



UNEP review of the Haiti Project Phoenix municipal waste management and waste to energy proposal

Final report

September 2014



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Report Part 2

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Annex B - Revised Phoenix Offer, January 2014

Annex C - IEP Technical Summary Report, April 2012

Annex D - Phoenix Master Services Agreement, March 2012

Annex E - Phoenix Power Purchase Agreement, March 2012

Annex F - Port-au-Prince Municipal Waste Agreement, March 2011

Annex G - UNEP Greenhouse Gas Emission Modelling

Section A – Executive Summary and Introduction

Executive summary

Introduction to the review

On 23 July 2012 the United Nations Environment Programme (UNEP) was requested by the Secretary of State for Energy for the Government of Haiti (GoH) (now the Minister Delegate for Energy Security) to provide technical assistance (TA) to the Government in reviewing and if appropriate improving the proposed Phoenix private sector municipal waste management (WM) and waste-to-energy (WtE) project.

Subsequently from August 2012 to January 2014, UNEP undertook a multi-stage detailed and independent review of the proposed project. UNEP also worked and negotiated with the project developers on behalf of the GoH to improve the anticipated benefits, economic value and feasibility of the project. This document is the final report of the review.

Introduction to Project Phoenix

Project Phoenix is the marketing name of a large-scale waste management (WM) and WtE proposal, which was initially presented to the GoH in 2010 by a private sector consortium. The private sector consortium includes Haitian, USA, Spanish and English companies and is led by the USA private company International Electric Power LLC (IEP). A series of agreements were signed in March 2012 between IEP and the Government for a very specific design, hereafter labeled by UNEP and IEP as Scenario 1. In December 2013 IEP informally presented a draft revised offer, which contains a slightly modified Scenario 1 and two further design options: Scenario 2 and Scenario 3. IEP has indicated that its preference is for Scenario 2.

The proposed key activities of the **Scenario 1 project** are:

Municipal waste collection and management

- Collection of 1,200 tonnes per day (TPD) of municipal waste from the seven Communes of the greater Port-au-Prince (PaP) area and surrounding cities;
- Receipt of a further 400 TPD of municipal waste collected by the national waste management authority and private waste collection companies;
- Appropriate treatment of at least 1,600 TPD of collected and received waste in a central site (The Phoenix Plant) located on the coast north of PaP near the village of Aubry, via either recycling, disposal to a new engineered landfill or energy recovery in a dual fuel thermal power plant.

Lignite mining

- Opening, operation and eventual safe and responsible closure of a lignite open-cut mine in the Maissade region of the Centre Department. A mining rate of at least 730 TPD.
- Transport of the mined lignite by private and public roads approximately 143 kilometers (km) to the Phoenix Plant. Up to eight million tonnes is predicted to be transported over a 30-year period.

Power generation

- The generation of up to **50** megawatts (MW) of electricity to be injected into the PaP grid, through simultaneous combustion (co-firing) of the waste and the lignite in a high temperature dual fuel furnace and boiler, which will supply steam to a turbine-generator train. The proposed capacity factor is 65 percent, with a guaranteed availability of over 80 percent.

The proposed key activities of the **Scenario 2 project** are:

Municipal waste collection and management

- Exactly as per Scenario 1.

Lignite mining

- Deleted from the scope.

Coal importation

- Construction of a coal import terminal on the coast of the Aubry site;
- Importation of up to 600 TPD of black coal mined in either Colombia or the USA.

Power generation

- As per Scenario 1, with minor design changes to accommodate the change from low energy density lignite to higher energy density black coal.

The proposed key activities of the **Scenario 3 project** are:

Municipal waste collection and management

- Exactly as per Scenario 1.

Lignite mining

- Deleted from the scope.

Power generation

- The generation of up to **30MW** of electricity to be injected into the PaP grid, through combustion of the waste in a high temperature furnace and boiler, which will supply steam to a turbine-generator train. The variable moisture content (MC) and low energy density of the waste is expected to result in the need to co-inject high energy density “topping” fuels (proposed up to 10 percent of the total energy). The proposed topping fuels are heavy fuel oil and shredded vehicle tires.

IEP has presented a programme within the revised offer, which proposes reaching financial close by Q1 2015 and starting to produce energy from the plant in Q2 2017. This programme will require updating to reflect the deferred potential start of detailed development work.

At present, progress on project development is relatively limited and has been limited since Q2 2012. This is principally due to IEP being unable to secure project financing, which in turn was partly due to the proposed financier requiring indications of support for the project from some key international stakeholders.

Whether or not the project goes ahead is the decision of the GoH and the Phoenix consortium, including its financiers. In turn these decision-makers may be influenced by other significant national and international stakeholders, such as local communities, existing energy and waste service providers, the United Nations (UN), donor governments and multilateral donors such as the World Bank (WB) and the Inter-American Development Bank (IDB).

The UNEP review

UNEP has been active in both the energy and WM sectors in Haiti since 2010. One part of its Haiti programme is the provision of capacity building and TA to the GoH in the field of sustainable energy. This review is considered part of that TA package.

Review findings

The findings of the review are divided into three sections:

- A collation of individual findings at the project level
- A collation of findings for the various project components and design options
- A discussion of noted issues.

Rating	Description	Number of findings
All		45
A.	Positive: No concerns and positive features noted in some cases.	13
B.	Neutral: No major concerns noted, but more detailed work anticipated.	13
C.	Concern: Concerns, risks or uncertainties noted that would need to be adequately addressed to enable the project to proceed to financial close. Also clear and major opportunities for improvement not yet highlighted as such.	6
D.	Negative: Clear and major concerns and uncertainties that will completely stop the project well before financial close unless resolved.	10
E.	Strategic Issue: A clear and major concern that has implications well beyond the success or failure of the project.	3
C+D+E	Project level concerns, risks and uncertainties that need early resolution	19

Table A - Project level findings

Component Option	Status Quo	Waste Mgmt	Grid Inter-connect	Lignite Mining Option	Coal Import Option	30MW WtE Plant Option	50MW Dual Fuel Plant Options
Technical Feasibility		C	B	B	B	D	B
Environmental benefits, impacts and risks		A	A	B	B	C	C
Social impacts and risks		C	A	C	A	B	A
Greenhouse gas emissions million tonnes CO	19.0	4.0	App. Nil	0.7	0.80	11.3	1) 24.3 2) 18.2

Table B - Project component and option findings

Component Option	Waste Mgmt	Grid Inter-connect	Coal Import	50MW Dual fuel plant	Total
Technical Feasibility	C	B	B	B	
Environmental benefits, impacts and risks	A	A	B	C	
Social impacts and risks	C	A	A	A	
Greenhouse gas emissions	4.0	0	0.8	18.2	23.0

Table C - Findings for Scenario 2 - the highest ranked scenario

Discussion of Findings

The collated project level and project component findings present a mixed picture.

Positive aspects There has clearly been substantive investment in solution development and the project has many positive features. Currently the project demonstrates good value and balance and the potential for further improvement. The project development consortium appears overall sound. The project is relatively positive from a climate change perspective although it could be improved further.

The most recent Phoenix offer and development of different scenarios represents a significant improvement on the original proposal. For UNEP at least, there is a clear ranking of scenarios, with Scenario 2 being the obvious choice on economic, environmental, climate change and social grounds.

Negative aspects The project is clearly still at an early and high-risk stage of development and it has encountered a range of difficulties to date. Uncertainty remains over the project economics and hence the capacity of Phoenix to deliver on the revised offer. UNEP counts a total of 22 concerns, risks, uncertainties and opportunities for improvement that are expected to need resolution for the project to fully succeed (the sum of project level findings ranked either C, D or E plus three project component findings for Scenario 2).

Critically, many of these issues are out of the control of the Phoenix consortium and fall within the responsibility of the GoH. The original procurement process was partially flawed and transparency was insufficient, although these elements do have some potential for improvement as the project continues to develop.

Strategic aspects and agreement legacies Project Phoenix is a large potential project and it is also a highly visible test case for the GoH and for the ongoing potential for large scale foreign investment in Haiti. Notwithstanding the flaws in the sole source procurement process, the GoH and an international private sector investor have signed a major agreement in apparent good faith and the investor has as a result invested several million dollars completely at risk in project development.

It is considered very important for the credibility of the GoH and the economic future of Haiti that major public-private agreements once signed are honored. Projects may advance, be altered or be dropped with mutual agreement as appropriate, however the core principles of trustworthiness and professionalism need to be visibly demonstrated if Haiti wishes to attract large scale direct foreign investment and move away from aid dependency. At the same time, the noted flaws in the procurement process must be resolved if at all possible in order to ensure legal compliance, provide assurance to external parties and protect the project from future legal challenge.

The status quo and alternatives to Phoenix The quality and potential of Project Phoenix is relative: it needs to be judged against the current situation and the viable alternatives. In this context UNEP has researched the current situation and searched for evidence of existing or emerging alternatives. Its findings in summary are as follows:

- Clearly the existing situation (the no-project case) is highly problematic and a major obstacle to the sustainable development of Haiti. In both the waste management and energy sectors, the GoH is clearly struggling to even maintain the current poor levels of service and has negligible potential for improving the situation with its own financial and technical resources.
- UNEP has found no evidence of emerging credible alternative or competing solutions in the WM sector. The sector is clearly neglected by Haiti's international development partners and all other projects noted to date are very small sector specific solutions such as the promotion of small biogas units.
- There are multiple competing alternatives in the private electricity supply sector. According to the GoH Minister Delegate for Energy Security, there is no shortage of firms looking for a market opportunity and presenting speculative proposals to Haiti Electricity Company (EDH), the country's state-owned electricity provider, and the GoH for power generation via gas, coal, wind, solar and hydropower. However UNEP considers that there are three important caveats to these alternatives:
 - Phoenix already has a signed agreement and has invested heavily in project development. Both legally and practically, Phoenix should take precedence if prioritizing becomes an issue.
 - Many of the findings noted in this review are not linked to either the project consortium or the design. They instead reflect problems in the wider energy project investment environment of Haiti. Hence every proposed alternative is expected to strike many of the same issues noted in this review. The enthusiasm of some private sector promoters in part may reflect that they have yet to investigate in depth or practically encounter the issues already faced by Project Phoenix.
 - Speculative and caveated offers of low energy prices are not considered equivalent to firm offers linked to a signed agreement. The potential savings offered by some alternatives are expected in the end to prove illusory.

The extent and impact of poor EDH performance The key finding that Project Phoenix is currently non-financeable in part due to EDH financial difficulties is simply indicative of the broad ranging damage inflicted on the economy of Haiti by EDH in its current form and the expected difficulty in resolving this issue.

In this specific case, the current status of EDH effectively excludes the implementation of a project that has the potential to:

- Lower EDH average power generation costs;
- Improve grid stability;
- Greatly reduce load shedding;
- Provide a cheaper and less polluting alternative to up to 50MW of power that is currently generated off grid by thousands of standby generators.

Substantial reform of the energy sector and EDH is warranted to break this negative cycle.

International stakeholder engagement and patronage The difficult history of Project Phoenix linked to its engagement with key international stakeholders illustrates the critical role of bilateral or multilateral political patronage for project development in Haiti.

Project success is considered unlikely in the absence of a financially and/or politically powerful international patron organization: either a government or a multilateral institution. Note that UNEP can

never play the role of such a patron, as it is both working in a neutral facilitation role and it is insufficiently powerful.

Investment coordination and catalysis of private sector investment In September 2012, the GoH issued a shortlist of priority investments for the Haiti energy sector ^(17.7). The total investment cost was in the order of US\$2 billion and included WtE. Whilst this list was never endorsed by the international development partners of Haiti, UNEP considers it nonetheless to be a valid order of magnitude estimate of the required scale of investment and a useful tool for coordination and investment prioritization.

Since then, the total of the grant investments allocated by international partners is approximately US \$300 million, representing 15 percent of the government target. This is commendable; however there are no further plans in the public domain for vast increases in grant funding within the next two years. This still leaves 80 to 85 percent of the GoH list un-financed.

What is currently missing is a concerted effort to secure the missing 80 to 85 percent of investment from the private sector. At present, based on funding allocations, the experience of Project Phoenix and background communications between UNEP and several donors, the majority of donors are not highly motivated to assist the GoH in either securing appropriate private sector investment or accelerating privatization.

This is considered problematic, as the GoH has understandably become frustrated with this impasse and has attempted to fast-track private sector investment and partial privatization without international development partner assistance or endorsement. Many of the issues noted in the Project Phoenix review can be sourced to this break in working relations and lack of teamwork.

A relatively simple solution to this impasse would be for grant funding to support more substantive and high-level TA to the GoH in the field of energy policy and planning.

Recommendations

The recommendations developed by UNEP are directed to the GoH and divided into strategic and detailed categories. The detailed recommendations are only relevant if the strategic recommendations are followed first.

Strategic recommendations – in general sequence:

- Progress the project - Attempt to progress development of the project, whilst preparing contingency measures in case development of the project proves impossible within a reasonable timeframe.
- Accept in principle the revised offer of open-book partially competitive tendering and engage and seek the formal approval of the National Commission for Public Procurement (CNMP) in progressing the revised offer.
- Select Scenario 2 and cease all work on other scenarios.
- Immediately restart project development and seek the approval of CNMP, but defer some work and at-risk investments until the affordability of the project improves due to EDH and energy sector reforms.
- Focus development efforts first on attempting to remove the noted 14 issues which are presently considered showstoppers.
- Seek international TA to support the GoH project counterpart role.
- Invite an appropriate bilateral or multilateral development partner to act as an independent observer during project development and to support CNMP to play its mandated role in oversight of major public procurement activities.

Detailed recommendations

UNEP has developed a detailed table with recommendations for Scenario 2 only, for each one of the 22 findings rated C, D or E.

Way forward for the GoH

To progress the strategic recommendations, it is suggested that the GoH:

- Absorb and discuss the findings of the final report on a confidential basis.
- Convene a high level meeting to debate the findings and take the strategic decisions.

1. Introduction

1.1. The purpose of this report

1.1.1. Introduction to the review

On 23 July 2012 UNEP was requested by the Secretary of State for Energy for the GoH (now the Minister Delegate for Energy Security) to provide TA to the government in reviewing and if appropriate improving the proposed Phoenix private sector municipal WM and WtE project. The UNEP acceptance of this request and confirmation of the terms of reference is presented in Annex A.

From August 2012 to January 2014, UNEP undertook a multi-stage detailed and independent review of the proposed project. UNEP also worked and negotiated with the project developers on behalf of the GoH to improve the anticipated benefits, economic value and feasibility of the project.

1.1.2. Purpose and formal status of this report

The purpose of this final technical report is to close out the review process and communicate its findings to key stakeholders. The report presents a detailed record of the UNEP engagement, the results obtained and the rationale for the findings and recommendations presented. This is a public document in its final version and available in English and French.

Note that Phoenix is a proposed Haitian domestic infrastructure project with development bank financing. If implemented, the directly participating (legally mandated and/or contractually obligated) organizations would be several institutions within the GoH, a private sector consortium and multiple financial institutions, led by a bilateral or multilateral development bank.

Legal and formal approval or non-approval of the project rests with only the **participating** organizations. Neither UNEP, nor any other non-participating bilateral or multilateral organization has any formal approval or veto role. The input of UNEP, via interim reports, verbal briefings and this final report, is provided in the form of TA – which the GoH is free to accept or not as it sees fit.

1.2. Introduction to Project Phoenix

1.2.1. Project Phoenix – the base case and revised offer

Project Phoenix is the marketing name of a large-scale WM and WtE proposal, which was initially presented to the GoH in 2010 by a private sector consortium. The private sector consortium includes Haitian, USA, Spanish and English companies and is led by the USA private company International Electric Power LLC (IEP).

A series of agreements were signed in March 2012 between IEP and the GoH for a very specific design, hereafter labeled by UNEP and IEP as Scenario 1. Thereafter IEP continued to develop its design and also consider interim feedback from the UNEP review.

In December 2013 IEP presented to UNEP a draft revised offer for the GoH. The offer contains a slightly modified Scenario 1 and two further design options: Scenario 2 and Scenario 3. IEP has indicated that its preference is for **Scenario 2**.

This revised offer is presented as Annex B in its entirety and its implications have been incorporated in full into the UNEP review.

1.2.2. Scenario 1 – Waste collection, lignite mining and Waste-to-Energy

The proposed key activities of the **Scenario 1 project** are:

Municipal waste collection and management

- Collection of 1,200 TPD of municipal waste from the seven communes of the greater PaP area and surrounding cities;
- Receipt of a further 400 TPD of municipal waste collected by the national WM authority Service Métropolitain de Collecte des Résidus Solides (SMCRS) and private waste collection companies;
- Appropriate treatment of at least 1,600 TPD of collected and received waste in a central site (The Phoenix Plant) located on the coast north of PaP near the village of Aubry, via recycling, disposal to a new engineered landfill or energy recovery in a dual fuel thermal power plant.

Lignite mining

- Opening, operation and eventual safe and responsible closure of a lignite open cut mine in the Maissade region of the Centre Department. A mining rate of at least 730 TPD;
- Transport of the mined lignite by private and public roads approximately 143 km to the Phoenix Plant. Up to 8 million tonnes is predicted to be transported over a 30-year period.

Power generation

- The generation of up to **50 MW** of electricity to be injected into the PaP grid, through simultaneous combustion (co-firing) of the waste and the lignite in a high temperature dual fuel furnace and boiler, which will supply steam to a turbine-generator train. The proposed capacity factor is 65 percent, with a guaranteed availability of over 80 percent.

Selected IEP graphics of the Scenario 1 project are presented in Annex C.

1.2.3. Scenario 2 - Waste collection, imported coal and Waste-to-Energy

The proposed key activities of the **Scenario 2 project** are:

Municipal waste collection and management

- Exactly as per Scenario 1.

Lignite mining

- Deleted from the scope.

Coal importation

- Construction of a coal import terminal on the coast of the Aubry site;
- Importation of up to 600 TPD of black coal mined in either Colombia or the USA.

Power generation

- As per Scenario 1, with minor design changes to accommodate the change from low energy density lignite to higher energy density black coal.

1.2.4. Scenario 3 – Waste collection and Waste-to-Energy

The proposed key activities of the **Scenario 3 project** are:

Municipal waste collection and management

- Exactly as per Scenario 1.

Lignite mining

- Deleted from the scope.

Power generation

- The generation of up to **30 MW** of electricity to be injected into the PaP grid, through combustion of the waste in a high temperature furnace and boiler, which will supply steam to a turbine-generator train. The variable MC and low energy density of the waste is expected to result in the need to co-inject high energy density “topping” fuels (up to 10 percent of the total energy). The proposed topping fuels are heavy fuel oil and shredded vehicle tires.

1.2.5. Other options and scenarios

IEP has undertaken exploratory feasibility work on a range of design options, such as the inclusion of anaerobic digestion (AD) systems, different waste sorting and pre-treatment systems and the increased use of high-energy fuels such as heavy fuel oil and shredded tires. As the project develops it may continue to explore and select other options. The UNEP review is by necessity focused only on what is presented to date, but that does not preclude further design changes by IEP.

1.2.6. Original commercial terms

The original commercial structure proposed to implement and finance Scenario 1 is complex and is defined in full in the GoH and IEP executed (signed) agreements presented in Annexes D, E and F: the Master Service Agreement (MSA), the Power Purchase Agreement (PPA) and seven Commune Administration waste collection agreements.

In concise summary, IEP, minority Phoenix shareholders and the GoH would develop a new project company with a Phoenix shareholding of 90 percent and a government shareholding of 10 percent. This new public-private company is labeled in Haitian legislation as a Société Anonyme Mixte (SAM). The SAM would sell the generation capacity and the generated energy to the government-owned national electricity utility EDH for an all-inclusive tariff of approximately US\$0.25 per kilowatt, subject to a range of conditions and an inflation adjustment of +2 percent per annum.

