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KenGen Geothermal Energy Carbon Credit Projects: Status, Benefits, Challenges, Lessons Learnt and Post-2012 Plans

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ABSTRACT

KenGen has registered three geothermal Clean Development Mechanism (CDM) projects with potential emission reduction of 1.4 million tCO2 /year. The registered projects are at different stages of monitoring, reporting and verification (MRV). KenGen is also implementing 560 MW of geothermal projects with a potential emission reduction of about 2.5 million tCO2 /year by 2019. The paper discusses status and the Company's experience in geothermal carbon credit projects, including benefits, challenges and lessons learnt. The paper also discusses the current role of KenGen in the post-2012 new market mechanisms (NMM), bilateral trading options and the Voluntary Carbon Market prospects. The challenges include; project boundary with regard to steam supply/sharing between two geothermal fields, monitoring requirements with regard to frequency, staffing, data analysis instrument and as more carbon credit projects come online, access to third party data, delay in project registration and issuance (mostly caused by the choice of validator/verifier), delay in project construction due to financing and rigorous government procurement regulations, collapse of the carbon markets, type and structure of Emission Reduction Purchase Agreements (ERPA), and potential challenges for emission trading in the post-2012 era. Main benefits include; enhanced community benefits and sustainability of the projects with implications for the Millennium Development Goals, additional revenue streams, enhanced green energy supply and security, internal capacity in developing carbon credit projects etc. Lessons learnt are that there is need to clearly define the project boundary in the project design documents with regard to supply of steam from two or more geothermal fields, experience of a verifier is key to timely project registration and issuance, type and structure of the ERPA is important in guaranteeing carbon revenue, linking aspects of the monitoring plan to Power Purchase Agreement (PPA) and existing systems is important to avoid deviation in PDD post-registration, clear community benefits ensures project's social bottom-line etc. However, ability to generate more carbon revenue from these projects will depend on access to financing, capacity building and technology transfer.

1. INTRODUCTION

1.1 Background

Kenya Electricity Generating Company Limited (KenGen) is a publicly listed Company at the Nairobi Stock Exchange (NSE) and is 70% owned by the Government of Kenya (GoK). The Company is the leading power generator with an installed capacity of 1230MW and a market share of 72% from a mix of generation sources. Additional 1600MW is expected by 2018.

As the biggest energy generator in Kenya and East Africa Region, KenGen has taken a leading role in developing Clean Development Mechanism (CDM) projects. Clean Development Mechanism is one of the instruments created by Kyoto Protocol of the United Nations Convention on Climate Change (UNFCCC) whose first 5 year commitment period ran between 2008 and 2012. The second commitment period will run from 2013 to 2020, when a new international agreement adopted in 2015 will come to force.

2. STATUS OF THE GEOTHERMAL CLEAN DEVELOPMENT MECHANISM PROJECTS

KenGen has registered five Clean Development Mechanism (CDM) projects with potential emission reduction of 1.4 million tCO_2 /year (Table 1).

Table 1: List of registered KenGen Clean Development Mechanism (CDM) Projects

	Project	Projected emission reduction tCO_2/yr
1.	35 MW Olkaria II Geothermal Expansion Project	149,630
2.	20 MW Redevelopment of Tana Power project	25,680
3.	20+ MW Optimization of Kiambere project	41,204
4.	140 MW Olkaria I Units 4&5	635,049
5.	140 MW Olkaria IV Units 1&2	651,349.00

The 35 MW Olkaria II Geothermal Expansion Project, 20 MW Redevelopment of Tana Hydropower and 20+ MW Optimization of Kiambere Hydropower Project were registered under the World Bank Community Development Carbon Fund (CDCF). Clean

Development Mechanisms (CDM) Projects under the CDCF are expected to give at least one dollar per ton of their Carbon Credit revenue to the surrounding communities for sustainability. In addition to the World Bank CDCF projects, KenGen has also registered the 140 MW Olkaria I Units 4&5 and 140 MW Olkaria IV Unit 1 & 2, and recently submitted the 5.1 MW Ngong Wind Energy Project for registration under CDM. KenGen is also implementing 560 MW of geothermal projects with a potential emission reduction of about 2.5 million tCO_2 /year by 2019. The total emission reduction expected from planned renewable energy projects is 5 million tCO_2 per annum by 2019 out of which geothermal energy is expected to contribute over 4 million tCO_2/ year, if all the planned projects are implemented and registered in an emission trading scheme.

