3% of capex |
| **Replacement of parts:** | Inverters in year 10 |
| **System output:** | 125 MWh/a (degradation 0.5%/a) |
| **Offset tariff:** | 16c/kWh escalating to 21c/kWh |
| **IRR:** | 10.2% |

### Accumulated cash flows (in USD ‘000)

<table>
<thead>
<tr>
<th>Year</th>
<th>Investment</th>
<th>O&amp;M expenses</th>
<th>Replacement of parts</th>
<th>System output</th>
<th>Direct consumption</th>
<th>Offset tariff</th>
<th>IRR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>177 kUSD</td>
<td>0.3% of capex</td>
<td>Inverters in year 10</td>
<td>125 MWh/a</td>
<td>95% of output</td>
<td>16c/kWh</td>
<td>10.2%</td>
</tr>
</tbody>
</table>

Nairobi, 28 February 2014
Case studies – key messages

- **Solar insolation** 30% more Timau vs Mombasa
- **Cost reduction** USD/kWp 20% less for Uhuru Flowers in 2013 vs SOS Mombasa in 2011
- **Power cuts** 4-6.5% grid downtime reduces output
- **Tariffs** important to determine what can be offset
- **System sizing** Uhuru system meets 36% of on-site electricity demand. With net metering the system could have been sized to cover 100% of demand, meaning 200 kWp system instead of 72 kWp
Net metering impact on load profile (2012)

- Displaced energy generation
- Output of 100 MWp of solar
Net metering impact on load profile (2012)

- Displace thermal
- 10% of midday load
- 1.6% of generation
- Partially address suppressed demand
Net metering impact on load profile (2018)

- Displaced energy generation
- Output of 100 MWp of solar
Net metering impact on load profile (2018)

- Projected load & dispatch (LCPDP)
- Displace thermal
- 3.4% of midday load
- 0.7% of generation
Technical considerations for net metering

- Compatibility of distributed generation under net metering with Kenya Electricity Grid Code

- Minor additions needed for inverter-based solar PV systems (GIZ 2011)

- Report Volume 2 and draft regulations contain suggested standards and procedures
Economic impact on the utility

Methodology: rate impacts perspective

<table>
<thead>
<tr>
<th>Benefits to the Utility</th>
<th>Costs to the Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoided energy purchases</td>
<td>NEM Bill Credits</td>
</tr>
<tr>
<td>Avoided T&amp;D losses</td>
<td>Program Administration</td>
</tr>
<tr>
<td>Avoided capacity purchases</td>
<td>Cross-subsidy impact</td>
</tr>
<tr>
<td>Avoided T&amp;D Investments and O&amp;M</td>
<td>Tariffs not reflecting fixed costs</td>
</tr>
<tr>
<td>Environmental Benefits—NOx, SOx, PM, &amp; CO2</td>
<td>Connection/approval costs (meter, technical inspection, etc.)</td>
</tr>
<tr>
<td>Avoided RES Generation Purchases</td>
<td></td>
</tr>
<tr>
<td>Reliability Benefits</td>
<td></td>
</tr>
</tbody>
</table>
Costs and benefits of net metering to KPLC

USD millions based on maximum uptake

- Cross subsidy impact
- Tariffs not reflecting fixed costs
- Administrative costs
- NEM bill credits
- Avoided T&D losses
- Avoided energy purchases

Nairobi, 28 February 2014
Net metering assessment findings
## Costs and benefits of net metering to KPLC