The SAM would charge the communes US\$3/tonne for waste collection. The SAM would also sell recyclable materials such as metals, glass and potentially some plastics, if the latter are not used for energy recovery.

The combined capacity and energy tariff and the waste collection charges would include payments for full cost recovery for the mining and waste collection operations of Phoenix and is conditional on a) the capital cost of the entire scheme not exceeding US\$325 million and b) waste collection and waste treatment quantities not exceeding 1,200 and 1,600 TPD respectively.

The duration of the agreement is 30 years from the start of operations, with the potential for a further 15-year extension. There is a wide range of detailed terms distributing financial risks and responsibilities between the GoH and IEP, with many risks falling on the government. The SAM would benefit from significant project-specific tax exemptions and terms for over 15 years.

1.2.7. Public procurement – original terms

The original proposal was sole sourced, meaning that it was presented in the absence of a competitive bidding process launched and managed by the GoH. The proposal is also in part unsolicited, as the GoH never issued a specific invitation to submit proposals for WtE. However in 2011 the government did clearly signal its openness to expressions of interest in large-scale foreign direct investment in Haiti via The Haiti is Open for Business presidential and communication campaign.

1.2.8.

1.2.9. Public procurement – revised offer

The revised commercial terms are at the draft offer stage and presented by IEP in Annex B.

The current terms present an initial fixed set of charges and adjustment scales, with some caveats for potential capital cost increases. These are changed substantially in the revised offer. For the purposes of discussion, UNEP is labeling the revised offer as **open-book partial competitive bidding** – a blend of competitively bid and negotiated components.

The offered model is based upon agreeing a target shareholder Internal Rate of Return (maximum IRR), with an estimated capital cost, competitive bidding and a capital cost cap guarantee. To explain this complex model:

- Ongoing procurement activities are conducted on an open-book and independently validated basis: commercial information is fully shared between IEP, GoH and an independent 3rd party providing oversight and facilitation.
- IEP further develops its existing Excel-based financial model (FM). The FM has a wide range of estimated cost inputs, tariffs and a resultant calculated IRR for the Phoenix shareholders – including the GoH with its 10 percent share.
- IEP are offering a target shareholder IRR of 21 percent (post Haitian tax). The GoH and IEP need to negotiate and agree on the target IRR as a fixed figure and other items such as tariff inflation rates.
- The GoH and IEP also need to agree on the initial tariffs and cost estimates, resulting in a version and date stamped financial model.
- The GoH and IEP also need to agree on a Phoenix procurement plan. IEP is offering a procurement plan where 80 percent of the capital cost of the project is competitively bid by IEP and its core partners.
- IEP then progresses project development, including competitively bidding the agreed 80 percent as a series of contracts.
- This results in a new FM, based on actual received bids which replace the earlier estimates. If the target IRR is fixed in the model, then these new costs change the capital cost of the project and therefore the tariffs.
- The tariffs therefore may rise or fall based upon the results of the bidding.
- IEP is in addition offering a capital cost cap. If the actual capital cost cap is exceeded, then the tariffs do not exceed the value set by the cap – what does change then is the IRR, which will reduce below the target IRR. IEP does reserve the right to abandon the project if the bid capital cost is so far above the estimate that it cannot accept the resultant low forecast IRR.

Note that the original proposal to charge the Communes US\$3/tonne for collection has been dropped: waste will still be collected, but the Communes will not be charged by Project Phoenix. The cost of collection is now proposed to be 100 percent covered through energy charges and sale of recycled materials.

1.2.9. Project financing

The proposal does not at present request international grant aid. The proposed sources of finance are private sector equity, development bank loans and government investment. The project does not demand significant upfront GoH cash expenditure but does demand government investments in securing land, access and approvals. This makes it unusual in the context of Haiti in 2014, where the great majority of infrastructure development is either grant aid or government funded.

The economic feasibility of the proposal is dependent upon project financing (project-oriented loans) by international development banks, which are able to offer lower interest rates and have a higher tolerance of financial risks linked to developing country-specific factors than Haitian or international commercial banks.

A small part of the financing required for the project has come from private and commercial equity – the financial resources of the project consortium itself. Equity is the source of the funding expended to date at risk by the project consortium. Phoenix states that the figure as of February 2014 is US\$7.5 million.

1.2.10 Project history

The project has an extensive and complex history. The following summary table of the history was provided by IEP and amended by UNEP and shows how the project has evolved from the IEP point of view.

Date	Action
May 2010	Presentation of project to Central Bank of Haiti
May 2010	Presentation of project to Haitian President René Préval
Jul 2010	First International Finance Corporation (IFC) meeting
Aug 2010	First Overseas Private Investment Corporation (OPIC) meeting
Oct 2010	Interim Haiti Recovery Commission (IHRC) application filed
Nov 2010	Bank of America provides “Comfort Letter” to GOH
Jan 2011	Spain’s Ros Roca SA becomes a formal partner in Project Phoenix
Feb 2011	Ministry of Finance provides “Letter of Support” to IHRC
Mar 2011	EDH and IEP agree upon PPA format
Mar 2011	First IHRC response
Apr 2011	EDH and IEP agree upon draft PPA
Apr 2011	IEP visits Mallorca waste facility
Apr 2011	Michel Martelly wins Haitian presidential election
May 2011	OPIC provides “Letter of Interest”
Jun 2011	Project Phoenix presented to IDB President Luis Moreno
Jun 2011	Second IHRC submittal
Aug 2011	President Martelly approves project
Sept 2011	GoH and SMCRS visit Mallorca facility
Sept 2011	Waste collection routes developed with SMCRS
Oct 2011	Final submission to IHRC and agreement to approve project pending Environmental Impact Assessment (EIA)
Nov 2011	GoH Ministers and Directors conduct due diligence and participate in design requirements
Nov 2011	EIA initiated
Dec 2011	GoH provides two land options for WtE Plant
Dec 2011	Waste Characterization Study initiated
Dec 2011	GoH and IEP negotiate financial terms
Dec 2011	GoH and IEP agree to SAM
Dec 2011	Memorandum of Understanding (MOU) No. 1 signed

Dec 2011	MOU No. 2 signed
Jan 2012	OPIC provides input to EIA
Feb 2012	GoH provides new site for WtE Plant
Mar 2012	“Basis of Design” meeting held in Pittsburgh, USA
Mar 2012	UK firm Atkins assigned role to support EIA
Mar 2012	MSA and PPA documents finalized and executed
Apr 2012	Washington DC meeting with key stakeholders
June 2012	IEP submits changed proposal to the US State Department, eliminating lignite
June 2012	Release of IEP Waste Availability Study
July 2012	Release of IEP Waste Costing Study
Oct 2012	First UNEP Report Released
Nov 2012	IEP, World Bank and Spanish Embassy meet to discuss project
2013	Review of all project information with UNEP and ongoing stakeholder engagement
Dec 2013	IEP submission of the draft revised offer
Feb 2014	GoH and IEP review of the confidential draft UNEP final report
July 2014	Completion of consultation period and restricted release of the final draft
Aug 2014	Release of the final version in English
Sep 2014	Release of the final version in French

Table 1.2.10 Project History

1.2.11. Current status and generic project development activities

Notwithstanding the extensive work done to date, as of July 2014, Project Phoenix remains essentially a proposal for an infrastructure project, albeit with signed preliminary agreements for power purchasing, waste collection and establishment of a public-private partnership. To progress to construction, the following generic steps would be required:

- Either the preliminary agreements (for Scenario 1) are confirmed in full without change, **or** the GoH and IEP would need to select a scenario and then update and renegotiate these agreements as a first step. In either case, CNMP would need to be brought in to approve the procurement process.
- The GoH and IEP would need to enact the government minority shareholder terms within the MSA to form the SAM.
- The SAM would need to present the confirmed or new agreements to project financiers and secure provisional project financing and insurances.
- Technical and commercial development would need to be progressed to finalize the design and the cost.
- The enlarged project partnership, now including financiers and insurers, would then finalize all key agreements to reach the milestone known as **financial close**. This would enable the

implementation team to commence mobilization, recruitment, equipment and service procurement and facility construction.

IEP have presented a programme within the revised offer which proposes reaching financial close by Q1 2015 and starting to produce energy from the plant in Q2 2017.

1.2.12. Deciding upon the future of the project

At present, progress on project development is relatively limited and has been limited since Q2 2012. This is principally due to IEP being unable to secure project financing, which in turn was partly due to the proposed financier requiring indications of support for the project from some key international stakeholders.

Whether or not the project goes ahead is the decision of the GoH and the Phoenix consortium, including its financiers. In turn these decision-makers may be influenced by other significant national and international stakeholders, such as local communities, existing energy and waste service providers, the UN, donor governments and multilateral donors such as the WB and the IDB. As such this UNEP review and final report will play an influencing role, but will not decide the fate of the project.

1.3. Introduction to UNEP in Haiti

1.3.1. UNEP

UNEP is the environmental voice of the UN system. Its mission is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.

1.3.2. The UNEP Haiti programme

In 2009 UNEP established a project office in Haiti and commenced work on a range of sustainable development topics. It has maintained an operational office and an international and national staff team in place since that time. UNEP now has a main office in Port Salut, South Department and a support office in PaP.

In January 2010, the UNEP work scope was redirected in response to the emergency and early recovery needs resulting from the earthquake, but is now refocused on longer-term sustainable development issues ^(1.1). Its current portfolio includes projects on sustainable energy, agroforestry, the marine environment, protected area management and integrated development planning ^(1.2).

Within the field of sustainable energy, one key component of its work in Haiti is supporting the early development of large-scale private sector renewable energy projects ^(1.3). Within the South Department, its work is focusing on early development of grid-connected projects for small-scale hydropower, wind power and agricultural WtE. Within the PaP area and the West Department it is focusing on municipal WtE and wind power.

1.4. The UNEP review

1.4.1. UNEP prior engagement in Haiti waste management and Waste-to-Energy

UNEP's involvement with the WM and WtE sectors in Haiti has an extended history. This review is considered to be one component of a TA facility that UNEP has been providing to the GoH since 2010.

In 2010 UNEP was highly active in the field of WM, with a focus on emergency and early recovery issues such as medical waste and interim waste disposal. From June to December 2010 it supported the GoH in the development of a national biogas strategy ^(1.4).

In December 2010, it commenced exploratory work on general WM and a pre-feasibility assessment on waste treatment and disposal options for the Truitier landfill. Option analysis on waste treatment focused on AD of the organic waste. This work was conducted in partnership with the UN Office for Project Services (UNOPS) and the USA National Renewable Energy Laboratory (NREL), which was contracted by the US government.

The main UNEP-UNOPS input into the partnership was a waste characterization study, which provided a detailed snapshot of the composition and volumes of the waste entering the Truitier landfill in October 2011. The final report from this study, the UNOPS Haiti Waste Sort Report November 2011 ^(1.5), provided key input for this review. Thereafter UNEP continued communication with NREL on waste treatment options for Truitier. As of December 2013 the NREL report "Feasibility of Waste to Energy options at the Truitier site in Haiti October 2013" ^(1.6) is at an advanced draft stage but remains confidential.

1.4.2. The initial engagement of UNEP with the Project Phoenix development process

UNEP became aware of the Project Phoenix initiative in January 2011 in the context of the UNEP/UNOPS/NREL Truitier pre-feasibility study, but had no formal contact with the project consortium or role in the project. Over 2011 the public profile of Project Phoenix grew substantially, but the two teams did not interact.

In February 2012, the then Secretary of State for Energy René Jean-Jumeau (now the Minister Delegate for Energy Security) requested the engagement of UNEP in the topic. It was also clear to UNEP that the fate of the Truitier facility and Project Phoenix were interconnected via the formal preliminary agreements between the GoH and IEP, so it was no longer valid to continue work in isolation on the Truitier pre-feasibility study.

On 13 February 2012 UNEP released a short technical advice note entitled "Project Phoenix – Environmental, Social and Economic Safeguarding" ^(1.7). This report was based upon a review of the summary information in the public domain provided online by the Phoenix project consortium at that time. The UNEP note questioned many of the Phoenix design assumptions and concluded that the project as presented at that time did not appear physically or economically feasible. It also recommended that the GoH seek more in-depth and continuous independent advice.

1.4.3. The review mandate and context

On 24 July 2012, the Minister Delegate for Energy Security formally requested UNEP to conduct a more in-depth review. UNEP agreed to this request and the original Terms of Reference (TOR) are provided as Annex A. These TOR were modified and extended several times by exchange of emails between UNEP and the Minister.

The formal review commenced in July 2012 and has continued for over 18 months. The project context changed in several ways during that period, resulting in the need for UNEP to greatly extend and expand its work. Five items were of particular note during this 18-month period:

- IEP continued with limited project development and has developed an improved offer, partly due to UNEP interaction;
- Three important international stakeholders provided negative feedback on the project, which prompted UNEP to invest further in investigation of the noted concerns;
- Haiti energy policy evolved slowly and in a positive manner;
- EDH entered into a turbulent period of attempted reform and increased financial losses and this continues today, prompting UNEP to invest further in investigation of project risk reduction options;
- The WM situation temporarily improved due to significant aid investments in earthquake debris removal and extra short-term government funding for SMCRS, but SMCRS nonetheless remained severely overstretched and under-funded.

1.4.4. Review process

The review has been an extended, interactive and partly flexible process, with UNEP reacting and adjusting to the changing project context and stakeholder feedback and participation.

Desk research by UNEP found that no single or standardized internal or external methodology was suitable for direct or unaltered application to the review of Project Phoenix. There were however multiple international thematic standards, guidelines, policies, methodologies, case studies and references that could apply to individual parts of the review. In response UNEP developed a bespoke approach based on a composite of many sources.

Finally, in support of the GoH, UNEP has invested significantly in identification and early development of project improvements and potential solutions to the problems and obstacles noted during the review. This entailed significant technical and other background work, with only the summary results presented in this report.

In this context, the UNEP review process is presented in point form below. Note that the process was not strictly sequential in the order presented, as for example solution development work progressed in parallel with the detailed review.

Mobilization and the initial review

- Background and issue exploration.
- Mandate definition and confirmation.
- Initial exploratory review.
- Development of interim findings.
- Restricted release of a Technical Advice Note on 26 October 2012 on potential alternatives to Project Phoenix ^(1.8).
- Restricted release of a Technical Advice Note on 9 December 2012 on progress and noted issues.
- Meeting with IEP at their head offices in Pittsburgh, USA on 7 December 2012.
- Convening and chairing a meeting in Washington DC on 15 February 2013 for international stakeholders to convey progress and receive feedback.

The detailed review

- Full review team recruitment, consisting of a project manager, expertise in energy, WM, climate change mitigation and contract law and a peer review group.
- Review scoping, which was revisited and refined over eight months.
- Identification and initial parallel review of the full list of relevant subjects. Ranking the results using bespoke criteria to identify subjects of concern.
- Analysis of the interaction of the individual subjects and issues of concern.
- Restructuring the noted subjects into logical groups and in a logical hierarchy and again reviewing, this time in more detail and in an integrated manner.

Development of improvements and solutions

- Development and refinement of individual recommended improvements and solutions to issues of concern.
- Key meeting with the GoH on 30 October 2013, to present findings and discuss solutions.
- Meeting with IEP in Pittsburgh between 5 and 8 November 2013 to present findings and discuss solutions.
- Working with the GoH and IEP to test the feasibility and acceptability of the proposed solutions.
- Collating and structuring the disparate recommendations into a cohesive proposed strategy.
- Development of the proposed strategy into a recommended way forward.

Final reporting

- Report drafting and UNEP peer review.
- Confidential draft review by the GoH and IEP.
- Report finalization and delivery to all key stakeholders.
- Report briefing meetings with key stakeholders.

Two important caveats on the depth of the review are that a) Project Phoenix is still at the development stage and b) UNEP did not have access to the full list of documents in the possession of IEP and its consortium partners. For example, despite requests, UNEP did not have access to all of the combustion engineering designs and calculations. In contrast a great deal of information was available on the WM components of the project.

As such the UNEP review relied heavily upon second tier outputs from the Project Phoenix team (such as its business plan presentation and technical reports) and external benchmarking rather than just Phoenix primary data and analysis. This level of detail and access was considered just sufficient for UNEP to conduct its review, but insufficient for a formal due diligence process. This deficiency is not considered problematic for the goals of the UNEP review.

In order to secure project finance, Project Phoenix would need to pass a very detailed lender managed and formal due diligence process, which would need to see all primary data and analysis. Simply put, if insufficient detail and robust solutions are not clearly presented and demonstrated at a later stage, Project Phoenix will not get financed.

Hence in the review, UNEP has identified and focused on the larger, more obvious and more difficult items present at this stage of project development, noting that there are literally hundreds of smaller items and issues that need to be addressed in full as the project progresses and before it can secure financial close. In addition insufficient data was available to quantify the scale of some of the larger issues – for example there is negligible data on groundwater resources in the vicinity of the WtE plant or on the numbers of informal workers in the recycling sector that may be displaced or absorbed by the project. In these cases further data collection by Project Phoenix is required as a pre-requisite to finally resolving the noted issues.

1.4.5. Issue rating system

UNEP has developed and applied the following bespoke issue rating system throughout the report.

Review Ratings by Item

- A.** - Positive : No concerns and positive features noted.
- B.** - Neutral: No major concerns noted, but more detailed work anticipated.
- C.** - Concern: Concerns, risks or uncertainties noted that would need to be adequately addressed to enable the project to achieve financial close. Also noted clear and major opportunities for improvement not yet highlighted as such.
- D.** - Negative: Clear and major concerns and uncertainties that will completely stop the project well before financial close unless resolved.
- E.** - Strategic Issue: A clear and major concern that also has implications well beyond the success or failure of the project.

It is important to note some features and consequences of this system:

- The ratings are date-specific snapshots of UNEP views on specific individual issues. Project progress and/or changes in the project context will make these ratings obsolete – relatively quickly in some cases.
- UNEP has been relatively rigorous and broad ranging in its approach to rating – every major and material concern, risk or uncertainty identified by UNEP or others has been listed. The report simply notes items rated positive or neutral and then focuses attention and text on subjects and issues of concern, with the aim of attempting to develop solutions. This results in a negative rating bias based only on the color tables and focus of the review content.
- The process of project development normally includes an ever-increasing level of investment in resolving issues. This gradually escalating level of investment is needed to achieve milestones such as securing specific approvals, completing specific design stages or completing activities such as contractor selection or taking possession of land. It is normal and acceptable for projects in the early stage of development to have a high number of subjects that are not “green”, where more work, time and financial investment is required.
- It is also normal for project developers to ration such financial investments based on progress and indications of increased certainty and feasibility and reduced risk of loss. These indications are dependent in many cases on the actions and decisions of external parties. In this specific case, IEP has slowed down or halted investment in project development on many items pending improvements in the prospects for project financing and assured payment by EDH.
- All major infrastructure projects, even when completed and operational, have a range of positive and negative features and residual risks. Hence projects can and do progress despite individual negative features – it is not necessary for an overall beneficial project to be rated positive in all aspects.

1.4.6. Final report structure and contents

The UNEP final report is also the principal document of public record for the review. As a result it is a large document that includes extensive background and interim findings as well as final findings, conclusions, recommendations and extensive annexes. The report has four main sections, 18 chapters and seven annexes:

Section A - Executive Summary and Introduction: Chapter 1.