Clean Development Mechanism projects under go several phases of development. The KenGen registered projects are at different stages of monitoring, reporting and verification (MRV). The 35 MW Olkaria II Geothermal Expansion Project, 20 MW Redevelopment of Tana Hydropower and 20+ MW Optimization of Kiambere Hydropower Project are currently undergoing Monitoring Reporting and Verification (MRV). Monitoring Reporting and Verification (MRV) involves monitoring of the project emission reductions as documented in the monitoring plan in the registered Project Design Documents (PDDs) on an annual basis over a given crediting period. The emission reductions achieved and documented in the monitoring report are subject to audit by the UNFCCC/CDM Executive Board registered DOE (Verifier) before further checks and issuance of CERs are obtained (CDM Rulebook:102). Monitoring for the 140 MW Olkaria I Units 4&5 and 140 MW Olkaria IV Unit 1 &2 is expected to start immediately after commissioning in late 2014.

Since this paper focuses on geothermal projects, a summary of the status geothermal projects are summarized in Table 2.

Table 2: Status of KenGen CDM projects by June 2014

	Project	**Projected emission reduction tCO_2/yr**	**Crediting Period**	**Status**
1.	35 MW Olkaria II Geothermal Expansion Project	149,630	7 year twice renewable	• 1st and 2nd year Monitoring Reporting & Verification (MRV) complete • 1st Issuance of CERs received in November 2013 for 152,000tCO_2 • 3rd Monitoring Report complete and verification planned in October 2014 • 4th Year Monitoring in progress
2.	140 MW Olkaria I Units 4&5	635,049	7 year twice renewable	• Monitoring to begin after commissioning in October 2014 • Preparation for 1st year MRV in progress
3.	140 MW Olkaria V Units 1&2	651,349	7 year twice renewable	• Monitoring to begin after commissioning in October 2014 • Preparation for 1st year MRV in progress

Note: The information provided in this Table reflects the status in May 2014 when this paper was submitted

3. MONITORING EXPERIENCE

This section discusses the monitoring experience with example from the 35 MW Olkaria II Geothermal Expansion Project in 2012. The project has undergone at least three monitoring periods i.e. December 2010 to December 2011; January 2012 to December 2012; January 2013 to December 2013, and continued into 2014. The estimated emission reduction for the 35 MW Olkaria II Geothermal Expansion Project in the registered PDD is 149,630 tCO_2/year. The estimates were based on an annual average generation of 276 GWh/ year based on 92% plant availability.

Monitoring plan of the of the 35 MW Olkaria II Geothermal Expansion CDM Project involves four main parameters i.e.

- *Msteam,y*: Quantity of steam produced during the year y e.g. monitoring of quantity of steam that feeds Unit 3 or 35 MW Geothermal Expansion Project e.g. in 2012, Quantity of steam produced/monitored during for the CDM project was 2,139,577 t steam/year**.** Steam is measured using the venture flow meter.

- Average mass fraction of non-condensable gases (NCG) in the steam (from the 21 wells that feed the power plant and at the interface i.e., CO_2 and CH_4 this methodology assumes that all NCGs entering the power plant are discharged to atmosphere via the cooling tower. NCG measurements are carried out in production wells and at the steam field and

power plant interface using ASTM Standard Practice E1675 for Sampling 2-Phase Geothermal Fluid for Purposes of Chemical Analysis. Results for 2012 monitoring were as follows:

- *Wsteam,CH4,y*: Average mass fraction of methane in the produced steam in year y the average mass fraction monitored for CH_4 was 0.0000014 tCH_4/t steam.
- *Wsteam,CO_2,y*: Average mass fraction of carbon dioxide in the produced steam in year y e.g. the average mass fraction monitored for CO_2 for 2012 was 0.00350 tCO_2/t steam
- The project emission from steam for the monitoring period was 7565tCO_2e

- *FC Diesel (y):* Quantity of diesel consumed by the emergency diesel generator (EDG). Most of the fuel consumption is as a result of weekly testing of the EDG. KenGen installed a flow meter specifically to monitor fuel consumption by the EDG for CDM purposes. The total diesel consumed in the monitoring period was 4.8 tonnes generating about 15tCO_2 as project emission from diesel consumption.

- *EGFacility, y*: Net electricity generated by Unit 3 (electricity exported to the grid and imported) and by the existing Units 1 and 2 is metered by KenGen and Kenya Power.

The net emission reductions achieved during the monitoring period 2012 were 83,000 tCO_2, lower than the emission reductions estimated in the PDD for the equivalent period i.e. 149,631.47 tCO_2e/yr.

The PDD had estimated a combined grid emission factor of 0.594 tCO_2/MWh. The calculated grid emission factor for 2012 was 0.5422 tCO_2/MWh, which gave lower baseline emissions.