<table>
<thead>
<tr>
<th>Year</th>
<th>Avoided energy purchases</th>
<th>Avoided T&amp;D losses</th>
<th>NEM bill credits</th>
<th>Administrative costs</th>
<th>Tariffs not reflecting fixed costs</th>
<th>Cross subsidy impact</th>
<th>Balance per kWh USD/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>200</td>
<td>16</td>
<td>-235</td>
<td>-11</td>
<td>0</td>
<td>-5</td>
<td>-0.033</td>
</tr>
<tr>
<td>2013</td>
<td>2,667</td>
<td>213</td>
<td>-3,137</td>
<td>-141</td>
<td>-106</td>
<td>-61</td>
<td>-0.04</td>
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<tr>
<td>2014</td>
<td>4,416</td>
<td>353</td>
<td>-5,195</td>
<td>-232</td>
<td>-228</td>
<td>-129</td>
<td>-0.044</td>
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<tr>
<td>2015</td>
<td>7,312</td>
<td>585</td>
<td>-8,603</td>
<td>-383</td>
<td>-673</td>
<td>-239</td>
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<tr>
<td>2016</td>
<td>12,109</td>
<td>969</td>
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<td>-632</td>
<td>-1,389</td>
<td>-391</td>
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<tr>
<td>2017</td>
<td>20,053</td>
<td>1,604</td>
<td>-23,593</td>
<td>-1,043</td>
<td>-2,784</td>
<td>-704</td>
<td>-0.061</td>
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<tr>
<td>2018</td>
<td>33,208</td>
<td>2,657</td>
<td>-39,071</td>
<td>-1,721</td>
<td>-4,967</td>
<td>-1,320</td>
<td>-0.064</td>
</tr>
</tbody>
</table>
Utility impact assessment – key messages

- No technical constraints
- Costs to KPLC are higher than benefits
- Net metering credits for exports should be discounted

<table>
<thead>
<tr>
<th>Year</th>
<th>DC (&lt;1500)</th>
<th>DC (&gt;1500)</th>
<th>SC</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>82%</td>
<td>89%</td>
<td>83%</td>
<td>79%</td>
<td>77%</td>
<td>77%</td>
<td>76%</td>
<td>76%</td>
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<tr>
<td>2013</td>
<td>78%</td>
<td>87%</td>
<td>79%</td>
<td>74%</td>
<td>72%</td>
<td>71%</td>
<td>71%</td>
<td>70%</td>
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<tr>
<td>2014</td>
<td>76%</td>
<td>86%</td>
<td>78%</td>
<td>72%</td>
<td>69%</td>
<td>69%</td>
<td>68%</td>
<td>67%</td>
</tr>
<tr>
<td>2015</td>
<td>72%</td>
<td>83%</td>
<td>73%</td>
<td>67%</td>
<td>64%</td>
<td>62%</td>
<td>62%</td>
<td>61%</td>
</tr>
<tr>
<td>2016</td>
<td>69%</td>
<td>82%</td>
<td>71%</td>
<td>64%</td>
<td>60%</td>
<td>59%</td>
<td>58%</td>
<td>58%</td>
</tr>
<tr>
<td>2017</td>
<td>67%</td>
<td>80%</td>
<td>68%</td>
<td>61%</td>
<td>57%</td>
<td>55%</td>
<td>54%</td>
<td>54%</td>
</tr>
<tr>
<td>2018</td>
<td>65%</td>
<td>79%</td>
<td>67%</td>
<td>59%</td>
<td>55%</td>
<td>53%</td>
<td>52%</td>
<td>51%</td>
</tr>
</tbody>
</table>

Weighted average net metering credit 62% of variable retail tariff
FIT equivalent (USD/kWh) of 62% credit

<table>
<thead>
<tr>
<th>Scenario 1: COSS 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC (&lt;1500)</td>
</tr>
<tr>
<td>0.12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scenario 2: 2013 tariff revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC (&lt;1500)</td>
</tr>
<tr>
<td>0.12</td>
</tr>
</tbody>
</table>

Project IRR

<table>
<thead>
<tr>
<th>Scenario 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
</tr>
<tr>
<td>DC (&lt;1500)</td>
</tr>
<tr>
<td>9.1%</td>
</tr>
<tr>
<td>2018</td>
</tr>
<tr>
<td>13.1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scenario 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
</tr>
<tr>
<td>DC (&lt;1500)</td>
</tr>
<tr>
<td>3.3%</td>
</tr>
<tr>
<td>2018</td>
</tr>
<tr>
<td>5.3%</td>
</tr>
</tbody>
</table>
Impact on government revenue

- Scenario A
- Example cash flow analysis of 365 kWp solar PV
- VAT on capital costs more than offsets VAT losses on electricity sales
Impact on government revenue (2018)

- **Scenario A:** 100 MWp, only exported electricity considered
- **NPV** of programme is **positive** for the government