Section B – Project level assessment: Chapters 2 to 10. This is an assessment of project level subjects – those that are high level and cross cutting and do not vary with different design scenarios. The various subjects are assessed individually and in parallel, rather than in sequence and are presented in the following thematic chapters:

- The development model
- Legal issues
- Waste sector needs and waste feedstocks
- Electricity demand
- GoH policy alignment, political support and the counterpart role
- The Project Phoenix organization
- Stakeholder engagement and transparency
- Greenhouse gas emissions and climate funding
- Economics

Section C – Project component technical assessment: Chapters 11 to 16. This is a summary of the UNEP technical assessment of the project common components and options, presented in the following structure:

- Waste collection, classification, recycling and disposal – Common to all scenarios.
- Haitian lignite mining and transport – Scenario 1 only.
- Coal import – Scenario 2 only.
- Waste only energy production – Scenario 3 only.
- Dual fuel energy production – Scenarios 1 and 2.
- Grid Interconnection – Common to all scenarios.

The assessment of each component and each chapter follows a standard structure:

- Technical feasibility.
- Local environmental benefits, impacts and risks.
- Greenhouse gas emissions.
- Social impacts and risks.

Section D – Integrated analysis and recommendations: Chapters 17 and 18. This section first collates and integrates all of the prior chapter findings within one integrated analysis chapter. All of the project level assessment findings are collated and discussed. The three scenarios are compared and ranked.

The report is concluded with a detailed recommendations chapter, divided into three sections:

- Strategic recommendations.
- Detailed recommendations for Scenario 2 only.
- Recommendations on next steps.

Annexes

The annexes contain the UNEP review mandate, the existing key Phoenix agreements and the revised offer from IEP. Selected maps and Scenario 1 project graphics are also provided, noting that these are preliminary in nature.

Report exclusions

Two key groups of documents from the review are excluded from this report for commercial confidentiality reasons:

- The IEP Phoenix financial model
- The Phoenix engineering basis of design material

1.5. Chapter references

1.1 UNEP (2011). “UNEP in Haiti: 2010 Year in Review”

1.2 UNEP (2013). “Haiti 2013-2107 Strategy Paper”

1.3 UNEP (2012). Project Document, “Haiti Sustainable Energy – South Department, Norwegian Ministry of Foreign Affairs (NMFA) Project”

1.4 National Water and Sanitation Directorate – DINEPA (2012), “Haiti Biogas Programme Strategy 2010-2012”

1.5 UNOPS (2011). “Haiti Waste Sort Report November 2011”

1.6 National Renewable Energy Laboratory (Confidential draft 2013). “Feasibility of Waste to Energy options at the Truitier site in Haiti”

1.7 UNEP (2012). Technical Advice Note “Project Phoenix – Environmental, Social and Economic Safeguarding”

1.8 UNEP (2012), Technical Advice Note “PaP Waste Management and Waste to Energy alternatives”

Section B – Project level assessment

2. The project development model

2.1. Introduction

2.1.1. Scope of the assessment

This chapter presents an analysis of the development model of Project Phoenix. It also considers its suitability when compared to a number of other options for financing, shareholding, management and implementation.

The Project Phoenix model entails very large scale and long-term financial obligations for the GoH. These significant obligations effectively exclude other solutions in parallel. Hence it is considered important to assess the suitability, feasibility and availability of alternative models.

A particular feature of the Phoenix model is that it uses electricity sales as a mechanism to pay for waste collection and management. This is a form of transfer pricing that also warrants assessment.

2.1.2. The Project Phoenix model

The key elements of the current Project Phoenix development model (Scenario 1 – current commercial terms) are as follows:

Financing

- A new privately owned project company – a Special Purpose Vehicle (SPV) - will be financed by a combination of private sector equity, project finance and mezzanine (intermediate) finance.
- The project investors and financiers will be repaid by dividends and loan repayments, funded from the sale of electricity and recyclable materials.
- Project finance is expected to be secured from one or more bilateral or multilateral development banks and/or export credit agencies.
- There is no grant financing supplied direct to the SPV by any development assistance organization.
- The GoH will supply the land and the license to operate, as in kind support, in return for a minority equity stake.

Shareholding

- The SPV will construct, own and operate assets on government-supplied land that will remain in government ownership via a 99-year lease.
- The GoH will hold a minority share (10 percent) in the SPV. Private companies and investors will hold the majority share. The GoH has a 50 percent share of the revenue from recyclables and byproducts produced from the plant operations.
- As a for-profit company, the SPV is expected to generate dividends for its shareholders. However there will be a contractual sequence for the use and distribution of revenue received as long as the project financing remains in place.

Management

- The SPV and its supporting consortium will build and operate the WM and WtE complex for 30 years, with the potential for extension.
- The SPV and its consortium will also operate the waste collection fleet and collection and transfer stations.
- The GoH will not have an active management role, however it does and will continue to hold a regulatory role.

Public services

- The SPV will supply waste collection and treatment services to the GoH. A token fee per tonne to be charged to the Communes for waste collection is removed from the latest offer.

- The SPV will supply free waste disposal services to SMCRS.
- The SPV will supply free waste disposal services to private sector waste companies on behalf of the government, which supplies this service free of charge at present.
- The SPV will sell electricity generation capacity and energy (services) to the GoH and potentially to other buyers via a 30-year agreement.
- The electricity price will be bundled to include the cost of all the waste collection and treatment services supplied by Phoenix.
- At present no other sources of revenue are proposed other than the sale of small amounts of recovered recyclable materials, such as metal scrap.

Taxation

- The project will benefit from a range of tax relief measures, including the following:
 - Exemption from customs duties on capital goods.
 - Complete exemption from company income tax and payroll tax for 15 years.
 - Reducing relief from company income tax from the 15th to the 20th year of operation.
 - Accelerated depreciation of capital items.

In summary, Project Phoenix is a debt-financed private sector operation supplying services to public entities. This has three defining features:

- The private sector and their financiers take on virtually all of the responsibilities and workload – management, financing, construction and operation.
- The upfront costs for the GoH are negligible, but the long-term financial obligations of the GoH, via its wholly owned utility company EDH, are very significant.
- The tariffs paid for electricity need to cover the costs of the whole project including construction and mobilization, operations including WM, the costs of project finance and a target return for the shareholders.

2.2. Financing, shareholding and management

2.2.1. Financing options

The project is focused on construction and purchase of new assets and has a very high capital cost – in the order of US\$300 million. Financing this capital cost is one of the defining challenges of the project. Six potential sources and types of financing are examined:

GoH financing Haiti is one of 39 countries in the Heavily Indebted Poor Countries Initiative and the Multilateral Debt Relief Initiative. This means that Haiti qualified for debt relief (debt cancellation and reduction) from the multilateral and bilateral agencies and selected commercial lenders and since 2006 received approximately US\$1.1 billion in debt relief ^(2.1).

As a heavily indebted country, Haiti does not have easy access to global capital markets. Also at present the GoH does not access development lending. All support from the WB and IDB is currently supplied as grants and the GoH is at present effectively ineligible for further lending from these institutions. The US government is also only providing grant support at present.

Hence at present the GoH cannot cost-effectively raise debt for its own projects. This applies both to the central government and to its wholly owned service companies such as EDH and SMCRS.

Currently the government has negligible flexible financial reserves and a large list of existing unmet demands for its own sources of revenue. Hence for all practical purposes, the GoH is currently unable to finance the capital cost of a major infrastructure projects such as Project Phoenix.

Development bank financing Development bank financing is already a core strategy for this project, however it is not yet secured.

Large infrastructure projects in developing countries commonly have a project financing syndicate, with several banks (both development and commercial) collaborating to cover the senior and junior debt. At present Project Phoenix has a conditional letter for development finance from the USA's OPIC. OPIC has the capacity and mandate to potentially cover all of the financing needs of Project Phoenix – but that does not confirm that it will do so. Phoenix states that OPIC has also expressed interest in syndicating the debt financing with other multi-national banks, such as IFC and the Export-Import Bank (Ex-Im Bank) of the US.

Commercial bank financing Theoretically Project Phoenix could also resort to commercial financing. However there are several practical obstacles to this, which in effect will largely exclude the commercial lending sector:

- Commercial lending interest rates for Haitian projects are extremely high, anecdotally quoted as commonly well in excess of 10 percent per annum, compared to development banks and expert credit agencies which typically charge between 2 to 10 percent.
- The financial crisis and the associated implementation of new banking controls has greatly reduced the capacity appetite of the Haitian and international banking sector to take on project finance in high-risk developing countries.
- The recent EDH debt arrears issue has for the time being most likely shut off access for commercial project finance where payment by EDH is part of the business case.

Equity financing Theoretically Project Phoenix could also resort to financing via private sector equity. In practice it is already doing this at probably close to the limits of the developers capacity or motivation. An acceptable return on equity for Project Phoenix and similar potential infrastructure projects in Haiti will probably only be possible with a high debt: equity ratio (85:15 or higher). It is extremely rare for large energy infrastructure projects to be financed mainly with equity.

Grant financing Haiti is a major recipient of grant aid from many sources. Earthquake recovery and development aid inflows since 2010 were crudely estimated at US\$3.63 billion^(2.2). Recently USAID has grant financed the building of a 10MW heavy fuel oil power plant, a 2MW solar power plant and a local distribution network in the north of Haiti^(2.3). USAID, the WB^(2.4) and IDB^(2.5) are currently all providing grant financing for infrastructure and TA in the electrical sector.

Hence grant funding of a WM and WtE project is theoretically possible, even though Project Phoenix is not seeking such finance.

Full grant funding for Project Phoenix is **not** considered feasible by UNEP, due to the competing priorities of the major donors and the scale of the capital cost. Limited grant funding is however considered fully feasible, particularly for assets and activities that contribute to shared development outcomes, are one-off items and do not have to be managed by the private sector. Examples of such qualifying activities could include rehabilitation or closure works for Truitier, supporting SMCRS and construction of new transmission lines for EDH that also serve the project. UNEP estimates that financing 5 to 10 percent of the project may be feasible, however attempting to secure these funds may substantially delay the project.

Mixed financing It is normal for private sector infrastructure projects such as Phoenix to be financed by a coherent mix of financing sources: equity, development finance and limited amounts of commercial finance. In countries such as Haiti it is also common for development assistance including grants to be used to improve the economics of marginal projects and/or to reduce the financial burden on the host government or the beneficiaries.

A key finding of the economic assessment (see Chapter 9) is that the electricity tariff that needs to be charged to ensure the financial viability of the project may be difficult for the GoH and EDH to afford. In this context there is a strong case for mixed project financing (including grants) if the project goes ahead.

In summary, the proposal for project financing appears reasonable, given the effective absence of other viable options. Mixed financing may improve affordability for the Haitian state and EDH.

2.2.2. Shareholding

Shareholding is directly linked to financing. This basic fact precludes majority government ownership of the assets built with private sector funds. The current proposal is for Phoenix consortium private sector ownership, with a GoH minority and passive (10 percent) shareholding.

Further shareholding options include:

- Increased government ownership, which would need to be negotiated or purchased.
- Increased private shareholder diversification, which would need to be purchased from the existing shareholders. This could include an increased Haitian content through bringing in more local investors.

In summary, the proposal on shareholding appears reasonable, although there is the potential for improvement in both GoH and local investor shareholdings.

2.2.3. The proposed management and operational model

The proposed management and operations model is 100 percent private sector management of the Phoenix assets for all project options – the waste collection fleet, the lignite mine, the coal import terminal and the Phoenix complex at Aubry. This is normal and appropriate for a private sector financed project.

The project consortium has developed relatively extensive plans for the operation phase of the project. The plans include a range of positive proposed features:

- Extensive national manpower training as part of a national content plan.
- Preventive maintenance programmes and the establishment of a substantive maintenance reserve for equipment replacement.
- A high level of automation and control instrumentation.
- Joint venturing work with a local waste collection service.
- A community initiative labeled Phoenix Stars, focused on youth development.

In summary, operational plans appear positive.

2.2.4. The proposed waste collection model

Phoenix will fully control its own assets, however the overall responsibility for waste collection within the Phoenix collection catchment area will be shared between Phoenix and the incumbents: the GoH-SMCRS and private operators.

The proposed allocation of collection effort is as follows:

- At least 1,200 TPD for Project Phoenix and rising over time.
- 400 TPD (or 25 percent of the total) for SMCRS.
- Existing tonnages, estimated at 200 TPD, for private sector operators.

The rationale for continuing a substantive public waste collection operation through SMCRS in parallel with an enlarged private sector waste collection fleet is unclear to UNEP. Having an undercapitalized and aging public sector fleet run in parallel with a new and well-capitalized private sector fleet appears inefficient. SMCRS will also continue to draw on government support.

In summary, the proposed waste collection model does not appear efficient.

2.3. Services revenues and transfer pricing

2.3.1. The bundled services and alternatives

The financial foundation of Project Phoenix is based upon a bundled service model – it will deliver a service package of waste collection, WM, energy capacity and energy delivery. For these services it will charge EDH a bundled tariff for capacity and energy delivered. Metal recycling will provide small-scale supplemental revenues.

The strength of this approach is in its vertical integration – Phoenix has full control over virtually the whole WM and feedstock supply chain. Theoretically there are at least three other options, which are examined for completeness below:

- **Separate waste collection and WM tariffs.** Operating the waste collection and treatment service ensures the Project Phoenix power plant will secure the waste feedstock it needs in order to deliver electricity. Hence the service cannot be separated, however it could be separately charged.
- The central challenge with a separate WM tariff is the cost recovery mechanism for the GoH:
 - o At present the local tax collection systems and recovery rates do not adequately support the Communes and so financing the waste service by adding a new and significant local tax is not considered viable.
 - o The GoH is already struggling to fund the operation of SMCRS with central funding. It is also struggling to cover the funding gap created by the operating deficit of EDH. Hence the GoH is not in the position to easily cover an increased WM cost.
- **Private sector waste tipping fees** Charging private sector waste companies and individual trucks tipping fees for waste disposal has some potential and risks. The main risk is that some private companies will avoid paying the fees by illegally dumping loads elsewhere - a practice known as fly tipping.
- **Plastic recycling sales** At present Project Phoenix does not include any plastic recycling in its financial model, although the planned waste classification system has the capacity to separate out plastics. In the context of Project Phoenix, plastic recycling only makes economic sense if it yields a greater return when recycled compared to burnt for energy recovery. This is not expected to happen until the facility is operating at 100 percent capacity and a waste surplus is starting to be generated. Dependent upon the size of the facility, this may be five years or more after commissioning.

2.3.2. Waste to electricity transfer pricing

The integration of waste collection and management costs into the electricity tariff is a form of transfer pricing, which is in use in other countries. This has both positive and negative features in the case of PaP.

Positive

- Electricity sales can (generally) reliably capture revenue accurately through metering and billing systems, unlike public sector waste collection. Bundling revenue collection partially avoids the need for a second revenue collection system. The caveat on this is that at present EDH performance on metering and electricity revenue capture in general is extremely poor – an issue that is discussed further in Chapter 10.
- There is a strong correlation between household wealth, waste generation and electricity use – poorer households generate less waste and use less electricity.
- EDH electricity account holders cover virtually all levels of wealth except for the very poorest, who normally cannot support the cost of connection. This implies that a bundled waste-electricity tariff will entail some benefit transfer to the very poorest.

- There is a strong but not total geographic match between the Phoenix waste collection catchment and the PaP subnational grid – in the majority of cases households will both pay for Phoenix waste collection and receive the benefits of a cleaner neighborhood.

Negative

- The geographic match is not 100 percent - some households will receive waste collection benefits but pay no surcharge as they are either off-grid or currently on a different grid (such as Gonaives).
- Electricity costs in Haiti are already relatively high and integrating WM costs may contribute to make connection unaffordable for some poorer households.
- Unless managed in a transparent manner, the bundling of services can result in opaque costing and inefficient cross-subsidization. The Phoenix consortium proposes to create separate energy and waste collection companies with transparent accounts, so this is not considered an issue based on the current organizational design.
- The households and businesses currently paying for private waste collection will in effect pay twice for collection. They will not however pay twice for WM, as currently the private firms pay no tipping fees and SMCRS takes on the waste treatment and disposal burden.

UNEP estimated the scale of the transfer pricing, using the following methodology:

- Benchmark external cost rates in US\$/tonne were obtained for waste collection and WM from international case studies ^(2.6).
- These rates were then multiplied by the estimated tonnages to generate estimates of the total external cost/value of the service. The estimated value is very approximately US\$20 million per annum, which includes \$5 million per annum in amortizing the original capital costs. This compares well with the Phoenix capital and operational cost estimates for waste collection and management.
- The total Year 1 revenue for electricity sales for Project Phoenix Scenario 2 is estimated at US\$70 million.
- $20/70 = 0.285$, inferring that 28.5 percent of the power tariff is due to the cost integration of the waste collection and WM activities of Phoenix.
- The Phoenix maximum Year 1 power tariff is US\$0.247 per kW/hr, inferring a WM transfer price of US\$0.074 per kW/hr.
- The surcharge for waste collection and management would apply only to 50MW of power, whilst the PaP grid post Phoenix installation would have a capacity of at least 150MW. Hence for EDH PaP customers as a whole the surcharge would be diluted by a factor of 3.
- The cost of the waste surcharge when spread across the PaP grid would then be in the order of $US\$0.074 \text{ per kW/hr} / 3 = US\0.025 per kW/hr (2.5 US cents or approximately 100 gourdes per kW/hr).
- The EDH tariff table has a wide range of monthly payment and tariff bands, ranging from US\$0.16 to US\$0.33 per kW/hr. There is no firm data on the average cost of power across the EDH client base. For assessment purposes, UNEP has used the median $((0.16 + 0.33)/2) = 0.195$.
- $0.025/0.195 = 0.128$, approximately 13 percent.

This infers that the anticipated waste surcharge on EDH PaP customer bills would be in the order of 13 percent of the median. Given the very wide error bands on this model, a more valid conclusion would be that the anticipated surcharge could range from 10 to 20 percent dependent upon the electricity consumption and applicable tariff of the EDH PaP customers. Given the strong geographic correlation and the slight benefit transfer to poorer households, UNEP considers this level of transfer pricing to be substantial, but also reasonable and appropriate in the Haitian context.

2.4. Findings summary

The project development model	
A. The overall development model	The debt-financed private sector development model appears well suited to the project context. The alternatives look less viable.
B. Shareholding	The proposed shareholding appears reasonable, although the GoH and Haitian private sector shares could be increased.
A. Operational planning	Operational planning is sufficiently detailed for this stage and includes a range of positive features.
C. Waste collection management model	The rationale and benefit of SMCRS retaining a substantial role in waste collection is unclear. This arrangement appears inefficient.
A. The bundled service model and transfer pricing.	The bundled waste + energy service model appears sound and the extent of transfer pricing appears reasonable and entails a slight benefit transfer towards the poorest population.

2.5. Chapter references

2.1 WB website

<http://siteresources.worldbank.org/INTDEBTDEPT/ProgressReports/23395262/HIPCStatisticalUpdate2013.pdf>

2.2 Office of the UN Special Envoy to Haiti (2013). "Can More Aid Stay in Haiti and Other Fragile Settings?"

2.3 USAID Haiti Energy webpage <http://www.usaid.gov/haiti/energy>

2.4 WB website: Haiti - Rebuilding Energy Infrastructure and Access Project
<http://www.worldbank.org/projects>

2.5 IDB website: Haiti Energy Project list

<http://www.iadb.org/en/projects/project-description-title,1303.html?id=HA-L1083>

2.6 World Bank (2013). "What a Waste – A Global Review of Solid Waste Management, Annex E Estimated Waste Management costs"

<http://documents.worldbank.org/curated/en/2012/03/16537275/waste-global-review-solid-waste-management>

2.7 EDH CSA Les Cayes. EDH Power Tariff tables 2012.

3. Legal issues

3.1. Introduction

3.1.1. Scope of the assessment

This chapter presents an assessment of key legal issues: the GoH procurement process, the agreements signed by the GoH and IEP and selected background legislation that has a material impact on the project.