The annual steam quantities estimated in the PDD are 2,070,000 tonnes for the equivalent monitoring period while the actual steam amount measured was 2,139,577 tonnes for this monitoring period. Further, the PDD did not take into consideration the emissions from fossil fuel used by the standby emergency diesel generator, which was 4.8 tonnes during the monitoring period. Both the higher steam amount and fossil fuel monitored gave higher project emissions than estimated, which contributed to the lower emission reduction achieved in 2012. The PDD estimates were also made using 15 production wells which supply steam to Olkaria II power station compared to the actual monitoring where 21 production wells were used.

The calculation of the net electricity generated by the power plant also affected the overall emission reduction because the calculation used to determine electricity generated by the facility (*EGFacility)* takes into account the total electricity generated from the older non-CDM units (units 1 and 2) and CDM power unit (Unit 3) supplied to the grid in year y (MWh/yr). The methodology requires that the emission reductions for units 1 and 2 are also included in the calculations of final emission reduction to ensure that no steam from units 1 and 2 is being directed to Unit 3 for CDM purposes.

During the 2012 monitoring period, Unit 3 was at 95% availability while Unit 1 and Unit 2 were much lower. Whereas Unit 3 or 35 MW Geothermal Expansion Project which is the CDM Project was commissioned in the year 2010, Unit 2 and 3 were commissioned in 2003 and hence at a different performance level. The Unit 1 and 2 were due for overhaul during the monitoring period. The lower generation from Unit 1 and 2 also contributed to lowering the net emission reduction in 2012 compared to projections made in the PDD and as observed in 2011.

For units 1 and 2, the average historical value for power generation over a period of 5 years was estimated at 549,800 MWh/yr and for Unit 3, the value used is 276,000 MWh/yr. In 2011 the plant achieved its full emission reduction, since the conditions were more or less similar to the estimations in the PDD and all the three units were fully operational. The difference in energy generated by the three units of the power plant in 2011 compared to 2012 is summarized in Table 3. The drop in generation for Unit 1 and 2 in 2012 and above average performance of Unit 3 is evident in the data shown in Table 3. The emission reductions achieved in 2013, are about 80,000 tCO_2, which is similar to the 2012. Hence a loss of about 140,000 tCO_2 equivalent in 2012 and 2013 combined compared to the estimated values of 149,631.47 tCO_2e/yr in the PDD.

Table 3: Comparison of power generation between the three units of Olkaria II Geothermal Project

Year	Generation in MWh/year: Olkaria II Geothermal Power Plant			
	Unit 1	Unit 2	Unit 3	Total
2011	281,607.30	282,381.40	281,863.90	845,852.60
2012	229,858.40	223,843.50	277,174.50	730,876.40
Difference	51,748.90	58,537.90	4,689.40	114,976.20

The emission reductions for the 35 MW Olkaria II Geothermal Expansion Project are calculated using approved consolidated baseline and monitoring methodology ACM0002/Version 10, which is "Consolidated baseline methodology for grid-connected electricity generation from renewable sources"

This methodology also refers to the latest approved version of the following tools:

- Tool to calculate the emission factor for an electricity system

- Tool for the demonstration and assessment of additionality
- Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion

2. CHALLENGES

A number of challenges have been experienced with the implementation and monitoring of the geothermal project. the challenges include; project boundary with regard to steam supply/sharing between two geothermal fields, monitoring requirements with regard to frequency, staffing, data analysis instrument and as more carbon credit projects come online, access to third party data, delay in project registration and issuance (mostly caused by the choice of validator/verifier), delay in project construction due to financing and rigorous government procurement regulations, collapse of the carbon markets, type and structure of Emission Reduction Purchase Agreements (ERPA), and potential challenges for emission trading in the post-2012.

Despite several challenges mentioned above, this paper highlights three significant ones;

2.1 Defining project boundary with regard to steam fields

The project boundary of the Olkaria II Geothermal Expansion Project was questioned by the DOE during the first verification mission**.** The boundary issue revolved around the possibility of steam sharing between Olkaria I (non-CDM) and Olkaria II (Unit 3 CDM) projects. In the PDD for Olkaria II Geothermal expansion project, the project boundary was defined as Olkaria II steam field where as there were two wells serving Olkaria II from the Olkaria I steam field. The verifier's argument was that if both plants were using the same steam resource, then Olkaria I should be included in the project boundary of Olkaria II Unit 3 CDM project, to take into account impacts of Olkaria II Unit 3 operations, if any, on the existing Olkaria I plant. The wells in question were OW35A and OW32. The challenge was even compounded by the fact that OW32 previously served Olkaria I as a makeup well and was now serving Olkaria II. Despite KenGen installing an isolation stop valve to isolate the well from supplying steam to Olkaria I, more proof was required from KenGen to show that the operation of the CDM project in Olkaria II was not at the expense of power generation in Olkaria I (just so that the company can earn CDM revenues). The isolation valve was fully closed and the entire steam was being supplied to Olkaria II. Introduction of make-up wells is allowed in CDM but un-metered steam sharing between two power plants is subject to detailed analysis and review of data to avoid having an ambiguous project boundary and double counting if both projects are registered as CDM.