<table>
<thead>
<tr>
<th></th>
<th>DC (&lt;1500)</th>
<th>DC (&gt;1500)</th>
<th>SC</th>
<th>CI1</th>
<th>CI2</th>
<th>CI3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate capacity</td>
<td>8.8</td>
<td>5.7</td>
<td>27.9</td>
<td>40.5</td>
<td>15.4</td>
<td>1.8</td>
<td>100.1</td>
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<tr>
<td>capacity (MWp)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VAT losses (USD/a)</td>
<td>303,434</td>
<td>331,608</td>
<td>502,594</td>
<td>587,964</td>
<td>201,896</td>
<td>22,714</td>
<td>1,950,210</td>
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<tr>
<td>ERC losses (USD/a)</td>
<td>3,548</td>
<td>2,296</td>
<td>5,537</td>
<td>8,020</td>
<td>3,053</td>
<td>358</td>
<td>22,812</td>
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<tr>
<td>REP losses (USD/a)</td>
<td>94,823</td>
<td>103,627</td>
<td>157,061</td>
<td>183,739</td>
<td>63,092</td>
<td>7,098</td>
<td>609,440</td>
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<tr>
<td>NPV VAT and levies</td>
<td>307,435</td>
<td>-1,414,401</td>
<td>5,226,005</td>
<td>6,648,860</td>
<td>2,819,526</td>
<td>345,101</td>
<td>13,932,527</td>
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</tbody>
</table>

Nairobi, 28 February 2014
Net metering assessment findings
Impact on government revenue (2018)

- **Scenario B**: 100 MWp, all generated electricity considered
- NPV of programme is **negative** for the government

<table>
<thead>
<tr>
<th>DC (&lt;1500)</th>
<th>DC (&gt;1500)</th>
<th>SC</th>
<th>CI1</th>
<th>CI2</th>
<th>CI3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate capacity (MWp)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100.1</td>
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<tr>
<td>VAT losses (USD/a)</td>
<td>530,098</td>
<td>574,898</td>
<td>1,782,663</td>
<td>2,085,465</td>
<td>716,110</td>
<td>80,564</td>
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<tr>
<td>ERC losses (USD/a)</td>
<td>5,295</td>
<td>3,427</td>
<td>16,778</td>
<td>24,302</td>
<td>9,252</td>
<td>1,085</td>
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<tr>
<td>REP losses (USD/a)</td>
<td>165,656</td>
<td>179,656</td>
<td>557,082</td>
<td>651,708</td>
<td>223,784</td>
<td>25,176</td>
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<tr>
<td>NPV VAT and levies (USD)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Impact on government revenue

- Maximum **uptake of 100 MWp** is unlikely
- Corporate customer offsetting of **input/output VAT** not considered

**Government revenue – key messages**

- **NPV depends** on assumptions
- **VAT impact more** significant than other levies
Conclusion – key messages

- **No constraints** to net metering
- Can be designed in a way that is **revenue neutral for the utility** and other ratepayers
- Net metering **uptake depends on financial attractiveness**
- Proposed approach is **a compromise** between utility and net metering customer requirements
Summary of recommendations

Phase 1

- Launch phase 1 of net metering programme, 2-3 years
- Make all renewable energy sources eligible
- Only allow “banking”, no payment for net exports
- Apply a net metering credit of 62% per kWh exported
- Individual system cap of 500 kW
- Aggregate cap of 100 MW, subject to review
Summary of recommendations

Phase 1

- Apply fees to cover upfront costs
- Non-refundable application fee
- Site visit assessment fee
- Commissioning fee
- Dual metering only
- Conduct utility site visits for initial installations
Summary of recommendations

Phase 2

- Consider **option for payment** for exported units
- Consider to **increase individual system cap**
- Increase or **remove aggregate capacity cap**
- **Recalculate value of net metering credit** (62%), making use of more data that will be available
Draft net metering regulations

Joachim Wandaka, CA

Nairobi, 28 February 2014
Draft revised National Energy Policy

- Contains provisions on net metering
  - Framework for connection to national & isolated grids
  - Development of a tariff for net metering
  - Development of legislation (2012-2016)
Draft Energy Bill 2013