3.1.2. Limitations

UNEP found it necessary to assess multiple legal issues within the review in order to develop coherent findings and recommendations. However this is not a formal legal review, in the sense of a legal expert providing advice to a client under legal privilege. The GoH is advised to seek its own counsel from Haitian or international legal experts wherever legal issues are critical in interpreting this report or taking forward its recommendations.

3.1.3. Governing law for Project Phoenix

Phoenix is a Foreign Direct Investment (FDI) project, with project assets in Haiti and project partners located in several countries.

In this specific case, Haitian law governs most of the agreements and the implementation of the project, however there are several very important exceptions:

- The MSA executed between the GoH and IEP contains a clause (Article 8), stipulating that in the event of a major dispute, the parties will arbitrate at the International Centre for Settlement of Investment Disputes in New York and in French with English translation. If this is not possible, then arbitration will take place according to the Arbitration rules of the International Chamber of Commerce and the process will take place in New York, USA.
- Under the PPA, if a dispute cannot be settled, Article 15 provides that the dispute shall be submitted to arbitration in New York according to the International Chamber of Commerce Rules.
- Project finance loan agreements and insurance agreements typically use either the law of the host country for the bank or insurance company. International arbitration systems are sometimes included as well.
- IEP is a USA incorporated company and so it is expected that many of its subsidiary agreements will be governed by USA law.

This is a normal situation for FDI in a developing country such as Haiti. It is an inherent and normally accepted risk and so there is no UNEP finding or rating on this item. This background however needs to be understood by the GoH in considering its options.

3.2. Public sector procurement legal compliance

3.2.1. Haiti public sector procurement legislation and policy

The legislation of most relevance to the process is the law stipulating the general regulations for public procurement and public service concessions, as published in the official journal of Haiti – Le Moniteur on 28 July 2009 ^(3.1). This document is relatively clear on the general need for competitive bidding for public goods and services and the process to follow for routine items. Since 2009 this foundation document has been reinforced with several short decrees and regulations.

The legislation does not explicitly extend to the creation and management of public-private partnerships, but UNEP reads the legislation as consistent in the promotion of competitive processes for public goods and services of all kinds, irrespective of the implementing structure.

It also aims to promote credible and transparent financial procedures for procurement (Introduction p2). Specific clauses relate to the inclusion of concessions for Build Operate Transfer projects for public infrastructure and services.

The legislation is applicable to effectively all forms of government, including state companies and public-private partnerships where the government is a majority shareholder (Art. 2.1). By definition this includes EDH, the anticipated purchaser of electricity from Project Phoenix and the Communes who receive the WM services.

The legislation explicitly does not apply (Art. 3) to:

- Goods and services linked to national security.
- Goods and services procured under application of national emergency legislation.
- Small-scale procurement below a set of defined threshold figures.

WM and sanitation are explicitly listed as public services with respect to procurement (Art 4.23).

The CNMP, the national level public procurement body, has been established to provide semi-independent oversight of procuring entities (Art.9). The CNMP reports to the Prime Minister.

The default preferred mode of public procurement is open competitive tender. There are a number of variants listed, which are considered exceptions to be considered on a case-by-case basis by the procuring entities and requiring justification and the notification of CNMP.

The justification for exceptions include technical complexity, whereby pre-qualification is proposed. Where pre-qualification and a restricted tender are proposed the procuring entity should obtain a notice of non-objection from CNMP.

The legislation does explicitly present a number of grounds for exemption of individual cases from competitive bidding and procuring via sole source (Art 34.1). In summary they are:

- Where patent and license restrictions mean that only one vendor is feasible.
- Where an urgent case due to unforeseen circumstances does not allow for the extensive delays associated with open competitive tendering.
- Where procurement is required urgently to remediate a situation caused by the failure of another goods or service provider.
- Where the goods or service complement those already provided by a single provider, but only if the original contract was competitively procured and it is not practical to implement a separate procurement process.

Sole source procurement is specifically controlled by a clause requiring providers submit to fixed price controls and an open-book process whereby the real costs and margins of the provider can be established (Art 34.3).

The legislation is relatively clear on the appropriate process for public procurement. In general, the individual ministries and government bodies are recognized as the managing agents for procurement related to their respective thematic and geographic mandates and must comply with the legislation, whilst CNMP maintains an oversight and approvals role.

The correct process for launching procurement above the minimum threshold is to send the procurement plan to CNMP for validation prior to commencement (Art. 62). Following signature, the executed document should be sent to CNMP for final validation (Art. 64).

Haitian legislation is applicable for the procurement of public goods and services including WM and electricity. UNEP carried out a brief benchmarking process to compare the Haitian legislation against the procurement policies and template documents of a number of international organizations and standards. The most detailed and relevant reference found was the United Nations Commission on International Trade Law (UNCITRAL) Model Law for Public Procurement (2011)^(3.2). In summary, the Haitian legislation is very comparable in terms of principles and general approach, but somewhat limited in some details of implementation.

Overall it is clear that there is relevant legislation covering procurement of projects such as Project Phoenix and this legislation is fit for purpose, albeit lacking in detail in some parts.

3.2.2. Public-private partnership legislation and policy

Under Haitian law, the State of Haiti can participate as a minority shareholder in private sector companies, which by incorporation of government shareholding are classed as public-private partnerships or mixed companies: SAMs.

The relevant legislation is the law of 16 September 1963 for SAMs^(3.3). This legislation is very brief and is structured as additional clauses to normal Haitian company law. In summary, the key points relevant to Project Phoenix are:

- The state, including the Communes, can become a shareholder through investments in funds or in kind;
- The state cannot possess more than 50 percent of the share capital and must maintain a minority on the company board;
- Civil servants take on the role of shareholders on behalf of the state, but remain subject to Haitian civil service law;
- The Ministry of Finance is responsible for oversight of SAMs, including monitoring reporting by the civil servant representatives, holding share certificates and managing dedicated accounts for share and dividend transactions;
- SAMs dedicated to the construction of infrastructure serving the public are also overseen by the Ministry of Public Works Transport and Communications.

The legislation is silent on the criteria for selection of those suitable for State shareholding and valuation or negotiation of shareholdings. It also does not have any dedicated text on the interaction of SAMs with other entities of the state – such as the State procuring goods or services from SAMs.

The interpretation of UNEP on this omission is that given that SAMs can only have a minority state shareholding, they will probably need to be treated in the same manner as normal companies in the GoH public sector procurement system – treated neither better or worse.

3.2.3. The Phoenix process

As set out in Chapter 1, the agreements formed between IEP and the GoH were developed on a sole-source negotiated basis.

When the initial procurement process for Phoenix is compared to Haiti procurement legislation and to general good practice for the procurement of public goods and services, to UNEP at least, the process appears to have been partially flawed from the outset. There is significant room for interpretation in the legislation, so a process may be partially flawed but still legally compliant. This is not an issue where UNEP has either the capacity or mandate to issue a definitive legal ruling, so instead it is simply presenting the viewpoints of the organization.

The central flaw - in the opinion of UNEP - was the decision by the GoH representatives to entertain and then progress a sole source procurement process for a major and very long-term public sector financial commitment. This may or may not contradict Haitian legislation, but it does contradict general good public procurement practice. It also leaves the project development process at risk from challenges to the validity of the contracts signed and the enforceability of their terms. These challenges may come from within the government or be external.

The key space for interpretation of the decision to progress on a sole source basis rather than a tender is the 2009 legislation Article 34.1 point 2, providing grounds for exemption from tendering:

Where an urgent case due to unforeseen circumstances does not allow for the extensive delays associated with open competitive tendering.

From Q2 2010 to Q2 2012, clearly the urgency and unforeseen circumstances were the combined impact of the January 2010 earthquake, the cholera epidemic and the civil unrest, particularly linked to the election process. There is no doubting the scale of impact and associated political and practical urgency to improve the lives of the Haitian population and to restart the economy.

UNEP has reviewed all of the correspondence supplied by IEP, from which it can be seen that the early development of the proposal did take place in an atmosphere of real urgency linked to the post earthquake recovery process. UNEP was active in that period and concurs that the sense of urgency was real and encouraged both at the national and international level. Hence in the near complete absence of donor proposals to improve WM, it was understandable that government officials welcomed a private sector alternative that promised rapid results.

Nonetheless Phoenix is a project that, if successful, would take three years to develop and construct and would then have an operational life of over 30 years. In the opinion of UNEP there is little justification for treating the procurement and development of such a long-term project as a post earthquake emergency recovery activity, given that competitive tendering would have added possibly only six months to the development schedule compared to sole source negotiation.

Another point of interpreted non-compliance is the absence of a role for the CNMP. According to the 2009 legislation, the CNMP should have been informed of the sole source decision and been given the opportunity to provide its formal approval or objection. IEP stated to UNEP that CNMP was informed and aware of the project but the GoH deferred a formal submission until after the MSA/PPA was signed. Thereafter the project stalled and the CNMP formal review process was never started.

3.2.4. The revised offer

The revised offer of **open-book partial competitive bidding** does potentially go some way towards correcting the initial flaw. It also correlates well with the relevant Haitian legislation, where sole source procurement is specifically controlled by a clause requiring providers to submit to fixed price controls and an open-book process, whereby the real costs and margins of the provider can be established (Art 34.3).

The revised offer has in effect deferred final procurement of 80 percent of the capital cost of the project and proposed competitive bidding to procure this 80 percent. Hence there remains some potential to improve the current situation with respect to transparency and value and adherence to competitive tendering principles.

However the lack of prior formal input by CNMP is not at all mitigated by this offer. In addition the attempt to retrospectively adjust the process post-signature, whilst sensible as an ad-hoc action, may not substantially improve the overall legal position of the project.

3.3. Executed agreements

3.3.1. The list of agreements

Between 2011 and 2012, IEP Haiti – the legal entity set up by IEP for the purpose of Project Phoenix - and the GoH have signed eleven legal agreements:

- Two MOUs, signed 9 December 2011 and 22 December 2011.
- An MSA between IEP Haiti, the Ministry of Public Works, the Ministry of Finance and EDH, signed 30 March 2012. The MSA is the master agreement for the overall three-component project and is presented as Annex D.
- A PPA between IEP Haiti and EDH, which is noted as an annex within the MSA, but reads and is signed as a freestanding agreement. It is presented as Annex E.
- Seven waste concession agreements, one of which is presented as Annex F.

All agreements are signed by competent authorities including ministers and are thus considered valid at face value. IEP was represented by Cabinet Lissade in all legal drafting and matters of process. The GoH was represented by Lesly Etienne, lead counsel for the Minister of Finance.

3.3.2. Contingency terms and expiry dates

All of the agreements have a common major weakness, in that they are designed only with the expectation that the project will proceed directly towards financial close and implementation. Most terms in the agreements associated with defaults and termination are linked to a proposed Commercial Operations Date (start of electricity production and sales), which was not set at the time of signature. One term partially covers the situation of company abandonment of the project during construction.

The agreements are silent on the situation where the project does not succeed in reaching financial close or is extensively delayed – i.e. it never reaches the construction phase. In fact there are no expiry dates on any of the agreements linked to project development. UNEP interprets this gap as a serious issue.

There is insufficient clarity on the rights and responsibilities of each party if the project is delayed or potentially cancelled due to lack of progress, as is the case at present. This indicates a risk of a legal dispute.

The agreements remain active but at present are unfulfilled. Whilst they are unfulfilled, Project Phoenix is held back and in addition any potential alternatives to Project Phoenix are potentially constrained by the exclusivity terms and precedence as set by the signature date. To provide two examples:

- The waste agreements provide IEP with a first right of refusal to collect waste in seven Communes. Initiating other waste collection contracts may infringe IEP rights.
- The PPA provisionally books an undated slot to supply up to 50MW of energy to the PaP grid. This is a small grid (currently 180MW nameplate capacity) and so can only absorb a moderate amount of new generation capacity. Initiating other PPAs may reduce the potential for Project Phoenix to succeed and thus infringe IEP rights.

This is a serious potential constraint for the GoH, as it has a need and a legitimate right to pursue solutions to its domestic WM and energy needs in a timely manner.

Theoretically the GoH could take unilateral action and ignore or cancel the agreements – without the agreement of IEP. However this is emphatically not recommended, for two reasons:

- Both the MSA and PPA have clear terms guarding against unilateral measures by the GoH, so such measures may have legal consequences. As above the governing legislation for Project Phoenix extends beyond Haiti. Initiating a legal dispute where hearings and decisions take place outside Haiti will inevitably be time-consuming and expensive and the outcomes are very uncertain.
- The general attractiveness of any country for FDI of all types is governed in a large part by its legislation, policies and processes and most of all its track record in treatment of prior FDI efforts. Unfortunately Haiti is a recognized fragile state, with historical sovereign debt default and somewhat obstructive legislation and processes. As such the informal FDI country risk perception for Haiti is already very high.

Actions such as unilaterally and aggressively canceling signed major agreements will definitely increase the informal FDI risk perception for Haiti. **This may reduce the potential for securing FDI in any field in future.** A track record of breaking signed investment agreements, lost project development funds and legal battles could deter many future investors and their financiers. This deterrence effect would not be confined to the energy or waste sector – it could impact all potential government-private sector ventures.

Note that ignoring flaws in the procurement process and moving ahead as if there was no issue may also serve to deter many future investors and their financiers. Adherence to laws provides certainty to investors and avoids potential liabilities.

3.3.3. Critical terms in the MSA and PPA

The MSA and PPA are very extensive documents that contain multiple obligations for both parties, which brings up the issues of **balance**, **capacity** and **clarity**. Balance concerns (the overall fairness of the negotiated deal) are addressed in Chapter 9 on economics and not covered in this section. Capacity and clarity concerns are covered below.

The most common capacity-linked concern is where the GoH has a stated obligation which has the potential to significantly impact IEP if the obligation is not honored in a timely and robust manner. Several of the noted obligations are either substantive, urgent or socially complex. Given the noted financial and capacity weaknesses of the GoH, there is the strong potential for several obligations not to be delivered as and when needed, resulting in knock on impacts to IEP and the project as a whole. The agreements foresee this in several ways through providing IEP rights or redress, however this is not an ideal solution.

On clarity, there are several terms which are vague on general detail or on the allocation of responsibilities. Some of these are considered normal at the PPA stage and are expected to be addressed without risk during project development. Other areas of uncertainty may have a significant financial impact and so need to be addressed at an early stage.

The MSA

Terms of concern for the MSA include the following (concerns are listed in parenthesis – balance and capacity concerns are noted as **Obligations** and insufficient detail or a lack of clarity is noted as **Vague**):

Lignite mining

Art.13. All mining permits and concessions will be granted within 30 days of submission of the definitive reports. (Obligation).

Art. 13. The right to extract minerals from this land will be exclusive to the Company, and will not be up for reconsideration by the State. (Obligation).

Art. 14. Limitations to the scope of the mining permits shall be communicated at the time said permits are requested. (Vague).

Waste collection

Art. 18. The Company will work with SMCRS to ensure the collection of all waste in the 7 Communes of PaP. (Vague).

Art.18.5 The responsibilities of the Company and of SMCRS will... be eventually included in the Waste Management Plan after Financial Close. (Obligation, Vague).

Art 18.9 SMCRS shall be the primary enforcer of anti-dumping regulation,.. (Obligation).

Art. 18.9. All other types of waste that cannot be unloaded on IEP-prepared and -constructed site shall be unloaded at Truitier. (Vague).

Art. 18.9. The Parties shall already agree to implement and focus on a recycling policy for the processing of this waste. (Vague, Obligation).

Art 18.12 All recyclable materials (including metal, glass and plastic) shall be property of the Company and all recycling activities shall be the responsibility of the Company at the WtE plant. The State of Haiti will assist the Company to reinforce this article with the aim of preventing any third party from taking possession of these recyclable materials. (Obligation).

Lignite transport

Art 20.3 The Government of Haiti shall grant all concessions, permits and land for the construction and operation of the road (with a 75m wide right of way) for a period of 50 years. (Obligation).

Art. 20.3 ...the State of Haiti will be responsible for the expropriation procedure towards third parties. (Obligation).

Art 20.4 The Government shall ensure that residents do not build or settle in any event and for whatever reason within (75m) boundaries...(Obligation).

Art 20.6 The Government will remain responsible for the maintenance and upkeep of all other roads used for the transportation of lignite..... In case the State of Haiti is unable to maintain the road for any reason, the Company will maintain itself, providing that both parties agrees on a priced to cover the costs. (Obligation).

Art 21.8 The State will provide all concessions, land rights, right of way and free and clear title for all property required for construction of the lignite road... The State shall facilitate all land transactions in a manner that does not impact the Project schedule. (Obligation).

WtE plant and waste collection sites

Art 21.2 The Government shall make available to the Company the 161 hectares of land in the region in question.... The State shall be responsible for the removal and compensation of any occupants on the properties for the Community Collection stations, the Transfer Stations and the 161 hectare site before construction begins. (Obligation).

Art 21.5 The property, which shall be leased for 50 years to the Company or given to the Project in exchange for equity in Project Phoenix, is state-owned land. The land, if acceptable, will be provided to the project with free and clear title, and the state of title will be such that it will be

insurable by an internationally recognized title insurance company at regular rates. Notwithstanding any provision to the contrary contained herein, the lease will be non-cancelable, and no rental shall be payable thereunder. (Obligation).

Art 21.6 The State will provide up to 20 parcels of land within the 7 municipalities (Obligation) for the purpose of Community Collection Centers. (Obligation).

Art 21.7 The State will provide 4 parcels of land for 4 MSW transfer stations ...of 1500 meters each. (Obligation).

Environment

Art 22.3 The Company shall work jointly with the State through the Ministry of Environment to better manage the issue of carbon monoxide and sulfur emissions to better protect the environment. (Vague).

Art 22.5 To reduce the carbon monoxide? emissions at the power plant, the Company shall use the reasonable technical means to control pollution (Vague).. and verify that the ash resulting from the processing are within tolerable limits. (Vague).

Infrastructures, Environment, and Rehabilitation of Mined Sites

Art 23.2 The Company shall be required to conduct mining operations in such a manner as to limit pollution and environmental contamination hazards and to protect the health and safety of its personnel and local populations within admissible international limits (Vague, even with subsequent detailed bullet points).

Art 23.4in the event of a lack of funds (for adequate mine rehabilitation) the SAM shall provide additional funds... Such contributions shall be made equally between the Company and the Government. (Obligation).

Personnel

Art. 25.1d When appropriate, provide housing for workers employed on the site under clean and hygienic conditions that comply with the regulations in effect. (Obligation, Vague).

Art. 25.1e, f, Comply with . . . laws and regulations as stated in texts currently in effect or pending. (Vague).

Art. 25.2 The Company shall contribute to: a) The implementation, expansion or improvement of a medical and educational infrastructure corresponding to the normal needs of the employees and their families, at a reasonable distance from the mine. B) The organization, at a local level, of recreational facilities for its personnel. (Vague, Obligation).

General Warranties

Art 27.3 The State shall guarantee.... that all authorizations and administrative measures required to facilitate the performance of all work under the Project be granted and implemented as quickly as possible.... (Obligation, Vague).

Fees, Taxes, and Royalties

Art 28.2 4 a) The State shall ultimately be responsible for the provision of all land within the footprint defined in Annex IV. (Obligation).

Guarantees Regarding Land and Mining

Art 32.1 The State shall guarantee the Company the occupation and use of all land necessary for work associated with exploration and mining of the deposits that are a subject matter of exploration permits and/or mining permits within the scope of the present Agreement. (Obligation).

Execution of Work, Primary Processing

The Company shall carry out mining work according to the rules of the trade generally approved in the mining industry and to use internationally recognized methods. (Vague).

The PPA

Terms of noted concern for the PPA include the following:

Art 2.7 Price adjustment. Both the Energy Price and Capacity Price are based upon ... 1,200 TPD collection and 1,600 TPD treatment... and the capital cost of the project does not exceed US\$325 million. (There is a formula to deal with waste quantity variations but no formula noted on price adjustment if the capital cost exceeds US\$325 million. (Vague).