To prove that the CDM project in Olkaria II did not compromise power generation in Olkaria I, studies showing excess steam availability in Olkaria I were provided, and also Olkaria I power generation data from 1997. Records of steam output from the wells supplying Olkaria I was also shown. Olkaria I plant, consisting of three units installed from 1981-1985, has an installed capacity of 45 MW and requires 405 t steam at its specific steam consumption level. The records of steam output from wells supplying Olkaria I power plant demonstrate, the steam flow for Olkaria I has ranged between 623 and 647 t/hour during 2010 – 2012 proving that the steam supply to Olkaria I was more than adequate. The period between 2010 and 2012 was used for comparison because the CDM project in Olkaria II was commissioned in April 2010.

With regard to power generation and power plant availability between 1997-2012 for Olkaria I, taking into account the age of the power plant (30 years), and comparing power generation before and after the CDM project in Olkaria II, statistical analysis showed that, there was no difference in power generation in Olkaria I before and after the commissioning of the CDM project, and that the 35 MW from the CDM project was indeed additional hence the issue was closed. In September 2013, KenGen disconnected the steam pipeline from OW 32 to Olkaria I. The well now stands fully as an Olkaria II well despite being located in the Olkaria I steam field (the OW35A and OW32 are monitored under the CDM). The new 140MW Olkaria I Unit 4&5 is also a CDM project, and proof of excess steam in that Olkaria I geothermal field. KenGen is also planning to put an additional 70 MW Unit under the Olkaria I Unit 6 project.

Other informal arguments that surrounded this discussion were whether or not one can use an old well to supply steam to a new CDM project and how to determine steam supply boundary in geothermal CDM projects. The lesson learnt from the OW 32 issue is that a project boundary with regard to steam supply cannot only be determined by the steam fields but the extent of the impact of the CDM project on other geothermal projects. For instance, had it been determined that the CDM project in Olkaria II had negative impact on power generation and steam supply to Olkaria I, then KenGen would have been forced to modify the project boundary in the PDD to include Olkaria I. The inclusion of Olkaria I in the project boundary would have increased monitoring and staffing requirements as well as caused further delay in issuance of CERs. KenGen team worked closely with the World Bank Carbon Finance Unit to close this issue.

2.2 Delay in project registration and construction

The time taken to develop a PDD to registration determines the number of changes or modifications that PDD will undergo before registration. Unlike 140 MW Olkaria I Units 4&5 and 140 MW Olkaria IV Unit 1 &2 CDM projects whose PDDs were developed in less than a year (in 2012), the 35 MW Olkaria II Geothermal Expansion Project PDD took a while. Between the time that the Project Idea Note (PIN) for the 35 MW Olkaria II Geothermal Expansion Project was submitted to the Bank in July 2006 and project registration date in December 2010, several changes had occurred in CDM procedures and regulations (it is worth noting that CDM was still evolving during that period compared to 2012). The PDD for the 35 MW Olkaria II Geothermal Expansion Project had to be updated to reflect the new changes, which further delays the process.

Furthermore, the delay in construction of the 35 MW Olkaria II Geothermal Expansion Project also contributed to the amount of possible Certified Emission Reductions (CERs) that could be achieved before the end of the first commitment period of the Kyoto Protocol in December 2012. Despite the completion of the feasibility studies of the 35 MW Olkaria II Geothermal Expansion Project immediately after the commissioning of its Unit I and II in 2003, mobilization of project development finance and rigorous procurement requirements delayed the construction and hence commissioning of the plant.