- Defines net metering agreement

“an agreement agreement entered into in accordance with section 157 by a distribution licensee or retailer and a renewable energy generator of capacity **not exceeding twenty kilowatts** or such other limit as may be prescribed by the Cabinet Secretary.”
Defines net metering system
“a system that operates in parallel with the electrical distribution facilities of a distribution licensee and that measures, by means of one or more meters, the amount of electrical energy that is supplied:
• i. by the distribution licensee or retailer to a consumer who owns the renewable energy generator, and
• ii. by the consumer who owns the renewable energy generator to the distribution licensee or retailer.”
Draft net metering regulations

- **Applicability & eligibility**
  - Regulations to apply to a renewable energy capacity not exceeding 500KW installed primarily for self-consumption at the premises of an electricity consumer
  - All customers within an area of supply
  - All renewable energy technologies
Draft net metering regulations

▶ **General provisions**
  - All distributions licensees shall offer net metering
  - Obligation to accept electricity export from a net metering customer (“customer-generator”)
  - Customer exempt from obtaining a generation permit
  - Cabinet Secretary can review and amend
Draft net metering regulations

- **Generation capacity**
  - Not to exceed lower of facility’s main electricity supply circuit breaker or inverter, customer contract demand and 500 kW
  - Maximum aggregate capacity limited to 100 MW
  - Net metering agreement to be entered into
  - Distribution licensee can impose specific feeder line limits to ensure network performance
  - ERC to review regulations within 3 years
Draft net metering regulations

- Application to enter into a net metering arrangement
  - Standard application form
  - Non-refundable application fee
  - Distribution licensee has 45 days to consider
  - Distribution licensee can approve or reject
  - Notice of decision sent to application in 10 days
  - Grievance/appeals process – Energy Tribunal or ERC within 30 days of receipt of notice
Draft net metering regulations

- **Installation and maintenance**
  - Work shall be done by competent personnel approved by ERC
  - Equipment shall meet relevant standards
  - Provisions for conformity with Grid Code and Guidelines for Small-Scale Renewable Generation Plants
Draft net metering regulations

- **Installation and maintenance**
  - Distribution licensee may apply different procedures for: (i) 16 Amp per phase or lower, (ii) greater than 16 Amp but less than 50 kW 3-phase or 17 kW single-phase and (iii) anything greater
  - Distribution licensee can carry out inspections for various reasons
  - Approval needed before any system modifications
  - Problematic systems can be disconnected by utility
Draft net metering regulations

- **Costs, tariffs and billing**
  - Electricity rates charged to a net metering customer the same as for other customers
  - Customer to pay non-discriminatory fees for site visits and related
  - Customer-generator to be compensated for electricity supplied with a 62% credit for each unit exported in a billing period
Draft net metering regulations

- **Costs, tariffs and billing**
  - Billing and compensation procedure is explicit:
    (i) Customer billed for consumption after crediting
    (ii) Carry forward of credits in the case of surplus
    (iii) Unused credits forfeited each anniversary
  - Distribution licensee to facilitate participation of prepaid meter customers in net metering
Draft net metering regulations

- **Costs, tariffs and billing**
  - No compensation to customer generator for capacity, voltage support, reactive power and deemed generation
  - ERC may apply a specific methodology to net metering customers to capture VAT and other levies
  - Customer forfeiture of any surplus credits in case of relocation or termination of net metering agreement
Draft net metering regulations

- Monitoring
  - Annual report prepared by distribution licensee and submitted to ERC
Draft net metering agreement

- **Key provisions**
  - Executed after acceptance by distribution licensee of the customer-generator’s application
  - Details obligations of the parties as per the regulations
  - Amiable dispute resolution prior to escalation
  - Provisions for when a distribution licensee can require the customer-generator to interrupt or reduce output
  - Customer generator responsible for protecting their system
Draft net metering agreement

- **Key provisions**
  - Distribution licensee not liable for damages except in the case of gross negligence or misconduct
  - Agreement term of 20 years. No termination by distribution licensee expect for customer default

→ Change in regulations should not affect the customer’s investment
Adoption process