Art 5.2.4 Payments not made by the due date shall accrue daily interest at.... or the maximum lawful rate (Vague).

Art 9.3.1 Seller shall be afforded adequate Scheduled and Forced Outage provisions.... provided that Net Energy Output.... (amount to be determined by plant engineers as part of plant design process.... (Vague).

Art. 9.5 During its operation of the Plant in accordance with the provisions of Paragraph 9.5.1 above, Buyer shall not be liable for any damage to the Plant . . . except where such damage or loss is caused by the negligence or the deliberate action or inaction of Buyer. (Vague).

Art 11.3.1 (Default conditions) The occurrence of any action or inaction of any governmental authority of the Republic of Haiti which serves to materially affect (IEP Haiti's) ability to perform its obligations...(Vague, given the high likelihood of this occurring).

D1.4 Buyer, as applicable, will use its best efforts to assist the Seller in a timely manner in obtaining all permits, permissions and way leaves necessary for the construction of the [X] kV transmission line and all associated switchgear and protective devices, such assistance not to be unreasonably withheld. (Obligation).

3.4. The revised offer

3.4.1. Validity and integration of the revised offer

At present the revised offer has no contractual validity and the original MSA and PPA remain in force/unfulfilled. The MSA has articles (Article 37 and 38) permitting revision of specific items without affecting the validity of the whole agreement.

The proposed changes are however substantial, with associated changes required throughout the MSA and PPA. Hence negotiation and acceptance of the revised offer would be a substantive legal and commercial task requiring legal and other specialist expertise for both parties.

3.5. Other legal issues

3.5.1. The EDH monopoly

The national electricity utility EDH currently has an incomplete but nonetheless broad legal monopoly on the production, transmission and distribution of electricity. There are some important interpretations and exceptions to this monopoly :

- EDH has delegated or transferred rights for wholesale power generation to Independent Power Producers, which are currently mandated to sell power only to EDH. This is the foundation of the Phoenix MSA and PPA.
- The Commune Administrations have separate rights to supply and manage electricity services of their own, where EDH is not present.
- EDH has conceded rights for individuals, organizations and companies to generate their own power. This is the defacto situation for Haiti where self-generation capacity has attempted to fill the vacuum created by the absence of a reliable EDH service.

What is not permitted at present is for Independent Power Producers to sell power directly to retail or wholesale customers if that power needs to be transmitted from a production site to the customer. (If instead it is generated on-site, then it qualifies as self-generation).

This is an important constraint for Project Phoenix. It would not be important if EDH was capable of receiving and paying for all of the capacity and energy that Phoenix could produce, however currently it is not (see Chapter 10). In a more flexible market, the limitations and risks of selling to EDH could be balanced by selling to other parties. At present however, any such solutions will need to be undertaken within current legislation and with the participation and mandate of EDH.

3.6. Findings summary

Legal issues	
D. Legislative compliance of the original Phoenix sole source procurement process	The original procurement process is interpreted as partially flawed and not good practice and exposes the project and the government to legal challenge. Due to some space for interpretation in the relevant legislation, it may be legally compliant even if partially flawed, however this is not an issue where UNEP can provide a definitive ruling.
B. Legislative compliance of the revised offer for open-book partial competitive bidding	The revised offer is a positive change, which partially mitigates the original flaws. It is however yet to be delivered and should be subject to CNMP input and approval.
A. Legislative compliance of the proposed SAM structure	The proposed SAM structure is in compliance with Haitian legislation and a good example of securing government shareholding and influence in a public-private partnership.
E. The lack of contingency terms and expiry dates	The lack of contingency terms and expiry dates indicates a risk of legal disputes and constrains the options of the GoH.
E. The potential to worsen the FDI risk perception of Haiti	The need to avoid worsening the FDI risk perception of Haiti constrains the options of the GoH and the need to be transparent and adhere to Haitian procurement law.
D. Government land obligations in the MSA and PPA	The land provision obligations appear beyond the current capacity of the government to deliver in a timely manner. No requirements for free, prior and informed consent to be given by local communities prior to granting of concessions. No clear benefit sharing requirements with local communities hosting mining sites.
C. Government permitting obligations in the MSA and PPA	The permitting obligations appear beyond the current capacity of the government to deliver in a timely manner.
C. MSA and PPA clarity	The MSA and PPA have a number of items where clarification and/or extra detailing are a priority.
B. Validity and integration of the revised offer	Integration of the revised offer into the original MSA and PPA is a substantive task requiring specialist support.
E. The legal monopoly of EDH	The EDH monopoly constrains options for improving the financial viability of Project Phoenix.

3.7. Chapter references

3.1 Haiti CNMP website and public procurement legislation. Loi fixant les règles générales relatives aux Marchés Publics et aux Conventions de Concession d'Ouvrage de Service Publics (2009)
<http://www.cnmp.gouv.ht/textesfondamentaux/index>

3.2 United Nations Commission on International Trade Law (UNCITRAL). Model Law for Public Procurement (2011)
http://www.uncitral.org/uncitral/en/uncitral_texts/procurement_infrastructure.html

3.3 Le Moniteur 30 September 1963. Law of 16 September 1963 regarding SAMs

4. Waste sector needs and feedstocks

4.1. Introduction

4.1.1. Scope of the assessment

This chapter presents the assessment of the waste sector needs and feedstocks. It focuses on the proposed waste collection catchment area of Project Phoenix and assesses how well the project could address the needs of that area. The project in turn has a critical need for particular volumes and types of waste as feedstock for the WtE plant, hence the assessment also covers this issue.

4.1.2. Project Phoenix waste sector outcomes

Project Phoenix proposes two outcomes related to SWM:

1. Increased and improved waste collection in seven urban Communes and potentially also the large towns of St Marc and Gonaives - via regular removal of at least 1,200 TPD in predefined areas for at least 30 years.
2. Responsible and permanent management of 1,600 to 2,000+ TPD of collected waste for at least 30 years – via recycling, energy recovery or land filling.

These outcomes are the same for Scenarios 1, 2 and 3.

4.2. Waste collection

4.2.1. General needs

Even a cursory inspection of the greater PaP area shows that improved waste collection is sorely needed. The appropriate scale and form of that improvement is however a more complex technical and economic question. This is a central issue for the Phoenix project and the Phoenix consortium has invested heavily in data collection, analysis and design of its proposed solution. UNEP has reviewed the Phoenix material and also undertaken its own independent assessment, starting with a detailed examination of the issue of waste production.

The starting assumption used by UNEP for waste production is that the great majority of solid waste produced in the urban areas of Haiti is currently not adequately managed at the point of generation. The great majority of waste is generally either a) collected in a (relatively) controlled manner by existing services or b) discarded or burnt in an uncontrolled manner. A minority of the waste is recycled.

The anecdotal evidence from UNEP team observations in Haiti since 2009 is that household and business level internal recycling is limited, as is organic matter composting. In peri-urban areas, feeding suitable organic waste to domestic animals (chickens, goats, pigs) is clearly a partial solution for those with the necessary land or access to land. There is however zero quantitative data on this subject, so there is no basis for estimates.

There is an active recycling industry in Haiti, both formal and informal, that collects from or is adjacent to households and businesses. The main target materials for recycling are metal and selected plastics. There is relatively limited quantitative data available on this subject.

In the absence of organized collection, the usual uncontrolled disposal routes are simply discarding waste in public spaces (roads, kerbs, gutters, drains, fields, ravines and watercourses) and open burning. There is no municipal sewage system, which could otherwise act as an alternative appropriate disposal route for some waste.

This inadequate local management of waste is widely acknowledged as a major problem in Haiti: contributing to the spread of pests and disease; blocking roads, pedestrian routes, canals and watercourses; damaging ecosystems; blighting neighborhoods and increasing the risk of flooding^(4.1). The disease risk is a particular public health issue for Haiti, given its low levels of access to clean water and improved sanitation and the ongoing presence of cholera^(4.2).

Hence there is a clear general need to collect the waste generated within the project targeted urban areas. The more specific question related to the Project Phoenix assessment is whether there is a need to collect the proposed extra 1,200 TPD of waste, beyond what is already collected by existing operators.

The additional waste collected will be required as fuel for the WtE plant, so the linked question is whether there is the potential to economically collect the proposed 2,000 TPD or more (from all sources including Phoenix, SMCRS and other private operators) in order to keep the plant adequately supplied.

4.2.2. Waste analysis methodology

Several basic studies have been undertaken on the Haiti WM situation, however there are many important data gaps. Hence UNEP has based its analysis on a combination of local studies and benchmarking from WM literature from other relevant countries.

The amount of extra waste collection needed has been estimated by UNEP in several steps:

1. Confirmation of the viable catchment area for a central WtE facility.
2. Confirmation of the current population within that catchment.
3. Population forecasting over the proposed life of the project.
4. Estimation of the total amount of waste generated daily within the catchment.
5. Estimation of the amount already collected by existing waste collection services.
6. Estimation/speculation on the amount already collected by existing recycling services/actors.
7. Estimation of the waste collection needs.

4.2.3. Confirmation of the viable waste collection catchment

The viable catchment size for any centralized waste treatment facility is governed by the economics of waste collection and transport. These economics are in turn governed by external factors and project design.

The key external factors are the location and nature of the waste producing regions and the existing road, rail and port infrastructure between these regions and the central plant. For Project Phoenix the main constraints are the limited and poor quality road infrastructure and the high volumes of traffic in the greater PaP region.

Project Phoenix proposes to use high levels of waste compaction in collection trucks as well as waste transfer stations. In addition the majority of the collection and transfer traffic will occur at night. These

project features maximize the efficiency of waste transport. There is also some potential to use water transport as the Phoenix plant is at a deepwater coastal location.

The proposed waste catchment area for Project Phoenix is the seven Communes of PaP and potentially also the cities of St Marc and Gonaives.

In this context, for assessment purposes, UNEP assumed that the viable waste catchment area for Project Phoenix is bound by a two-hour truck journey time, with waste from the more distant areas first being compacted and/or reloaded for more cost-efficient transport. This allows for the worst-case scenario of two return truckloads per eight-hour operating shift.

A two hour radius from the Aubry site encompasses all seven Communes of PaP and a number of provincial towns and small cities including Petit Goâve, Grand Goâve, Léogâne, Kenscoff, Ganthier, Mirebalais, Cabaret, Arcahie, Montrouis and St Marc. Gonaives appears to be just outside this two-hour radius.

Compared to the IEP proposal, the UNEP assessment of the viable catchment size is considered comparable to the Phoenix proposal in total population, but different in geography. The major differences are that Phoenix includes Gonaives but excludes all other provincial towns except St Marc. Overall these differences would be expected to balance out.

4.2.4. Current population estimates in the Waste-to-Energy catchment.

The date used for starting population estimates is 2015 as Q4 2015 is considered by UNEP to be the earliest feasible date for commencing waste collection.

The 2010 population of Haiti was estimated by the Haitian Institute of Statistics and Informatics (IHSI) to be 10.085 million and growing at 1.6 percent per annum^(4.3). This generates a 2015 estimate of 10.918 million. Based on current geographic distributions an estimated 3.966 million will be living in the West Department, the focus of the WtE project.

The following table presents an estimate of the population living within the Phoenix catchment for waste collection. The table uses the data collated by IEP in 2012 from direct enquiries to the Communes^(4.4), adjusted to 2015 population estimates by UNEP using 1.6 percent per annum growth.

Commune-City	2012 Estimate	2015 Estimate
Port-au-Prince	875,978	918,725
Delmas	359,451	376,992
Carrefour	499,371	523,740
Tabarre	99,011	103,842
Cité Soleil	241,055	252,818
Croix des Bouquets	84,812	88,950
Petionville	271,175	284,408
St Marc	223,214	234,106
Gonaives	295,620	310,046
Total	2,949,687	3,093,631

Table 4.2.4 Population estimates in Phoenix catchment for waste collection

In summary, approximately three million people live within the viable catchment area for a centralized WtE facility located at Truitier. Importantly this catchment also covers the main industrial zones in Haiti.

4.2.5. Thirty-year population forecasts

According to the IHSI, the population of Haiti is currently growing at approximately 1.6 percent per annum. However this is an overall growth rate. The growth rate in cities is boosted beyond the national average through in-migration from rural areas. IHSI report an urban population growth of 3.2 percent per annum over the period 2005 to 2010^(4.3).

The long-term projections are clouded with uncertainty due to limitations in extrapolating current trends. The likelihood and scale of ongoing urbanization is particularly difficult to predict. The IHSI in 2007 developed a national level forecast^(4.5) and simple ratios have been used by UNEP as the basis for its own estimates in the table below.

Year	WtE Catchment Projection for 1.6% p.a growth	WtE Catchment Projection for 2.5% p.a growth
2015	3,093,631	3,093,631
2020	3,349,164	3,500,159
2025	3,590,653	3,921,706
2030	3,925,311	4,480,500
2035	4,249,547	5,020,116
2040	4,600,565	5,679,800
2045	4,980,578	6,489,100
Change	62%	210%

Table 4.2.5 Global Waste Generation Rates, in kg/per capita/per day

The table is speculative in nature, however it clearly shows both major growth and the sensitivity of the long-term population to the annual growth rate and the difference between national and urban growth rates. Depending upon the stability of the trends noted today and national stability in general, UNEP forecasts a population of **4.5 to 6.5 million** in the Phoenix waste collection catchment at the nominated end of the 30-year MSA and PPA contract.

4.2.6. Estimating waste generation per capita

UNEP consulted three main sources of data available to generate an estimate of waste generation within the WtE catchment. Each source is described below.

1. A 2009 peer-reviewed research report, which studied the rate of household waste generation, amongst other factors, entitled "Household solid waste generation and characteristics in Cape Haitian City, Republic of Haiti" by F.Philippe and M.Culot and published in Resources, Conservation and Recycling.^(4.6) The study analyzed waste generated from households in a controlled survey and after adjustments generated a weighted average of 0.21kg/per capita/per day. Examination of the report however, indicates some major caveats – the survey method excluded data from the first week as apparently households used the opportunity of bag provision and collection to dump a large amount of stored/old waste into the bags. The survey also only covered households – it did not cover businesses or public places.

The report remarked on the very low figure and also benchmarked the collected data against other references, which showed a very wide variation (Santiago, Cuba - 0.09, Chittagong, Bangladesh - 0.25, Kinshasa, Democratic Republic of Congo - 0.5, Dar es Salaam, Tanzania - 0.7).

2. The 2012 World Bank Urban Development Report entitled "What a waste: a global review of solid WM."^(4.7) This report provided a global level snapshot of waste generation rates. The most relevant figures are listed below.

Region	Lower	Upper	Mean
Sub Saharan Africa	0.09	3.00	0.65
Latin America and Caribbean	0.11	14	1.1
Eastern and Central Asia	0.29	2.11	1.1

Table 4.2.6 Global Waste Generation Rates, in kg/per capita/per day

The report also indicated a range of trends such as a strong correlation between waste generation, income level and levels of urbanization. Finally, Annex J of the report shows a current figure for Haiti of 1.0 kg/per capita/per day (however it is not possible to confirm the source of this estimate).

UNEP reviewed the table in Annex J to search for credible benchmarks for Haiti and considers the following to be relevant due to either a comparable GDP, proximity and island population: Dominican Republic 1.18, Madagascar 0.80, Philippines 0.50, Fiji 2.10. The reported data from Jamaica (0.18) is so low as to indicate a data collection or reporting error.

3. A 2009 peer reviewed paper by A.M.Troschinetz and J.R.Mihelcic entitled "Sustainable Recycling of Municipal Waste in Developing Countries"^(4.8). This paper cited municipal waste generation rates for 23 countries in kg, per capita, per day. Relevant benchmarks listed include Philippines 0.38, Indonesia 0.70, Jamaica 1.0, with the average quoted as 0.77.

The review as noted above illustrates the huge variation in reported waste generation rates, which are considered by UNEP to reflect a combination of a) actual long-term differences, b) natural variation resulting from small scale and ad hoc surveys, c) differences in methodologies and d) inconsistent reporting. Notwithstanding all of the noted variations, UNEP considers a credible range for the PaP region to be 0.3 - 1.0kg/per capita/per day and proposes to use the midpoint rate of **0.65 kg/per capita/per day** for its benchmarking calculations.

Note that Project Phoenix has used **0.70 kg/per capita/per day** for its benchmarking calculations.

4.2.7. Waste generation forecasts

The table below shows the UNEP selected benchmark rate applied to the population projections to develop long-term waste generation tonnage forecasts.

Year	WtE Catchment Popn. 1.6% p.a growth	Waste generation TPD	WtE Catchment Popn. 2.5% p.a growth	Waste generation TPD
2015	3,093,631	2011	3,093,631	2011
2020	3,349,164	2177	3,500,159	2275
2025	3,590,653	2334	3,921,706	2549
2030	3,925,311	2551	4,480,500	2912
2035	4,249,547	2762	5,020,116	3263
2040	4,600,565	2990	5,679,800	3692
2045	4,980,578	3237	6,489,100	4218
Change	62%		210%	

Table 4.2.7 UNEP Waste generation forecasts

4.2.8. Waste collection ratios and forecasts

The ideal scenario for WM is of course that waste generation is precisely matched by waste collection. However, the universal presence of litter and illegal dumps on land and marine garbage shows that waste generation exceeds waste collection in virtually all countries. The key unknown for Haiti and for the assessment of Project Phoenix is the percentage collected, both currently and during Phoenix operation.

There are no reliable methods for accurately gauging the percentage of waste collection in the absence of very extensive real data sets on both generation and collection. In the case of Haiti, the data is both scarce and very low quality and so cannot be fully relied upon.

Full waste collection is a stated goal of Project Phoenix. This is theoretically possible, but considered by UNEP to be very unrealistic and unreliable as the basis of plant design. A preferred approach for UNEP would be to:

- Develop waste collection estimates via two contrasting methods;
- Use these two figures and engineering judgment to select a conservative figure or range to use for plant design.

The two recommended methods for estimate are:

- A. Applying a collection ratio to the waste generation forecasts;
- B. Applying an improvement ratio on existing documented rates of collection.

For method A, in the absence of better local information or relevant references, UNEP recommends using a conservative theoretical collection ratio of **70 percent at project commencement rising over time to 80 percent**. The missing 20 percent to 30 percent would cover three categories:

- Material separated and removed on-site for recycling by informal waste scavengers.
- Waste burnt on-site (a common WM solution in Haiti).
- Organic waste eaten on-site by pigs and goats.
- Waste dumped into the environment not accessible to retrieval at a reasonable cost. This includes a percentage of waste thrown into vacant lots, gullies, ravines and watercourses.

The table below presents the results of applying a 70 percent collection ratio to the UNEP forecasts of waste generation for the project waste collection catchment and the 1.6 percent and 2.5 percent population growth rate scenarios.

Year	Waste collection TPD 1.6% growth scenario	Waste collection TPD 2.5% growth scenario
2015	1408	1408
2020	1524	1593
2025	1634	1784
2030	1786	2039
2035	1934	2284
2040	2093	2584
2045	2266	2953

Table 4.2.8 Waste collection forecast – 70 percent collection scenario

In summary the UNEP forecast of potential waste collection rates for Project Phoenix – using largely theoretical WM and population figures – is for an initial rate of 1,400 TPD rising gradually over the life of the facility to between 2,200 TPD to 3,000 TPD: based upon an assumed 70 percent collection. The volumes rise to approximately 1,600 to 3,400 TPD based upon an 80 percent collection rate. For the remainder of this review UNEP has used a 70 percent collection rate.