Both delay in project registration and construction of the power plant led to reviews of the Emission Reduction Purchase Agreement (ERPA) between KenGen and the World Bank. The result of the two delays was subsequent reduction in the expected revenue from the contracted CERs and corresponding post 2012 VERs under that ERPA. For instance, the project was commissioned in April 2010 and registered in December 2010. What that meant is that KenGen could only benefit from certified emission reduction (CER) generated from December 2010, 2011 to 2012, as opposed to if the project was constructed and registered at the beginning of the Kyoto Protocol first commitment period in 2008. For instance, the CER volume was reduced from 600,000 CERs in the original ERPA to 257,671, while the VER volume was reduced from 300,000 VERs to 220,861 VERs between the first and the last amended ERPA in December 2012. Given the fact that this project was under Community Development Carbon Fund, where one dollar per ton of CDM revenue, goes back to the community, the loss of CERs due to delays also led to less revenue for community benefit projects where the CDM plant is located. Access to project development financing and quick CDM project registration is key to maximizing benefits from CDM projects.

2.3 Collapse of the Carbon Market in 2012

KenGen still has several geothermal projects lined up for development by 2019, the projects commonly referred to as the 560 MW geothermal projects, in addition to other renewable energy projects. The price of CER fell drastically in 2012 due to weak demand in CERs, European economic downturn as well as, project developers rushing to register CDM projects ahead of new quality restrictions under the EU ETS's Phase III. The EU ETS's Phase III began in 2013, restricting purchase from only CERs generated from projects registered in least developed countries (LDCs). However, CER issuance from projects registered from non-LDCs before the end of the first commitment period of the Kyoto Protocol in 2012 remain eligible. The restriction ignited a last-minute rush to register CDM projects, most of which have historically been based in India or China. The rush contributed to a market with huge oversupply and very little demand and a final price collapse with CER price averaging 0.33 €/tonne of CO_2 which continued into 2013 and 2014. Furthermore EU ETS limits have been surpassed. The low CER prices and EU restrictions amid continued geothermal expansion have a negative impact on the sale and price of CERs from the 140 MW Olkaria I Units 4&5 and 140 MW Olkaria IV Unit 1 &2 CDM projects. KenGen is yet to sign an ERPA for these projects.

3. BENEFITS

Since KenGen is yet to accrue benefits from the 140 MW Olkaria I Units 4&5 and 140 MW Olkaria IV Unit 1 &2, most of the benefits discussed in this Section are drawn from the 35 MW Olkaria II Geothermal Expansion Project and covers community benefits, national benefits, global benefits as well as benefits realized by KenGen.

3.1 Enhanced Energy Supply and Security

The current over-dependency on hydro (which contributes about 50% of the electric energy consumed nationally) puts the country at a higher risk due to re-current drought and deforestation of catchment areas (Ogola et al. 2011a). Droughts are the main cause of power rationing and the engagement of emergency diesel power plants. Additionally, only about 30% of Kenyans have access to electricity. The deployment of geothermal energy in Kenya is not only expected to lead to low carbon growth, but improve access to electricity and reduce over-dependency on hydropower electricity hence provide the much needed energy security. The Olkaria II Extension CDM Project has contributed towards these potential benefits. Furthermore, the commissioning of the 140 MW Olkaria I Units 4&5 and 140 MW Olkaria IV Unit 1 &2 is expected phase-out the emergency diesel power plants.

3.2 Increased Project Profitability

Despite the fact that the geothermal CDM projects did not change the tariff in the negotiated Power Purchase Agreements (PPA), geothermal power plants are operated on base load and hence given priority in terms of dispatch by Kenya Power over other modes of power generation including hydro. Unlike hydro CDM projects which are also susceptible to changing weather conditions, and also affected by droughts, geothermal CDM projects are not susceptible to changing weather conditions and have high availability factor of over 90%, hence generate more electricity and therefore CDM revenue. This is because emission reductions are tied to the net electricity generated and geothermal CDM projects, from KenGen experience have better profitability than hydropower projects from sale of power and CERs. Therefore revenue generated from CERs and corresponding VERs is also expected to increase the overall project profitability above the profits from the sale of power.

3.3 Enhanced Environmental Integrity and Sustainability of the Projects

3.3.1 Measurable and certified emission reduction

Carbon dioxide (CO_2) occurs naturally in most geothermal systems, however, development from geothermal energy has lower emissions per kilowatt hour (kWh) than fossil fuels (Armannsson et al. 2005). Other authors that have extensively studied CO_2 emissions from geothermal energy include Bertani and Thain (2002); Fridleifsson et al. (2008)Alfredsson et al. 2010; Goldstein et al. (2011); Ogola et al 2011a; Ogola et al 2012 among others. Due to considerably low CO_2 emissions of geothermal in comparison to other forms of energy, geothermal projects are considered as Clean Development Mechanism (CDM) projects, and have been used in offsetting emissions from thermal plants through the grid under Consolidated baseline methodology for grid-connected electricity generation from renewable sources ACM0002 (UNFCCC 2011). The emission reductions must be verified before certification using methodologies and procedures set by the CDM Executive Board.