- **Energy Act**: Assent
- **President**: Forward
- **Parliament**: Approve
- **National Energy Regulatory Commission**: Recommend
- **Energy Bill**: Legislate
- **Net Metering Regulations**: Formulate
- **Cabinet Secretary**: Implement
- **Subsidiary legislation**: Implement
- **Customer generator and Distribution Licensee**: Implement

Nairobi, 28 February 2014

Net metering regulations
Proposed application and implementation procedures

Faith Nangabo, CA

Nairobi, 28 February 2014
Grid connection study procedures

Matthew Woods, CA

Nairobi, 28 February 2014
Grid connection study procedures

- **Why?**
  - Provide clarity on the process
  - Identify roles and responsibilities of the parties
  - Agree on fixed timeframes
# Grid connection study procedures

<table>
<thead>
<tr>
<th>Step</th>
<th>Responsibility</th>
<th>Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Prefeasibility study</td>
<td>Project owner</td>
</tr>
<tr>
<td>2</td>
<td>EOI submission under the FIT</td>
<td>Project owner</td>
</tr>
<tr>
<td>3</td>
<td>EOI review</td>
<td>FIT Committee Utility</td>
</tr>
<tr>
<td>4</td>
<td>Preliminary grid connection opinion</td>
<td>Utility</td>
</tr>
<tr>
<td>5</td>
<td>Full feasibility</td>
<td>Project owner</td>
</tr>
</tbody>
</table>
## Grid connection study procedures

<table>
<thead>
<tr>
<th>Step</th>
<th>Responsibility</th>
<th>Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Grid connection study</td>
<td>Project owner, Utility</td>
</tr>
<tr>
<td>7</td>
<td>Review of grid connection study</td>
<td>Utility</td>
</tr>
<tr>
<td>8</td>
<td>Start of discussion on grid connection arrangements</td>
<td>Project owner, Utility</td>
</tr>
</tbody>
</table>
## Grid connection study procedures

<table>
<thead>
<tr>
<th>Step</th>
<th>Responsibility</th>
<th>Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Design of interconnection facilities</td>
<td>Project owner</td>
</tr>
<tr>
<td>10</td>
<td>Review and approval of interconnection facility</td>
<td>Utility</td>
</tr>
<tr>
<td>11</td>
<td>Grid connection annexes to PPA</td>
<td>Project owner, Utility</td>
</tr>
</tbody>
</table>
START

Prefeasibility study & connection point → Application FIT Expression of Interest (EOI) → FIT committee rep shares with utility personnel → Utility contact applicant if needed

Step 1

Step 2

Utility provision of data → Full feasibility study Request for grid data → EOI Approval?

Y

EOI review → Preliminary grid opinion

N

Step 3

Step 4

Grid connection study by project owner → Grid connection discussions → Utility review of grid connection study

Step 5

Step 6

Step 7

Project design of interconnection facilities → Approval of interconnection → Grid connection annexes to PPA

Step 8

Step 9

Step 10

Step 11

END
Grid connection study procedures

- Grid opinion letter template
  - Provides preliminary indication of suitability
  - Utility can suggest alternative interconnection point
  - In the case the system may require upgrading, initial assessment of specific requirements is provided

- Embedded link to letter
Grid connection study procedures

- **Deep system costs**
  - FIT policy → project owner responsible for interconnection costs (covered in tariff)
  - What about “deep” costs?
  - Proposed approach, where upgrades, reinforcements, etc are needed to evacuate the full power output
Grid connection study procedures

- **Deep system costs**
  - Step 1 – assess whether upgrade is already part of utility planning
  - Step 2 – if already planned, generator pays only any incremental costs for the integration of their generator
  - Step 3 – if not planned, project owner is responsible for full costs of deep system improvements reasonably associated with the generator
Grid connection study procedures

- **Deep system costs**
  - Step 4 – In either case, if the new generation project helps the utility to avoid or postpone future network improvements the value of this taken into account in assessing any costs to be paid by the generator.
  - Step 5 – The generator’s contribution shall subject to cost-sharing or reimbursement of a relevant portion of the costs if the new network is used by the utility, other generators or consumers in the future.
Grid connection study ToR