4.2.9. Existing SMCRS waste collection rates and activities

The Phoenix consortium has conducted its own assessment of existing collection rates. UNEP separately reviewed this issue four times between 2011 and 2013, with the most recent interview with SMCRS being held on 12 June 2013. The interview and reviews illustrate a positive and interesting trend.

In mid 2010, there was no clear estimate of the amount of waste being collected by SMCRS. SMCRS management reported to a team from the Solid Waste Association of North America (SWANA) that it was able to collect only 20 percent of the 1,600 tonnes of waste it estimated were generated daily in the PaP urban area^(4.1). This translates to a roughly estimated 400 tonnes collected per day.

In January 2011, UNEP and UNOPS conducted a waste characterization study at Truitier landfill^(4.9). The study included a truck traffic survey to estimate on-site dumping rates. The survey was not fully rigorous however the data collected indicated that an average of 65 compactor and dump trucks per day were dumping at the facility. A conservative estimate of the tonnage per truck would be 10 tonnes for a compactor and three tonnes for a dump truck. This indicates a dumping rate of between 200 and 400 TPD. It is important to note that the waste collection rate may have been much higher, but that much of the waste was then illegally dumped elsewhere.

In December 2012, SMCRS reported to IEP that it had steadily improved its waste collection performance and was now collecting an estimated 800 TPD from the seven Communes in PaP. In this case SMCRS had more detailed records of the volume collected and a very conservative density unit (0.35 tonnes/m³) was used to generate the tonnage estimate.

On 12 June 2013, SMCRS reported to UNEP that it was collecting in excess of 2,000 TPD. UNEP has not seen the basis for this estimate, but does consider it to be likely to be a major over-estimate. What is clear is the anecdotal evidence of greatly increased SMCRS collection rates: the streets and public areas of the greater PaP area are on average much cleaner than in late 2010. This is an excellent and commendable effort by SMCRS, irrespective of the precise statistics.

The director of SMCRS outlined to UNEP the sources of the improvement:

- Improved human resource management, including small but critical salary rises for workers;
- Improved routing to increase collection turnaround rates;
- Greatly increased efforts on major equipment repair and maintenance, which has returned a large number of trucks into service;
- Improved equipment and kerbside collection arrangements, which has reduced turnaround time;
- Full working of two shifts.

SMCRS has recently been well supported in its efforts by the GoH, which has temporarily increased the SMCRS operating budget from approximately US\$400,000 per month to US\$900,000 per month. UNEP presented a range of questions on financing to the Director General of SMCRS, Donald Paraison, who responded as follows:

- The current budget of US\$900,000 is not secure and is not enough. SMCRS has calculated that the organization would need approximately US\$2,100,000 of monthly operating budget to fully deliver on their responsibilities. This sum does not account for any significant capital works or depreciation of the equipment fleet.
- With the current budget, SMCRS is not undertaking any long-term repairs or preventive maintenance or spare part inventory work – all efforts are focused on daily operations. Hence the current rate of collection is considered unsustainable in the medium and long-term – due to the need to replace an aging truck fleet.
- The current budget also does not allow for adequate management of Truitier.
- The current budget does not allow for waste collection away from the roadsides – this leaves waste in inaccessible areas: in ravines, canals and drains, steep informal housing and the centers of markets.

SMCRS only operates in the PaP region. UNEP has not investigated existing Commune or private-led waste collection in St Marc or Gonaives.

4.2.10. Existing private sector waste collection volumes

One of the SMCRS responsibilities is monitoring of the private waste collection centre. The director of SMCRS reported in June 2013 that private sector waste operators are currently dumping between 300 and 450 TPD at Truitier. The variability is reported to be due to contract specific spikes of activity for individual companies.

4.2.11. Waste collection tonnage design criteria

In summary, based on largely anecdotal evidence, the existing combined SMCRS and private waste collection activities within the catchment area are very roughly estimated by UNEP to be in the order

of 1,000 to 1,500 TPD. After observing the environment of the PaP region there is also a great deal of waste left uncollected in addition to this 1,000 to 1,500 tonnes. Also clearly there is significant potential for the major investments from Project Phoenix to greatly increase collection rates.

Returning to the two methods for forecasting waste collection quantities, it can be seen that the two methods actually generate reasonably similar forecasts:

- The estimated initial collection is (end 2015) 1,400 TPD, using a 0.65kg/day capita waste generation and a 70 percent collection scenario.
- The estimated existing collection estimates (Jan 2014) are 1,000 to 1,500 TPD, with clear scope to immediately increase via capital investment.

It is considered unsound for a WtE plant with an operating lifecycle of over 30 years to be designed only for the starting conditions. A reasonable allowance should be made for managing the growth in waste generation – estimated by UNEP to be between 1.6 and 2.5 percent per annum. There is also potential to expand the waste collection catchment. At the same time there are economic limits to the extent of initial over-sizing of the facility as it is too expensive to operate any major WtE facility at partial capacity.

The dual fuel process of Project Phoenix Scenarios 1 and 2 is highly positive in this respect, as it allows for ongoing management of a changing quantity of waste by simply changing the coal/lignite - waste ratios.

The current Project Phoenix design criteria for waste collection is a minimum of 1,640 TPD. The assessment of UNEP is that this is slightly optimistic as a starting condition, with 1,400 tonnes considered conservative. However UNEP and IEP are in agreement that the volume of waste collected should rise quickly over time, particularly in the first few years as the collection process is tuned and the productivity of the collection teams increases. At present IEP forecasts 90 percent efficiency of its own collection efforts after a few years.

This difference in early waste volumes has very important implications for Scenario 3, where waste is the only fuel. It is less important for Scenarios 1 and 2, where any early shortfall in waste tonnage can be balanced with lignite or coal without any loss of WtE performance or energy production.

This issue is addressed further in Chapters 12 to 14.

4.2.12. SMCRS and private sector waste collection workload

Project Phoenix is anticipated to have a positive impact on the SMCRS waste collection workload. The current proposal is for Phoenix to collect 1,200 TPD and for this effort to include partial replacement of current SMCRS efforts. The IEP assessment is that the collection workload of SMCRS will remain at 400 TPD (the 2012 estimate), which is approximately 50 percent of its current (Q4 2013) workload. The UNEP assessment is that this is a reasonable estimate, however its accuracy is inherently limited.

The private sector to date has focused on responding to demands for priority collection from specific businesses and residences. It is difficult to predict the impact of Phoenix on their operation, except for the Boucard WM company, whose waste collection efforts will be integrated into the Phoenix consortium.

At a more strategic level, the proposed parallel operation of waste collection fleets by SMCRS, Project Phoenix and other private sector operators does not seem logical. SMCRS is an underfunded state institution which will continually struggle to maintain its operational capacity and is unlikely to ever match the efficiency of the private sector.

Therefore it is considered that longer term savings could be made by further outsourcing the waste collection workload to the private sector and reducing the SMCRS waste collection and transport

activities to the minimum. This could be achieved through any competent private sector operator: either existing firms, Project Phoenix subcontractors or new entrants. IEP has had multiple discussions with the GoH on the possible acquisition of SMCRS if necessary to support the operations for the PaP region.

This issue of the proposed waste collection model was examined in brief and reported as a finding in Chapter 2 and so is not repeated as a finding in this chapter.

4.3. Waste composition

4.3.1. The impact of variable waste composition

The composition of the waste collected has a critical impact on the technical and financial feasibility of Project Phoenix. In this case moderately good quality data is available on the composition of the waste to be collected. The data indicates several points of concern that warrant further assessment.

4.3.2. IEP and UNEP/UNOPS waste characterization studies

In 2011 UNEP partnered with UNOPS to implement a waste characterization study at Truitier landfill (4.9).

In 2011 IEP commissioned a completely separate waste characterization study at Truitier. This study was implemented by the consulting firm Applus(4.10).

Both UNEP and IEP have compared the studies and found them to be overall moderately comparable, with some very clear differences in the methods:

- The IEP sampling included substantial volumes of building debris linked to post-earthquake demolition and IEP included these in their analysis.
- The IEP sampling method was based upon assessing whole truck loads whilst the UNEP method relied on large grab samples.

In summary of the key characteristics of the sampled waste:

- There is a high content of organic matter – decaying fruit, vegetables, vegetation and wood.
- The organic matter is generally quite wet due to entrained (inherent) moisture.
- Much of the waste – organic matter, paper, plastic and fabric is also quite wet due to absorbed water from rainfall and from the waste being left on the ground, often in ditches.
- The easily combustible content (plastic, wood, paper, cardboard and fabric) is moderate.
- The potentially recyclable content (metals, glass, some plastic, cardboard and paper) is moderate.
- Medical waste is present in small quantities.
- The other hazardous waste content is very low.

The table below presents the summarized results of the two surveys, noting that there are major percent differences noted in the categories organics, debris and inert which may be partly due to survey methodologies.

Waste type	IEP survey % composition by wet weight.	UNEP survey % composition by wet weight.
Organic	16.53	53
Paper & cardboard	12.68	12
Vegetables	14.86	inc in organics
Textiles	9.29	6.5
Plastic	10.09	15.4
Wood	3.07	1.8
Glass	2.99	2.1
Metals	1.88	1.5
Sands and inert	28.52	4.3
Hazardous/other	-	2.9
Bulky	0.09	-
TOTAL	100	99.5

Table 4.3.2 Summary of waste composition results, Truitier landfill, Haiti

The average MC of the waste from the IEP survey was 44.5 percent^(4.11). The average MC of the waste from the UNEP survey was 61.5 percent. This is the most critical difference between the two surveys, as the MC has a major impact on WtE performance as it decreases the net amount of energy available to create power.

Note that the two surveys cannot be simply averaged to provide mean figures due to the larger sample size of the IEP survey. A weighted average analysis would infer a mean waste composition closer to the IEP samples. Nonetheless the UNEP survey provides a realistic snapshot of the pessimistic case for waste feedstocks for a WtE plant in the PaP region.

4.3.3. Implications of the Haitian waste characteristics on Project Phoenix feasibility

With respect to WtE options, the waste characteristics are very challenging, as they are not optimum for either of the two most reliable WtE technology options:

- For combustion, which is the Phoenix technology, the waste has a relatively low calorific value - resulting from a combination of high organic content and high MC. Significant energy will be lost through the heat of evaporation of the wet materials. Either significant pre-treatment or a dual fuel system will be required.
- For AD, the waste has a high organic content, but this is fully mixed in with a range of non-compatible waste, which must be fully separated out for advanced AD systems to function. Some of the waste theoretically suitable for AD such as cardboard and wood are in practice uneconomic to process due to very slow reaction rates. The high content of non-compatible waste also severely limits the extractable energy per tonne of waste, if only AD is used.

This issue is addressed further in Chapters 13 and 14 and so is not reported as a finding for this chapter.

4.4. Waste management

4.4.1. Current management of collected waste

At present the waste which is actually collected within the proposed catchment of the WtE facility are not well managed or disposed. Hence there is a clear need for improvement.

Only PaP has a formal WM facility: the Truitier landfill. This facility services most but not all of the greater PaP region. The landfill is located on flat ground near sea level 500 meters from the Bay of Port-au-Prince, approximately 5 km north of the city centre. The surrounding land use is mainly agricultural, with some informal settlements. The entire area is prone to episodic flooding from the Grise River and is also vulnerable to storm surge and sea level rise.

Besides Truitier the waste disposal sites in use are all semi-formal or entirely informal/illegal. Typically they are gullies or open spaces on the edges of urban centers where waste is tipped but otherwise not formally treated.

Both Truitier and the other sites have a local population of waste-pickers, who pick through the waste for recyclable materials and set fire to the waste. IEP reports that waste-picking at Truitier supports up to 700 families^(4.12).

At present SMCRS trucks use only Truitier for disposal. SMCRS also requires that all commercial WM companies active in greater PaP use only Truitier, however this not fully enforced. As stated in the section above, SMCRS does not have the funds to operate Truitier in an appropriate manner and the manager of SMCRS noted in a discussion with UNEP that this situation will not improve.

The impact of substandard management of the collected waste is highly visible at Truitier and at the other informal sites:

- Wind and water-transported litter;
- High levels of vermin, with the associated spreading of disease;
- Locally very high episodic air pollution levels from waste burning, generating black clouds of toxic smoke;
- Surface and marine water pollution due to leachate running from the base of the waste dumps.

The intensity of these issues varies from site to site, however the issues are universal. Truitier benefits from the permanent presence of SMCRS, which operates some heavy equipment and controls the behavior of waste trucks on-site.

In summary, there is a clear and current need for greatly improved management of the estimated 1,000 to 1,500 TPD of municipal waste that is currently collected. This need will increase over time with population growth, potentially doubling over the next 30 years.

4.4.2. Project Phoenix waste management

Project Phoenix proposes to divert virtually all waste currently going to Truitier to the Phoenix plant. Once at the plant the waste will be treated, classified and either recycled, burnt for energy recovery or landfilled on-site in a new engineered landfill. The current plans are caveated however, by stating that Truitier may remain open and still accept limited amounts of waste on a contingency basis ^(4.12). The logic of this plan is not clear to UNEP, as this will leave the GoH with an ongoing operational cost for Truitier and preclude its responsible closure.

Subject to detailed assessment of the quality and feasibility of the WM processes proposed, it is clear that the Phoenix plant will fully tackle all of the needs currently addressed in an imperfect manner by Truitier – but only if all waste is diverted.

IEP has proposed using the Truitier site as a transfer station for the current private collectors (and SMCRS) that cannot or are unwilling to drive to the Aubry site. This will allow the current collectors to continue their operations and encourage legal depositing of waste rather than disposal in illegal landfills.

4.4.3. Truitier legacy management

At present the scope of Project Phoenix does not include any investment whatsoever in Truitier. Nonetheless Truitier is considered by UNEP to be an integral part of the WM challenge for the PaP region and so is included in the review.

Truitier has been operating in a substandard manner for over 20 years and this has resulted in a major WM legacy.

There are no accurate survey figures for the volume of waste already deposited at Truitier. UNEP has developed a very rough estimate of the volume based upon satellite imagery, SMCRS plans and a walkover survey. Assuming the absence of large holes and that all waste has simply been deposited on the flat original surface, the volume of waste at July 2013 is very roughly estimated at 1 million m³ (750m by 150m by 10m waste depth) The waste tonnage cannot be estimated due to a lack of data on waste density.

The legacy waste is essentially composed of the residues left after waste-picking, uncontrolled surface burning and organic waste decomposition. It is still partly exposed and represents an ongoing source of pollution.

Proper closure of previously uncontrolled waste dumps can be very expensive. Comprehensive treatment and re-disposal of the Truitier waste in a modern landfill cell built to USA or European standards could cost well in excess of US\$30/m³ or US\$30 million. This is considered unaffordable in the context of Haiti.

A more affordable and pragmatic engineering solution could however deliver major benefits at a fraction of this cost. UNEP has scoped a potential package of measures, that collectively would greatly reduce the long-term impact of the landfill on the environment, even though the works would not fully match USA or European standards. The package includes:

- Reshaping the existing landfill to collect isolated areas of waste and remove steep slopes.
- Excavating on-site clay and creating a wetland in the excavation – incorporating a non-mechanized leachate management system.
- Using the clay and stockpiled crushed building debris to deposit a thin layer of semi-permeable clean cover.
- Installing passive landfill gas vents.
- Improving surface drainage and directing runoff and leachate to the new wetland.

These works are estimated to cost in the order of US\$3 to US\$5 million.

Once rehabilitated the long-term future use of the Truitier site is likely to be a combination of rough grass and woodland on the dump areas and agroforestry/banana plantations in the surrounding areas.

4.4.4. Truitier climate change funding

The UNEP analysis of greenhouse gas emissions and climate funding opportunities indicates that proper closure of Truitier may be a candidate project for Clean Development Mechanism (CDM) funding. If secured this funding would enable a much more comprehensive closure project. This issue is discussed further in Chapters 9 and 17.

4.5. Findings summary

Waste sector needs and feedstock	
A. The waste collection catchment	The proposed Phoenix waste collection catchment appears viable, although covering slightly different areas from the UNEP assessment.
C. Waste collection tonnage design criteria	The Phoenix design criteria of initially 1,600 tonnes of waste collected per day appears slightly optimistic – with UNEP estimating initially 1,400 TPD as being more reasonable. This is very important for Scenario 3 but has limited impact on Scenarios 1 and 2.
A. Future management of collected waste	Phoenix offers a full spectrum solution for WM – it is designed to receive and manage a large volume of practically all forecast waste types.
C. Current management of collected waste at Truitier	Phoenix will in practice fully remove the need for the continued operation of the Truitier landfill. However current IEP proposals include for ongoing limited operation of Truitier by the GoH.
D. Truitier landfill legacy	The current scope of Project Phoenix does not include any funds or works to enable closure of Truitier in a responsible manner. A minimum of US\$3 to US\$5 million is needed for this work. There is the potential for CDM funding.

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5. Electricity demand

5.1. Introduction

5.1.1. Scope of the assessment

This chapter presents an assessment of the consumer demand for electricity in the PaP region and assesses how Project Phoenix fits within the existing and anticipated electricity market.

The current Project Phoenix PPA is based upon “take or pay” terms, whereby the buyer EDH must pay for all power supplied by Phoenix, whether or not it is needed. In this context, the focus of the assessment is on whether the electricity market in the PaP region has a current and forecast demand for an additional 30MW to 50MW of electricity.

Note that the capacity of the PaP electrical grid to physically absorb the additional transmitted energy is a technical feasibility issue that is addressed in Chapter 15.

5.1.2. Power Engineers report 2011

The Project Phoenix assessment of electricity demand is based upon a November 2011 technical memorandum by consultancy firm Power Engineers (PE)^(5.1) which in turn uses a March 2011 report by the (different) consultancy firm Power Engineering International (PEI)^(5.2).

The Power Engineers report of 2011 to Project Phoenix generated short-term forecasts based on PEI and EDH reported figures. The key results of that analysis were:

Demand

- In 2011, there was a speculated peak demand of 200MW for the PaP grid. It was speculated because EDH has never achieved that level of supply.
- Ten percent spinning reserve should be added to that demand to ensure power quality and continuity.
- Hence the current demand (for high quality power at a very high level of availability) was speculated at 220MW.

Supply

- Current peak production was highly variable but in the order of 105MW in the wet season and 79MW in the dry season, due to the variable production of the Péligre Dam in the Centre Department.
- The plant operated by E-Power (a power generation company) would add a further 30MW, delivering a total of 109 to 135MW

Shortfall

The PE predicted shortfall in Q1 2014 (the original proposed start date for Phoenix electricity generation) between the current situation and the ideal, will range from 85MW to 111MW (UNEP calculations based on PE figures).

This assessment did not take into account any increase in demand due to customers switching from autonomous private generators to the grid. The autonomous generator fleet has not been catalogued in Haiti, but is estimated by PEI to be in the order of 50MW to 200 MW. Switching over is anticipated if the power was available and of sufficient quality and reliability, as the cost of autonomous generation is generally higher than the grid.

5.1.3. The UNEP assessment

UNEP supplemented PE's work with direct enquiries to EDH in July 2013 and made its own calculations. Despite repeated enquiries, insufficient data was provided by EDH to enable development of a continuous and fully robust demand forecast for the 30-year life of the plant.

In October 2013, the GoH and the WB launched a call for consultants to support the development of a national electricity sector master plan. According to the scope of work, development of the plan will include a substantial study on demand forecasting. This study is scheduled for completion in Q3 2014.

In the interim UNEP has developed three very basic forecasts, each of which is explained below:

- 2014 - An estimate of current demand.
- 2016 - Forecast demand at Phoenix power generation startup.
- 2030 - Demand at the approximate halfway mark of the Phoenix PPA.

The issue of dispatching priority is also assessed – where the demand for power depends in part upon the price of the power compared to other Independent Power Producers.