The expected and achieved emission reduction from the CDM projects reported by KenGen has undergone a rigorous verification process. For instance despite the challenges discussed in Section 2 of this paper, Olkaria II Geothermal Expansion Project has achieved about 300,000 tCO_2 of emission reduction in the three monitoring periods (2011-2013), out of which 152,000 tCO_2 have been issued from the first monitoring period and subsequent monitoring periods in advance verification stages. Another 1.25 million tCO_2 equivalent is expected after first monitoring of the 140 MW Olkaria I Units 4&5 and 140 MW Olkaria IV Unit 1 &2 in 2015. KenGen is also implementing 560 MW of geothermal projects with a potential emission reduction of about 2.5 million tCO_2 /year by 2019. The total emission reduction expected from planned renewable energy projects is 5 million tCO_2 per annum by 2019 out of which geothermal energy is expected to contribute over 4 million tCO_2/ year, if all the planned projects are implemented. KenGen can confidently account for its contribution to overall global emission reduction, most of which is from

geothermal energy. The Olkaria II Geothermal Expansion Project is the first to be issued with Certified Emission Reductions under CDM in Kenya.

3.3.2 Meeting social bottom-line through community benefit projects from the CDM proceeds

Meaningful economic and social benefits can also be made through geothermal development. Further CDM projects have better potential for providing additional funds for improving local livelihoods if implemented under the community development carbon fund (CDCF), e.g. the 35 MW Olkaria II Geothermal Expansion Project. Community Development Carbon Fund (CDCF) supports projects that combine community development attributes with emission reductions to create "development plus carbon" where one dollar of every ton of carbon traded is ploughed back into the host community by the project developer (World Bank 2011). So far, four community benefit projects with positive implications for health, education, access to water among other key elements of the Millennium Development Goals (MDGs) are at different stages of development with the advance payment of USD 225,000 from the World Bank. The projects implemented under the advance payment include:

- Construction and equipment of 3 classrooms at Oloirowua Primary School serving 450 pupils/year
- 10 km water pipeline to Maiela serving 20,000 people
- Excavation of Olosing'ate water pan for watering about 40,000 livestock
- Construction and equipment of 3 classrooms at Ngambani Nursery School serving 350 pupils/year

The community projects increased acceptability within the recipient community and smooth implementation of the geothermal project. The second and the last payments are expected to enhance the existing projects and start others. These projects are in addition to the Corporate Social Responsibility Projects (CSR) that KenGen has continued to give to the community, such as the benefits that have come with the 140 MW Olkaria I Units 4&5 and 140 MW Olkaria IV Unit 1 &2 CDM projects which are not being implemented under the CDCF. The community benefits recommended by the on-going Strategic Environmental Assessment (SEA) for geothermal expansion including the planned 560 MW will be implemented. The Draft Energy Bill of Kenya 2013 and County governments have also recommended benefit sharing agreements which will be used in guiding developers.

3.3.3 Contribution to local and global adaptation

The CDCF and CSR projects that have come through geothermal development in KenGen have not only contributed towards mitigation but enhancing local adaptation. Potential synergy between mitigation and adaptation in geothermal development are discussed using the Geo-Adam Conceptual Frameworks by Ogola et al 2012. In addition to the community projects, the 35 MW Olkaria II Geothermal Expansion Project contributed 2% of the CDM revenue earned from the first monitoring period to the Adaptation Fund. The amount contributed to the Adaptation Fund will make a difference in the lives of vulnerable communities wherever they are in the World. The project is also the first Kenyan project to contribute to the Adaptation Fund through CDM.

3.3.4 Displacement of power generation from thermal sources

The engagement of emergency power providers and switch to thermal plants to reduce the cost of unfulfilled power supply leads to high cost of electricity per unit due to Fuel Cost Adjustments (FCA), which is passed on to the consumer, and drastically increases their power bills. During drought, the FCA constitutes > 50% of the consumers' electricity bills. The FCA is a direct impact of drought in hydropower plants and switch to diesel based emergency power generation that also contributes to CO_2 emissions (Ogola 2013). The displacement of thermal sources using geothermal energy will contributed in reducing consumers electricity bills. In the absence of geothermal projects, the additional megawatts would have been sourced from thermal sources with high implication on electricity tariff. The 35 MW Olkaria Geothermal Expansion Project contributed in reducing electricity generated from thermal plants and even greater contribution is expected from the 140 MW Olkaria I Units 4&5 and 140 MW Olkaria IV Unit 1 &2 CDM projects.