Jeff Murage, KAM

Nairobi, 28 February 2014
Grid connection study ToR

- **Purpose**
  - Provide/complement feasibility and engineering study to assess compatibility of project with the grid
  - Needed for bankability
  - Terms of Reference (ToR) template provides guidance and specifies minimum requirements. Can be used/adapted by project owner
Grid connection study ToR

Content

- Specific to project generation characteristics with network at the feed-in point
- Different technologies have different considerations
- Assesses impact of project on the grid
- Enables offtaker to anticipate technical characteristics
- Input for design of interconnection facilities and network improvements
Grid connection study ToR

- **3-step approach**
  - Data collection/sharing
  - Network and system modelling
  - Simulation and investigation
  - Input for design of interconnection facilities and network improvements

- **Important: collaboration between sponsor and utility**
Grid connection study ToR

- Focus on technical requirements
  - Load flow analysis
  - Voltage profile
  - Stability analysis
  - Fault current analysis

- Inputs needed from project sponsor
  - Feasibility study, generation schedule, single line diagram, protection equipment interface, etc
Grid connection study ToR

- **Study outputs**
  - Scope of study
  - Input assumptions
  - Results of analysis
  - Schematics and single-line diagrams
  - Recommendations
Feasibility study template

Faith Nangabo, CA

Nairobi, 28 February 2014
Feasibility study template

▶ Why?
• Quality and content of feasibility studies submitted to FIT committee can vary
• Difficult to assess project suitability
• Delays project development and financing

▶ The template
• Gives an indication of type and level of detail required
• Can be used as a template or a guidance document.
## Feasibility study template

### General components

<table>
<thead>
<tr>
<th>Technical aspects</th>
<th>Other aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site assessment</td>
<td>Regulatory analysis</td>
</tr>
<tr>
<td>Energy resource assessment</td>
<td>Environmental &amp; social analysis</td>
</tr>
<tr>
<td>Facility design</td>
<td>Economic assessment</td>
</tr>
<tr>
<td>Energy yield</td>
<td>Financial analysis</td>
</tr>
<tr>
<td>Grid integration assessment</td>
<td>Risk analysis and mitigation</td>
</tr>
<tr>
<td>Implementation plan &amp; logistics</td>
<td>Recommendations</td>
</tr>
</tbody>
</table>
Feasibility study template

- Small hydro power example

Embedded link to letter
Issues raised by stakeholders

- **Purpose** of a net metering policy?
- **Effects on load profile** and power purchase costs
- Would net metering **displace other green energy**?
- Payment for system use and **utility revenue neutrality**
- **Stability** and maintenance / system losses
- **Safety** considerations
- **Effect on system planning**
- **Financial attractiveness** for customers
Attractiveness for the customer - costs

---

**kW-scale**

### 2821 $/kWp

---

**MW-scale**

### 2180 $/kWp

---

![Graph showing PV installed price USD/Wp over years from 2010 to 2030 for different scales and categories: Residential (<= 10 kWp), Commercial (10 - 1000 kWp), Utility scale (>MWp).]
Attractiveness for customer - tariff

Simplified tariff projection CI1

- Energy component (per kWh)
- Demand component (per kVA)
Attractiveness for customer – solar insolation

The average daily radiation in more than 28,000 km² of land in Kenya is above 6 kWh/m² through the year, thus resulting in a continuously good and relatively stable potential for electricity generation from solar.

Figure 25: Average Daily Radiation Measured at 15 Meteorological Stations in Kenya by Month of Year in the Period 1964 - 1993

Photovoltaic (PV) technology uses solid-state semiconductor devices to convert sunlight into direct current electricity as shown in figure 25. Although the underlying science was discovered by Becquerel in the nineteenth century, significant progress in commercialization became possible with Bell Labs’ invention of the silicon solar cell in 1954 and its early use in powering earth satellites.
Attractiveness for the customer - mechanism

Scenarios:

1. Excess energy exported to the grid at equivalent retail tariff (energy banking)
2. Excess energy exported to the grid at feed-in-tariff rate
3. No compensation for excess energy exported to the grid
Estimated market size – international experience