5.2. Demand estimates and forecasts

5.2.1. The 2014 demand estimate

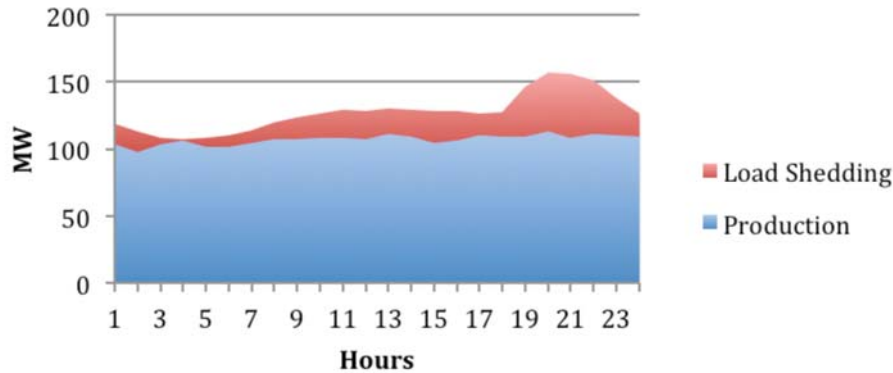
The UNEP 2014 demand estimate is based upon a collation of reports and anecdotal information obtained up to the end of December 2013. The Haiti electricity sector in December 2013 was in some turmoil, with numerous issues and initiatives ongoing, but very little formal or quantitative information being made available in the public domain. Hence there is a risk that this estimate is substantially incorrect due to a lack of data.

EDH kindly supplied UNEP with a daily energy production report for the PaP grid for Sunday 14 July 2013^(5.3). The chart below illustrates the calculated load profiles over the 24-hour reporting period.

Key items noted for Sunday 14 July 2013:

- Currently seven power plants are listed as power providers to the PaP grid.
- One provider E-Power, was completely offline and supplied no power, apparently due to EDH payment arrears.
- Peligre supplied an average of 24.9 MW over the 24-hour period.
- Production peaked at 113.6 MW.
- Demand exceeded supply for the entire 24-hour period and EDH shed load continuously.
- The estimated maximum load shed was 48 MW at 8pm, which represents 30 percent of demand.
- Operational time of the various units varied from 7 hours to 24 with an average of 16.50 hours.

EDH PaP Energy Report 14 July 2013



Clearly Sunday 14th July was a bad day for EDH, with load shedding required for over 30 percent of its customers. It was however also an unusual day, as E-Power was offline, removing up to 30MW from the production. However some load shedding would have occurred even with E-Power delivering at full capacity. Most industrial and commercial facilities in Haiti do not work on Sunday, so the snapshot provided is actually a best case scenario – during the week the extent of load shedding may be much greater.

In summary, UNEP enquiries validated part of the PE study – current production is in the 100MW to 130MW range and extensive load shedding is occurring due to a chronic demand-supply imbalance.

5.2.2. The 2016 forecast

The end of 2016 is six months before the earliest feasible start date for Phoenix electricity generation. The UNEP 2016 electricity demand forecast is developed by adding anticipated changes in the 2014 to 2016 period to the 2014 estimate. Hence this forecast suffers from the same risk of inaccuracy as the estimate.

Notwithstanding this caveat, three important changes are anticipated for the period 2014 to 2016.

- Increased demand.** There is no firm basis upon which to predict increases in demand between end 2013 and end 2016. As an absolute minimum, demand could be expected to rise with the urban population. As per Chapter 6, IHRI report an urban population growth of 3.2 percent per annum over the period 2005 to 2010 and UNEP is using a 1.6 - 2.5 percent urban growth rate in its waste generation forecasts. 2.5 percent compounded over three years is 7.7 percent. A 7.7 percent increase on the 2013 estimated minimum ideal supply of 220MW is 15.4MW, resulting in a revised (ideal case) demand of approximately 235MW. Note that in the absence of more connections, the growth will be in suppressed demand, not connected demand.
- Thermal plant performance reductions.** Only E-Power has near new thermal power generation facilities. All of the other power plant providers are utilizing equipment at least five years old and much older in some cases. A July 2010 report noted 20 thermal power units excluding E-Power. Eleven of those 20 units were noted as being out of service. It is impossible to predict the extent of performance reduction by 2016, other than a high confidence level that performance will be lower. For the purpose of this assessment, UNEP is assuming a 5 percent further reduction in

thermal power capacity due to aging equipment. Five percent of the total thermal fleet nameplate capacity of 180MW is 9MW.

- **Péligre Dam refurbishment** The IDB-funded rehabilitation of Péligre is underway and is expected to recover an additional 25MW of power, dependent upon the season.

Taken together the three changes amount to an increased supply vs. demand of effectively zero, $(-15.4 - 9 + 25) = 0.6\text{MW}$ so in 2016 the predicted shortfall between the likely situation and the ideal will remain in the range of 85MW to 111MW.

The forecast maximum generation capacity of Project Phoenix is 50MW, so based upon this simple analysis there is a clear demand gap that Project Phoenix can partially fill. Given the overall low availability of the generator fleet noted in July 2013, the proposed 80 percent+ availability of the Project Phoenix facility will provide a very useful base.

5.2.3. The 2030 forecast

The approximate 50 percent mark for the proposed Phoenix PPA is used to provide an informative point of reference for demand forecasting. Fifteen years after Phoenix startup, the following minimum changes are forecast:

- Urban population indexed (ideal case) demand will have risen 45 percent beyond the 2016 forecast of 235MW to 340MW.
- All of the existing thermal power plants except for the one operated by E-Power will have reached the end of their economic life and their PPAs will have expired, removing 136MW from the production pool.

Using only this very simple model, the supply-demand shortfall will have risen from 85MW to 111MW in 2016 to 326MW to 350MW in 2030.

Economic growth driven demand will also have risen, probably substantially, however it is not possible to forecast the level. Other new power plants will have started up to replace expired PPAs and service the demand gap, however their PPAs will be later in priority than Phoenix due to the take or pay terms of the latter.

This is an extremely basic form of long-term forecasting. Nonetheless, clearly there is ample demand for power from Project Phoenix in the medium to long-term and this demand is expected to continually rise.

5.3. Generation scheduling and cost comparisons

5.3.1. Lowest cost (merit) generation scheduling

The above basic supply gap figures are based simply upon using the existing power fleet in the same manner as at present. In practice this is unrealistic and uneconomic, as basic power economics dictate a power allocation hierarchy, where the cheapest units are given daily priority by EDH for energy production (within the limits of the existing PPA terms). This approach is known as scheduling by merit and is standard global practice.

For Phoenix, in practice this means that all sources of power that cost more than the latest Phoenix offer should be discounted and placed behind Phoenix in scheduling priority – to the extent contractually feasible with the existing PPAs.

5.3.2. Current generation costs

In January 2013 EDH released a summary 2012-2013 plan, which included a summary of its power generations costs as of June 2012^(5.4). The table below summarizes the costs relevant for the PaP grid versus the latest Phoenix offer for Scenario 1.

Facility	Nameplate MW	Total cost per kW/hr in US\$
Phoenix	50	0.153 energy service
Phoenix	50	0.247 collated energy + WM
Carrefour II	30	0.25
E-Power	30	0.25
Carrefour I	39.5	0.28
Varreux III	20	0.28
Varreux I	35	0.36
Varreux II	15	0.37

All of the existing fossil fuel power generation costs vary with the price of imported fuel. The long-term forecast for imported fuel is for sustained price increases.

Note that EDH claims an operational cost for Péligré of 2 US cents per kW/hr. This is considered an under-estimate however industry benchmarking^(5.5) indicates the cost is probably under 5 US cents per kW/hr. Peligre is an old project which has paid off the original construction cost but currently is undergoing an expensive refurbishment. Finally, Péligré has only relatively moderate storage capacity, so there is a “use it or lose it” aspect to Péligré power production.

5.3.3. Implications of merit scheduling for Project Phoenix

The implications for Project Phoenix are clear and positive. Based upon lowest cost scheduling and the revised offer, Phoenix should be scheduled after Péligré and equivalent to E-Power. If the added benefit of WM is accounted for, then Phoenix should be scheduled before E-Power. In practice E-Power already has an operational PPA on take or pay terms, so the two units would have equal financial merit at these prices.

The current Phoenix MSA and PPA are based upon take or pay terms, partly in order to ensure project financing is feasible. However the assessment indicates that this insurance in practice is largely redundant, due to the economic incentive to maximize use of the Phoenix resource compared to the more expensive diesel and Heavy Fuel Oil (HFO) plants (Carrefour and Varreux).

Note that these findings are dependent upon Phoenix being able to support its revised offer.

5.4. Findings summary

Electricity demand	
A. Electricity demand model results	Simple estimates and forecasts based upon available information indicate a substantial and growing supply-demand shortfall that Phoenix can help address.
D. Electricity demand model assurance	At present inadequate planning and communication by EDH and the GoH critically undermines the confidence in any Haitian electricity sector demand assessment. The level of assurance at present is expected to be insufficient to secure project financing.
A. Generation scheduling by financial merit	A current IPP cost comparison indicates that Phoenix generation should be scheduled at a high priority and that the MSA-PPA take or pay terms do not result in a major practical or financial risk for the GoH (with respect to demand and scheduling).

5.5. Chapter references

- 5.1 PE and Atkins (2011). Technical memorandum: Preliminary Load Analysis, Haiti
- 5.2 PEI (2011). Technical Assistance for the Electric Power Generation, Transmission and Distribution. Report supplied to the US Trade and Development Agency
- 5.3 EDH Daily Report 12 July 2013
- 5.4 EDH 2012 - 2013 Action Plan. Public Version
- 5.5 International Renewable Energy Agency (2012). "Renewable energy technologies: cost analysis series" – Volume 1 Power Sector Issue 3/5 Hydropower

6. Haitian government policy and the counterpart role

6.1. Introduction

6.1.1. Scope of the assessment

This chapter presents an assessment of the fit of Project Phoenix in the policy and political landscape of Haiti as of January 2014. It focuses on the fit of the project within the various sector policies of the GoH. The GoH currently lacks comprehensive strategies and policies for many sectors, so this assessment has its limits. In addition it assesses the performance of the GoH as a project counterpart and the associated prospects for project development.

6.2. Policy alignment

6.2.1. Electricity grid sector policy

As of Q4 2013, Haiti does not have a unified national electricity sector policy or master plan. This is despite a long history of dialogue and ongoing attempts at sector development and reform. There are however several institution-specific plans, draft energy policies and short statements by the GoH that provide a background of needs and priorities. In addition in October 2013, the GoH relaunched a national level electricity sector master planning process and a firm government policy is anticipated by Q4 2014.

In the interim, several key documents can provide clues as to the degree of fit of Project Phoenix with GoH informal and developing policy.

Energy Policy for the Republic of Haiti – Waste Section. Draft Version 9 January 2012. Bureau of the Ministry of Public Works, Transport and Communications^(6.1). Section 6.9 states the seriousness of the solid waste issues of Haiti and encourages the development of WtE solutions.

Action Plan for Electricity 17 September 2012. Multi-sectoral committee for energy security^(6.2)

This two-page note outlines the key desired investments in the electricity sector. Item 3 is the construction of 300MW of new lower cost power generation and diversification of energy sources. Item 9 is the construction of several WtE facilities throughout Haiti, including PaP.

Strategic Plan for the Development of Haiti: Emerging country 2030 (undated 2012)^(6.3). This short plan presents a vision and a programmatic approach to prioritizing activities over the medium term. Pillar 1 of the plan is Territorial Refoundation and programme 1.6 proposes an increase in national electrification.

EDH Electricity Haiti Action Plan 2012 - 2013 (January 2013)^(6.4). This plan sets out a range of planned and proposed short-term actions for the operational and financial turnaround of EDH. Key items include:

- Significant investments and actions to improve billing and recovery rates.
- Aim for increasing hours of operation and coverage towards national and 24/7 coverage.
- Significant improvement to reduce energy technical losses.
- Rehabilitate and improve performance of the existing public and private power generation fleet.
- Actions to start to reduce the cost of power generation and diversify supply to renewable energy.

Note WtE is not explicitly mentioned in this document. In addition only a fraction of the noted ambitions have been realized as of Q4 2013.

Working draft Presidential Decree (not advanced) to apply normative texts (Version 4 15 November 2012)^(6.5). This draft decree was designed to stimulate interim reform of the Haiti energy sector whilst longer term changes in legislation were enacted.

Article 2, amongst other items, states an intention to liberalize the EDH monopoly to allow independent power producers to sell directly to industrial power customers.

Article 7, intends to give electricity purchase priority to environmentally friendly forms of power generation.

Article 12, urges regulation of EDH and the private sector to ensure coordination.

In summary, the current national electricity sector policy is best described as fragmented and in flux, but with a recurrent theme of the need for major growth and improvement. Renewable energy projects, including WtE, are in general encouraged. In the short-term the focus is on the financial turnaround of EDH and improved management of existing assets. Medium term plans include ambitions for major increases in power generation capacity.

Project Phoenix fits relatively well into this proposed policy framework, however the draft status and lack of detail and coherence of the latter results in some ongoing uncertainty.

6.2.2. Solid waste management policy

As of Q4 2013, Haiti does not have a unified national WM policy or master plan. It does however have a draft policy report, developed and published in June 2011^(6.6). This 160-page document provides a conceptual framework for management of the entire sector, from the national to the local level.

The proposed framework includes the creation of a national WM agency and a number of subnational agencies with delegated authority and a comprehensive new law on WM. Concepts proposed and discussed include development of hazardous WM plans and facilities, local collection and transfer stations and public/private partnerships.

Project Phoenix fits relatively well into this proposed policy framework, however the lack of detail and incomplete status of the latter results in some ongoing uncertainty.

6.2.3. Foreign investment policy

Haiti at present has very strong political support for encouraging foreign investment but lacks a comprehensive policy and legislative framework for implementing this vision. Haiti is currently ranked 174 out of 185 countries in the World Bank Ease of doing Business Index^(6.7), so major improvements are clearly needed.

In the past major foreign investment projects have directly negotiated favorable terms with the Ministry of Finance and/or have been located in dedicated low taxation industrial parks known as zones franches.

The GoH's support for foreign investment and business development in general can be seen in the operation of the Centre for Facilitation of Investments (CFI) which is presented as the first port of call for foreign investors. The CFI has recently published the Haiti Investment Guide 2013. CFI leadership has been actively monitoring and supporting the Project Phoenix consortium in project development and approval activities.

Other supporting documents include the Strategic Plan for the Development of Haiti: Emerging country 2030^(6.3). Action Area 2 of the plan is Economic Rebuilding: Program 2.1 is: Implement proactive governance centered on accelerated and balanced economic growth; Program 2.1.4 is: Support private investment; Program 2.4 is: Support industrial development.

Hence Project Phoenix is closely aligned to the GoH high-level foreign investment policy. At the detailed level it is difficult to gauge the level of alignment between this project and some other general policies – such as company taxation and the appropriate level of tax income to be sacrificed in order to attract investment.

6.3. Project counterpart support

6.3.1. The Government of Haiti counterpart role

The performance of the GoH in its project counterpart role has been both cyclic and problematic and this remains the case as of end Q1 2014.

On the positive side, the GoH was heavily engaged and appeared very committed in the early development history of Project Phoenix in 2011 and 2012. A consortium of partners coordinated by the President’s Office progressed the development of the project from its concept stage through to the signing of the MSA and PPA.

Thereafter the project struck resistance from key international stakeholders (see Chapter 8) and progress effectively stalled. At the same time personnel changes in the office of the President resulted in a loss of focus on Phoenix. Over the period Q3 2012 to Q2 2014 GoH interest in Project Phoenix has apparently waned somewhat as the international stakeholder and associated finance issues appeared to remain intractable.

Current problems on the government counterpart side include:

- Instability with multiple personnel changes and poor handovers.
- Poor record keeping.
- Fragmentation and insufficient coordination between the various government stakeholders.

In summary, the project appears to continue to benefit from high-level political support, but it lacks a single government-civil service focal point with the resources to provide the necessary coordination, detailed support and continuity.

A stable and engaged government counterpart is considered critical to an initiative such as Project Phoenix. Moving from the PPA stage to financial close will require substantive government engagement, particularly on land issues. Further development of Project Phoenix is therefore not considered viable in the absence of significant improvements on the GoH side. However given the positive history of 2011 and 2012, this appears to be mainly a question of motivation. If project financing appeared possible, then the government may be motivated to re-start the process and again play a strong supporting role.

6.4. Findings summary

GoH policy, political support and the counterpart role	
B. Alignment with national energy policy	There is a good fit between Project Phoenix and GoH draft policies and ambitions for energy development. Deficiencies in the latter result in ongoing uncertainty.
B. Alignment with national WM policy	There is a good fit between Project Phoenix and GoH draft policies and ambitions for WM. Deficiencies in the latter result in ongoing uncertainty.

A. Alignment with national foreign investment policy.	There is overall a very good fit between Project Phoenix and GoH policies and ambitions for foreign investment.
B. High-level political support	High-level political support has varied but overall is high.
D. Government counterpart role	Further development of the project is not viable in the absence of significant performance improvements by the GoH in its role as a key project partner – returning to the level of support it provided in 2011 to Q1 2012.

6.5. Chapter references

6.1 Bureau of the Minister Delegate for Energy Security (2012). Energy Policy for Haiti – Electricity Section. Draft Version 9

6.2 Bureau of the Minister Delegate for Energy Security. Action plan for electricity 17 September 2012. Multi-sectoral committee for energy security

6.3 GoH (2012). Strategic Plan for the Development of Haiti: Emerging country 2030

6.4 EDH (2013). Electricity Haiti Action Plan 2012 - 2013

6.5 Bureau of the Minister Delegate for Energy Security (2012). Working draft Presidential Decree (not advanced) Decree to apply normative texts, Version 4

6.6 The Ministry of Public Works Transport and Communications (2011). Elaboration of a strategic policy for the management of solid waste

6.7 World Bank. Ease of doing business index 2013.
<http://www.doingbusiness.org/rankings>

7. The Project Phoenix organization

7.1. Introduction

7.1.1. Scope of the assessment

This chapter presents an assessment of the capacity and experience of the Project Phoenix organization.

Project Phoenix is a very challenging project. It is a proposed design-build-own-operate engineering project with a projected capital cost in the order of US\$300 million, located in a fragile least developed country. The technology proposed is 100 percent proven, but also of medium complexity due to waste characteristics and difficult waste collection. The stakeholder management situation is highly complex. The project is proposed for non-recourse project financing, however equity investments of at least US \$10 million will also be required.

In this context, UNEP has assessed:

- The key personnel and organizations that form the consortium.
- The evidence of equity investment and the potential for further investment.

As part of its assessment UNEP attended two multi-organization teleconferences in Q2 2012 and obtained the latest and additional information from IEP in writing in June 2013. In addition UNEP staff visited the IEP Pittsburgh office on 7 December 2012 and 6-8 November 2013 and met most of the project team and the CEO. A representative of Ros Roca (a Phoenix consortium member company) visited UNEP in Geneva in May 2013 and UNEP visited the Ros Roca factory and headquarters in February 2014.

It is important to note that this was a **preliminary and limited** assessment of the consortium – UNEP has not researched the full background of all individuals and companies involved. For example it has not reference-checked submitted CVs of key staff or verified the scale of equity invested and proposed by the shareholders.

7.2. Project organizational assessment

7.2.1. Organizational structure

The organizational structure of Project Phoenix is relatively straightforward and transparent. The key components are:

- IEP Haiti - the project company.
- IEP LLC – the principal shareholder and lead developer.
- The Phoenix consortium – A collection of companies coordinated by IEP LLC via a series of 1-1 contracts.

Each key component is discussed in further detail below. Note that at a later stage IEP may further subdivide into a number of operating companies which specialize in specific activities and have broader shareholdings , e.g. IEP Waste Management.