3.4 Positive Publicity, Capacity Development and Knowledge Sharing

The Geothermal Expansion Project was the second CDM project to be registered and the first to be issued with CERs in Kenya. The project participants are currently sharing the lessons learnt from this project with other Kenyan projects that are still at different validation and verification stages. KenGen staff members are undertaking monitoring of the CDM projects and have been subjected to stringent verifications (audits) which have improved internal capacity in managing CDM projects.

4. LESSONS LEARNT

Several lessons have been learnt from the geothermal CDM projects some of which have been discussed in the sections above but can be summarized as follows:

- Access to project development financing and quick CDM project registration is key to maximizing benefits from CDM projects**.** Green Climate Fund is expected to improve access to climate funds for renewable energy development once it is operationalised. Developing Countries must also work on their *readiness* to access such funds i.e. by establishing the right institutions and policies that will enable flow of climate funds from the international pool to national pool, for instance, Kenya is planning to establish a National Climate Fund within the Ministry of Finance.
- Type and structure of the Emission Reduction Purchase Agreements (Contracts for CER sale) is important for guaranteed revenue despite the carbon market conditions. For instance, the agreed carbon price in the ERPA between KenGen and the World Bank did not change despite the collapse of the Carbon Market in 2012 because it was fixed (forward contract).

- Experience of Designated Operational Entity (DOE) who are charged with validation and verification is very key in expediting completion of validation and verification processes. Inexperience DOEs may lead to unnecessary delays in project registration or issuance.

- It is important to establishing key partnerships and institutional linkages where data for CDM is sourced from third parties at an early stage. If these linkages are not established before the monitoring plan is put in place, and data is required (from third parties) to complete the monitoring report and verification, the CDM project might not succeed. For instance, KenGen relies on dispatch data from Kenya Power to calculate the Grid Emission Factor. Grid Emission Factor (GEF) methodological tool is used to determine the CO_2 emission factor for the displacement of electricity displaced by power plants in the grid system. A symbiotic working relationship established over the years improved access to hourly generation data from all power plants and any further clarification required during the monitoring and verification process. However, it was a challenge getting monthly data for specific fuel consumption from all the Independent Power Producers (IPPs) thermal power plants that export electricity to the national grid. The data is required for calculation of the Grid Emission Factor. KenGen resorted to using the gazette specific fuel consumption for specific plants in the Kenyan Energy Regulatory Commission (ERC) Tariff Schedule. Another lesson learnt is that the grid-emission factor (GEF) should have been documented in the PDD as *ex-ante* and not *ex*-post to reduce the amount of data required for the GEF.

- Linking the monitoring plan to the Power Purchase Agreement (PPA) and existing internal systems where possible is important to avoid deviation from the monitoring plan (and non-conformance) after registration and project implementation. The PPAs are between KenGen (power generator) and Kenya Power (sells electricity to consumers). KenGen and Kenya Power have procedures for testing, reading and replacing of energy meters and for energy billing which has been embedded in the monitoring plans and requirements for equipment calibration. KenGen must comply with the requirements of the PPA and therefore important to link these requirements with the CDM monitoring plan for consistency. The requirements in the PPA follow international standards and requirements for energy meter testing and hence compliant.

- Co-benefits of geothermal CDM projects compared to the non-geothermal CDM projects is enhanced monitoring, and identification of corrective and preventive actions arising from rigorous verification (audits) by third parties on an annual basis using international standards and procedures for all geothermal CDM projects across the globe. Enhanced monitoring and verification has positive impact of plant performance, data capture and storage, and continual improvement of the plant management.

- Building sustainability and defining clear community benefits at the outset of the project is important for social acceptability and projects contribution towards the millennium development goals (MDGs).

5. POST 2012-PLANS

The motivation to venture into the post-2012 new market mechanisms (NMM), and possibly the Voluntary Carbon Markets is driven by the fact that Kenya is a non- Least Developed Country (non-LDC) and therefore not eligible to trade its certified emission reductions (CERs) in the European Union –Emission Trading Scheme (EU-ETS) in the second commitment period of the Kyoto Protocol and the collapse of the CER markets (CER market is a buyers market). KenGen is currently seeking alternative markets such as the Japanese Joint Credit Mechanism (JCM), as well as bilateral government buyers, such as the Norwegian, Swedish and United Kingdom (UK) and others. KenGen is also participating in the Nationally Appropriate Mitigation Action (NAMA) for geothermal development in Kenya.

The company is also closely following the developments in the non-market mechanism and in preparation for the expected 2020 Climate Regime/Agreement.