Sri Lanka
Since 2009
0.7 MWp
0.02% of
installed capacity

Tunisia
Since 2004
1.3 MWp
0.03% of
installed capacity

For Kenya a maximum of 2-3% of installed capacity within 5 years in an aggressive uptake scenario of 100 MWp

Israel
FiT since 2008
250 MWp
2.1% of installed capacity

California
Since 1996
1022 MWp
1.4% of installed capacity
Avoided energy purchases

- Only fuel costs considered
- Average of thermal power plants excluding Aggreko
- Scenario 1
  - 2.5% escalation
- Scenario 2
  - 0% escalation
Other economic benefits

- Avoided T&D losses
- Avoided capacity purchases
- Avoided T&D investment and O&M costs
- Avoided RE generation purchases
- Reliability benefits

Not quantified at this stage
Average costs of net metering credits consumed during peak vs avoided energy purchases during daytime

- Scenario 1
  - 25% higher
- Scenario 2
  - 18% higher
Programme administration costs

- USD 9 (KES 800)/customer/month

Connection/approval costs

- One-off upfront fee charged to customers
## Tariff cross-subsidy impacts

- < 50 kWh/month is 9% of all utility sales

<table>
<thead>
<tr>
<th>Fixed charge KES/month</th>
<th>Fixed charge per kWh</th>
<th>Energy charge KES/kWh</th>
<th>FCA KES/kWh</th>
<th>Total KES/kWh</th>
<th>Tariff requirement COSS 2013 KES/kWh</th>
<th>Subsidy requirement KES/kWh</th>
<th>Cost implication for rest of consumers KES/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>1.28</td>
<td>2.00</td>
<td>5.42</td>
<td>8.70</td>
<td>12.56</td>
<td>3.86</td>
<td>0.381</td>
</tr>
<tr>
<td>120</td>
<td>1.28</td>
<td>2.00</td>
<td>5.42</td>
<td>8.70</td>
<td>12.56</td>
<td>3.86</td>
<td>0.381</td>
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<tr>
<td>120</td>
<td>1.28</td>
<td>2.50</td>
<td>5.42</td>
<td>9.20</td>
<td>14.13</td>
<td>4.93</td>
<td>0.486</td>
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<td>150</td>
<td>1.60</td>
<td>2.50</td>
<td>5.42</td>
<td>9.52</td>
<td>15.03</td>
<td>5.51</td>
<td>0.544</td>
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<tr>
<td>150</td>
<td>1.60</td>
<td>2.50</td>
<td>5.42</td>
<td>9.52</td>
<td>14.97</td>
<td>5.45</td>
<td>0.538</td>
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<td>9.52</td>
<td>15.44</td>
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<td>0.584</td>
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<td>150</td>
<td>1.60</td>
<td>2.50</td>
<td>5.42</td>
<td>9.52</td>
<td>16.23</td>
<td>6.71</td>
<td>0.662</td>
</tr>
</tbody>
</table>
Tariffs not reflecting fixed costs

**COSS tariff projection CI1**

**Simplified tariff projection CI1**

- Energy component (per kWh)
- Demand component (per kVA)
Summary of changes (Oct 2013 / Feb 2014)

<table>
<thead>
<tr>
<th>Change</th>
<th>Effect on net metering customers</th>
<th>Effect on utility</th>
<th>Effect on net metering credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>New schedule of tariffs</td>
<td>Increase in retail tariff (normative component only), 15 to 19% p.a. depending on category of consumer</td>
<td>All other factors (e.g. fuel charges) remaining constant, increased financial attractiveness</td>
<td>Reduced cost of net metering to the utility</td>
</tr>
<tr>
<td>Decreasing fuel cost</td>
<td>Government expects fuel cost to decrease rapidly due to introduction of coal, natural gas and fast-tracking more geothermal</td>
<td>Reduced financial attractiveness</td>
<td>Reduced cost of net metering to the utility</td>
</tr>
<tr>
<td>All DC customers accessing lifeline</td>
<td>All DC customers accessing lifeline</td>
<td>Residential net metering</td>
<td>Increased cost to the utility (or</td>
</tr>
</tbody>
</table>
Thank you!