5.1 Joint Credit Mechanism (JCM)

The Joint Credit Mechanism (JCM) is a new offset mechanism by the Japanese government which will be implemented bilaterally with several countries. The JCM crediting period will start in 2015 and end in 2020. JCM provides an alternative CER market after 2012 especially for non-LDCs. Joint Credit Mechanism is supposed to be easier than CDM in registration and monitoring requirements. The proposed scheme involves a non-tradable credit mechanism which is closely linked to Japanese technology acquisition and subsidy, and an off-take of only 50% of emissions reductions achieved in a year (no cash transactions). Kenya and Japan signed a MoU in June 2013 and have set a Joint Implementation Committee but are still discussing the general framework and guidelines for implementation.

The JCM feasibility study is targeting the 560 MW geothermal projects of KenGen projects from the Olkaria geothermal fields among other Kenyan projects under the Geothermal Development Company (GDC). The feasibility study is being done by Price Water House Coopers (PwC) Japan/Kenya (consulting on behalf of Toyota Tyusho). The study is focusing on developing and improving the Monitoring, Reporting and Verification (MRV) Methodology and a pilot JCM PDD for geothermal projects compared to CDM procedures (supposed to be simpler than CDM without losing environmental integrity). KenGen is working with PwC consultants in developing a pilot JCM PDD for the proposed 70 MW Olkaria I Unit 6 with modified monitoring requirements compared to CDM. The outcome of this study is subject to approval by the Japan JCM implementers.

5.2 Nationally Appropriate Mitigation Actions (NAMA)

Nationally Appropriate Mitigation Actions is a new UNFCCC mechanism under the convention but unlike other market mechanisms which are project based, they cover sector or sub-sector net-mitigation efforts at national level. For example, the geothermal NAMA feasibility studies that is currently being developed by the ECN (Energy Research Center for the Netherlands), consultancy firm under sponsorship of the Federal German government covers KenGen, Geothermal Development Company Ltd

and Private Sector (Independent Power Producers). The objective of the NAMA facility is to identify barriers or risks associated with geothermal development and how developers can be supported to reduce them.

The implementation of the geothermal NAMA, if successful will be jointly funded by the United Kingdom (UK) Department of Energy and Climate change (DECC) and German Federal Ministry of Environment, Nature Conservation, Building and Nuclear Safety (BMUB). The two governments have set aside USD 25 million each for different types of NAMAs in five countries including Kenya. The geothermal NAMA has to compete with other NAMAs for funding. An amount of USD 10 – 15 million (grant finance) is proposed for the Kenya geothermal NAMA phase I (August 2014 to December 2015) and will mainly focus on drilling risk insurance, providing technical support and capacity building for geothermal energy. Phase II of the NAMA will be linked to the Green Climate Fund with an estimated budget of USD 172-278 million (combination of grants, convertible equity and seed funding). If unsuccessful, phase I of the NAMA proposal will also be submitted for GCF funding. The potential benefits of this NAMA for KenGen as agreed with the consultants are summarized on Table 4.

Table 4: Potential Benefits of Geothermal NAMA for KenGen (extracted from the Draft geothermal NAMA proposal)

Component	Potential benefit for KenGen
Short-term loan/grant facility for high risk in early stage development	Grant support for feasibility studies, geological surveys, site preparation, etc
Premium payment mechanism	Premium on top of PPA negotiated tariff (from international climate funds) for certain developments (mirrors CDM)
Geological risk mitigation instruments	Risk mitigation instruments will improve the risk-return profile for KenGen for its drilling activities.
Performance guarantee mechanism	This could support KenGen's obligations under a Steam Sale Agreement with external parties, facilitating these agreements.
Transaction support for PPA	A Transaction Advisory could assist the Government of Kenya, GDC and KenGen to liaise with and support private developers in obtaining a PPA.
Capacity Building	Enhanced capacity building in geothermal development

6. CONCLUSION

Despite the collapse of the carbon markets in 2012, KenGen has benefited and still expects to benefit from CDM projects whose emission reduction purchase agreements signed before the collapse of 2012. The challenge of Kenya being a non-LDC has also complicated Kenya's access to the already saturated EU-ETS market. Despite this, KenGen expects to follow the developments in the climate change policy and new opportunities that are presenting themselves under the new market mechanisms (NMM), framework for various approaches (FVAs), as well as expected financial instruments for accelerating geothermal development under NAMAs or GCF. The challenges, benefits and lessons learnt under CDM will be instrumental in the implementation of opportunities under the new market mechanisms.

The information provided in this paper reflects the status of the CDM projects as at May 2014. Several developments could have occurred by the time this paper is published.

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