7.3. IEP and the consortium

7.3.1. IEP Haiti

The legal entity that has executed the legal agreements with the GoH for the development of Project Phoenix is the Haitian company International Electric Power Haiti. This Special Purpose Vehicle (SPV) was created in December 2010 specifically for the development and implementation of this project and other potential energy sector projects in Haiti. (Note it is common to set up SPVs when dealing with large-scale project-financed infrastructure projects).

On 19 July IEP LLC management stated the shareholding of IEP Haiti to be as follows:

- 5 Haitian national shareholders: 18 percent in total
- IEP LLC – 72 percent
- GoH – 10 percent (in addition to a 50 percent revenue share on recyclables)

With its 10 percent government shareholding, IEP Haiti is a form of public-private partnership. However the depth of the partnership is expressed more in the IEP Haiti – GoH legal agreements than the GoH minority shareholding. The GoH was initially heavily engaged but since Q4 2012 has been relatively passive pending resolution of the noted international stakeholder issues and the completion of the UNEP review.

IEP report that the Haitian national shareholders are actively engaged, primarily in government liaison, local enquiries and approvals. UNEP met with the Haitian national shareholders on 28 August and 5 September 2013 to verify the IEP statements and exchange information on the UNEP review process. The following table summarizes the key information received:

<p>Shareholder: Patrick Gardere and Max Laroche via DMAX Logistics S.A. Nationality: Haitian Shareholding: 10 percent Profession/business: Wholesale construction materials, tourism, logistics and shipping agency, hotel ownership Investment to date: In kind at risk - Communications, logistics, approvals Current role: Continuing as per investment to date</p>
<p>Shareholder: Didier Gardere via Truxton S.A. Nationality: Haitian Shareholding: 4 percent Profession/business: Construction, engineering consulting and insurance business owner Investment to date: In kind at risk - Technical development Current role: Engineering development</p>
<p>Shareholder: Alix Douyon Nationality: Shareholding: 3 percent Profession/business: Entrepreneur and multi-thematic business development Investment to date: In kind at risk – project development Current role: Coordinator and vice president</p>
<p>Shareholder: Edward Rawson Nationality: Shareholding: 1.5 percent Profession/business: Project development and coordination, graphic design Investment to date: In kind at risk - Communications, logistics, approvals, coordination Current role: Continuing as per investment to date</p>

7.3.2. IEP LLC

The principal shareholder and lead developer for Project Phoenix is the private company International Electric Power LLC, a US privately owned company registered in Delaware in 2007. The company head office is located at 603 Stanwix Street, Suite 1825, in central Pittsburgh, Pennsylvania 15222 USA. This office houses a small (approximately 10 persons) management and project development team, which is developing projects in several countries including Haiti, Pakistan and the Philippines. Small teams are also employed or contracted in each project country. The total staff and contract team is in the order of 30 personnel.

The management team of IEP is also its principal shareholders. The key individuals and their IEP titles are listed below:

- Peter Dailey – Chief Executive Officer
- Enzo Zoratto - Chief Operating Officer
- Steven Adelkoff – Chief Financial Officer
- Nazoor Baig - Senior VP, Engineering and Power Operations
- Jim Crisanti - Senior VP, Project Development and Finance

The summary curriculum vitae of the IEP key staff submitted to UNEP indicates that the team collectively has very extensive energy sector experience. The majority of the experience is in the development and operation of large-scale fossil fuel power stations in the United States. Non-fossil fuel project experience is more limited but does include WtE, run of river hydropower, wind and geothermal projects. International project and professional experience includes Canada, United Kingdom, the Middle East, North Africa, Asia and the Pacific region.

Clearly the IEP management team has a strong personal track record in the power generation sector. Upon review of the profile of the team versus the project challenge, UNEP considers that the team is more than qualified on general power project development, but does have three clear gaps, each with mitigating factors:

- IEP itself has been operating for several years and has several projects under development but has not yet developed a non-US major power project to financial close. As such the performance of the IEP team (not the individuals) has yet to be fully tested and proven in the non-US market and the team has yet to secure new sources of revenue. In mitigation, it is clear that the IEP management team itself is very experienced and well funded by private equity. As such it has been able to recruit experienced people, initiate projects and develop the organization for several years, without recourse to operating project revenue – i.e. it apparently has its own patient capital.
- IEP does not have general WM experience and relatively limited municipal WtE experience. This is mitigated by the presence of Ros Roca in the Phoenix consortium (see below).
- IEP does not have extensive fragile state experience or experience in dealing with the development sector including development banks. This experience gap is in part reflected in the current issues faced by IEP in Haiti. In mitigation, IEP is now gaining experience rapidly, in Haiti and other countries.

7.3.3. The Project Phoenix development and implementation consortium

IEP proposes to implement Project Phoenix as a public-private partnership using a hybrid consortium – subcontracting model. IEP LLC is the clear project lead, however a number of partner organizations have also invested or propose to invest at risk and so have a more senior role than simple subcontracting.

As per the discussion on procurement, IEP proposes to tender multiple components of the capital works. As such not all project partners are selected and there also may be some changes in the organization as the project evolves. The organizational analysis is limited to the following ten partners already nominated by IEP:

International companies

- Ros Roca SA
- WS Atkins plc
- ICA Fluor
- dck Worldwide LLC
- Mott MacDonald Group, including PF Engineers
- Jones Day

Haitian companies

- Boucard Pest Control & Sanitation SA/Boucard Waste Management SA
- Cabinet Lissade
- Arcotec Construction SA
- Truxton SA

Note that UNEP has not asked for or seen any of the 1-1 agreements between IEP and its proposed partner organizations.

Ros Roca The Spain-based multinational firm Ros Roca is probably the most important partner in the consortium. Ros Roca is a 60-year old firm with 25 branches in Europe and four branches elsewhere. The firm has a very extensive environmental engineering, WM and WtE portfolio, covering both incineration and anaerobic systems. The firm focuses on whole project delivery, including equipment provision, services and facility construction and management. Hence it could be classed as both a primary/lead contractor and a specialist subcontractor/supplier. (<http://www.rosroca.com>)

The proposed role for Ros Roca is leadership and practical implementation of the WM components – collection, treatment and disposal. Based upon its organizational profile and technical work already delivered, Ros Roca appears fully capable of delivering in its proposed role.

WS Atkins plc The UK-based multinational consulting firm Atkins is another key partner, with a broad ranging project management and technical support role, including for example the EIA process. Atkins is a 70-year old consulting and service company with currently over 17,000 staff in over 80 offices worldwide. It has particular strengths in the design and project management of large infrastructure projects. (<http://www.atkinsglobal.com>)

The proposed role for Atkins is detailed project management from financial close to commissioning. Based upon its organizational profile and technical work already delivered, Atkins appears fully capable of delivering in its proposed role.

ICA Fluor is a multi national EPCM (Engineering, Procurement, Construction, Management) and project management company. The company – the result of a joint venture between Fluor and ICA Industries - has very strong experience in energy and infrastructure project construction. (<http://www.fluor.com>)

The proposed role for Fluor is EPCM contractor for the central facility, including the WtE and WM systems. Based upon its organizational profile, Fluor appears fully capable of delivering in its proposed role.

dck Worldwide LLC dck is a multi-national construction company, with headquarters in Pittsburgh, Pennsylvania, USA. The firm is over 85 years old and has 1,800 employees. (<http://www.dckww.com>)

The proposed role for dck is construction management working under the EPCM contractor. To date dck have provided cost engineering services to IEP LLC. Based upon its organizational profile, dck appears fully capable of delivering in its proposed role.

Mott Macdonald including PF Engineers Mott MacDonald is an employee-owned, multinational technical consultancy. It has 50 offices and over 14,000 employees. It has a particularly strong track record in water and WM. (<http://www.mottmac.com>). PF Engineers is a small USA based technical consulting firm specializing in independent engineering services for power generation and industrial process projects. (<http://www.pfengineers.com>)

The proposed role of Mott MacDonald and PF Engineers is technical lead on the design and commissioning of the WtE facility. Based upon their organizational profiles, the two companies appear fully capable of delivering in their proposed roles.

Jones Day is a multinational legal firm with more than 2,400 attorneys. Its principal focus is commercial law, including project financing and acquisitions.

The proposed role of Jones Day is providing legal services to the project, with a focus on the financial close operations. Based upon its organizational profile, the firm appears fully capable of delivering in its proposed role. (<http://www.jonesday.com>)

Boucard Pest Control and Sanitation SA/Boucard Waste Management SA Boucard is a Haitian national company specializing in waste collection and sanitation, which was formed in 2007 from another firm, with a total track record of 20 years. The firm currently has approximately 120 employees.

The proposed role for Boucard is waste collection and a major expansion of the firm. Specifically Boucard would manage and operate the fleet of vehicles provided by the project. The proposal includes for the supply of approximately 120 waste collection vehicles and recruitment of approximately 800 new staff. Boucard will be technically supported by Ros Roca. Based upon its organizational profile, Boucard appears to be potentially capable of delivering in its proposed role – if given adequate technical and financial support.

Cabinet Lissade Cabinet Lissade is a Haitian law firm established in 1977. It has 14 attorneys and a broad ranging legal portfolio. (<http://www.lissadelaw.com/english.htm>)

The ongoing role for Cabinet Lissade is to provide legal services for the project. Based upon its organizational profile, the firm appears fully capable of delivering in this role.

Arcotec Construction SA. Arcotec is a Haitian construction company established in the 1990s. The company has over 1,200 employees and broad experience in general construction in Haiti, including multistory commercial buildings. (<http://www.arcotechaiti.com>)

The proposed role for Arcotec is civil works construction, working under the EPCM contractor. Based upon its organizational profile, the firm appears fully capable of delivering in this role.

Truxton SA Truxton SA was founded in 1990 with primary operations in construction and the production of construction materials.

Aside from the strength of the individual members of the consortium, UNEP notes two areas of concern:

- The small size of the IEP team means that it outsources virtually all technical work. It is therefore very heavily reliant on the input of its consortium partners. The shortcomings of this approach were noted in the review process, where different consortium members held key material remote from the IEP offices and design coordination was a clear challenge.

- This is a new consortium, with negligible prior experience of working together. Several of the consortium members are working at financial risk and their tolerance of risk and patience is expected to be variable. In this context, the very extended schedule of project development has undoubtedly resulted in some pressure testing for the consortium.

7.4. Project equity investment and financial capacity

7.4.1. Project development equity requirements

The financing of Project Phoenix is based upon a combination of equity and non-recourse project financing. Project financing typically starts to inject funds only upon the project reaching the milestone of financial close: the near simultaneous execution of a number of key agreements, including loan agreement(s), final government approvals and EPCM contracts/heads of terms.

Until this point, development of the project needs to be financed by the development consortium itself, via equity or corporate finance as appropriate. In addition, non-recourse financing typically does not exceed 80 percent of the capital cost of the project, so there is a funding gap that still needs to be filled via equity, corporate finance or mezzanine debt.

The current Project Phoenix budget is in the order of US\$300 million, so the 20 percent+ funding gap is in the order of US\$60 million.

In this context the Project Phoenix consortium needs to be able to access substantial equity and/or corporate finance in order to develop the project. In particular it needs to fully finance the pre-construction development activities. As a relatively new and small company, IEP LLC will not have access to large scale corporate finance or stable revenue streams from operating plants, so it will need to rely on shareholder equity and other sources of finance.

7.4.2. IEP and partner investments to date

UNEP has not investigated in detail the financial status of IEP and its capacity to invest equity or secure other types of finance besides the project finance. Hence it cannot provide a definitive judgment on this important issue. There is some indication however from the project development history that IEP does have the access to shareholder funds and other forms of finance to continue to develop the project.

In response to a written UNEP query, IEP replied that the Phoenix consortium expended an estimated US\$7.585 million in project development from May 2010 to June 2012. The response included a table detailing the costs incurred by each partner. Much of this work has been undertaken by both international and Haitian project partners on an “at risk” basis, i.e. the partners will only be paid for the work if the project secures financial close, otherwise that expenditure will have to be written off.

As detailed in Chapters 4 and 9, it is clear that substantive project development work has actually been carried out, so this is real rather than potential expenditure. In November 2013, the CEO of IEP stated that IEP itself had spent US\$2.3 million in project development, with the balance spent by partners as both cash and booked staff time.

UNEP has not verified the IEP statement, but does note that a) early project development costs for a complex and large engineering project can range from 1 percent to 3 percent of the capital cost and b) detailed development and project management can range from 5 percent to over 10 percent of the capital cost. Hence for a capital cost of \$300 million, early development may cost in the order of US\$3

to US\$9 million and detailed development and project management may cost US\$15 to over US\$30 million. So the early indications are that the IEP estimate is high, but of the appropriate general scale.

7.4.3. Capacity for ongoing investment in project development

Early indications are that the project will need to invest up to US\$15 million (including land values) before it can secure full scale project financing. Submissions from IEP indicate that the Phoenix consortium has already invested several million in project development. Finally, basic assessments of the implementing consortium indicates that they have very substantial financial resources – which they may or may not employ at risk in further development of this project.

This is a very good indication, but not a guarantee, that the consortium will be able to find the remaining funds to fill the gap prior to securing project financing.

7.5. Project financiers

7.5.1. The role of project financiers

The Phoenix consortium proposes to use development bank project financing. At this early stage, the lead and subordinate banks or agencies have yet to be formally selected, although IEP has been consulting with potential financiers since 2010.

IEP has indicated that OPIC is the preferred lead financier. IEP has secured a non-binding letter of interest from OPIC but has yet to commence any formal due diligence process. UNEP met with OPIC in January 2013 and the IEP and OPIC statements match.

7.5.2. OPIC

OPIC is the development finance institution of the USA government and was established in 1971. OPIC is designed to support the advance of USA government policies and can only support USA companies in international project development. It has supported more than US\$200 billion in investment since its establishment. Please refer to <http://www.opic.gov> for further information.

The main products and services of OPIC relevant to Phoenix are financial services and political risk insurance. It provides loans and/or loan guarantees of up to US\$250 million per project. Political risk insurance is available for qualifying development projects in high-risk countries. OPIC also works with the IFC, the WB, and other multi-national banks to share risk and tackle large projects.

Hence OPIC is clearly a very strong organization and capable of delivering in its proposed role.

7.6. Assessment summary

The project organization	
A. Organizational structure and shareholding	The consortium shareholding and structure is clear. Shareholding includes national content and 10 percent government ownership.
B. Lead developer capacity and focus	Very strong capacity in general power project entrepreneurship and core business focus. Three clear experience gaps noted, which are partly mitigated through the consortium partners and evolving experience.
B. Project Phoenix development and implementation consortium composition, capacity and coherence	A strong consortium with a full project development skill set and appropriate Haitian national content and roles. However IEP relies very heavily on outsourcing and the extended project development schedule has probably stress tested the cohesion of the consortium.
A. Project consortium investment to date	The consortium has clearly already invested several million in equity and finance in project development. UNEP has not verified whether or not the consortium has the means to continue to fund development until financial close and/or cover remaining funding gaps.
B. Project consortium capacity to finance further project development	There are reasonable indications that the consortium will be able to finance further project development prior to securing project finance.
B. Project financiers	Discussions with potential project financiers have been started and the current preferred financier (OPIC) is a very strong USA government-backed organization.

8. Stakeholder engagement and transparency

8.1. Introduction

8.1.1. Scope of the assessment

This chapter presents an assessment of the transparency of the project development process and the engagement of key national and international stakeholders.

Phoenix is a major long-term project that will impact over 3 million people for up to 30 years, in a country where insufficient local stakeholder engagement is a recurring problem. As such a high level of transparency and stakeholder engagement is warranted.

8.1.2. Benchmarks and standards

There is no Haitian national legislation specifically on transparency and key stakeholder engagement. The most relevant legislation is linked to public sector procurement, an issue covered in Chapter 3.

UNEP has drawn on five international sources to assess the performance of Project Phoenix against relevant standards and best practice guidelines in transparency and stakeholder engagement:

- Accountability AA1000 Stakeholder Engagement Standard 2011 – Final Draft ^(8.1).
- IFC Performance Standards on Environmental and Social Sustainability 2012^(8.2).
- IFC Stakeholder Engagement – A good practice handbook for companies doing business in emerging markets^(8.3).
- OPIC Environmental and Social Policy Statement – which contains statements defining meaningful consultation with groups and communities within a project's area of influence as well as accountability standards^(8.4).
- UN Office of the High Commission on Human Rights Guiding Principles on Business and Human Rights 2011^(8.5).

8.2. Phoenix stakeholder consultation and engagement

8.2.1. The general approach of Phoenix to stakeholder engagement

From UNEP observation and enquiry, the Project Phoenix consortium has invested substantially in stakeholder engagement within Haiti. Much of the effort has been aimed at high-level decision-makers, however the Phoenix consortium has also undertaken field level consultation and engagement activities^(8.6). The noted modes of engagement include:

- Multiple 1-1 and small group meetings with high level decision-makers;
- Posting information on the IEP website, including moderately detailed PowerPoint presentations of the core features of the project;
- Press releases;
- Local stakeholder site visits and meetings.

8.2.2. Local stakeholder engagement

The Phoenix team reported on their local stakeholder engagement activities for four main sites/sectors:

The proposed WtE site at Aubry Site visits confirmed that the site is GoH land. There are apparently a low number (less than 10 families) of squatters on the site. The neighboring sites are more vacant land, a cement plant and a coastal village with surrounding artisanal agriculture associated with the transient stream.

Truitier landfill waste-picking community The Phoenix team met with the waste-picking community at Truitier and also trained and hired 20 workers for the Applus waste characterization study^(8.7). The Phoenix consortium reports that the majority of waste-pickers were very positive about moving from their current situation to taking positions as waste sorters in the Phoenix plant (Phoenix has committed to hiring ex-Truitier waste-pickers to the extent practical).

Waste-pickers and recycling operations in PaP Phoenix has not engaged directly with the waste-pickers in PaP, but has engaged with the recycled material buyers – who purchase plastic, glass and metal from the pickers. Specifically on plastics, Phoenix proposes to work with a plastics buyer and recycler named Thread LLC. More information on the company can be found at <http://www.threadinternational.com>.

The Maissade lignite mine site The Phoenix team met with local residents and administration on two occasions in 2011. The precise number of families anticipated to be resettled has not been specified by Phoenix. Based upon satellite imagery UNEP estimates the number of households potentially affected to be in the order of 10 to 50.

The Phoenix team proposes to conduct a formal and comprehensive round of consultation within the SEIA (Social-Environmental Impact Assessment) process, which was started in 2012, but halted by Phoenix pending resolution of the international stakeholder issues.

8.2.3. National key stakeholder engagement

The Phoenix consortium has provided correspondence records to UNEP, which indicate a relatively comprehensive process of engagement by Phoenix management with the political leadership of Haiti and the leadership of the relevant agencies of EDH and SMCRS. This process was hampered by personnel changes in the GoH and variable levels of support and access for the project.

8.2.4. International stakeholder engagement

Phoenix correspondence records indicate a relatively comprehensive process of attempted engagement by Phoenix management with key international stakeholders including the governments of USA and Spain, the development banks (IDB and the WB) and the UN.

As interpreted by UNEP, this engagement was only partially successful for two reasons:

- Insufficient support and organization from the GoH meant that in many cases, Phoenix was left on its own to attempt to engage with international stakeholders. These stakeholders in many cases prefer not to engage with individual private companies in the absence of the national government and an organized liaison process.
- After initial contact and analyses, several stakeholders did not support or were not comfortable with Project Phoenix and so declined further substantive engagement (see below).

8.3. Stakeholder feedback and positions

8.3.1. National key stakeholders

At the national level UNEP has consulted only with the GoH and so cannot report independently on the position of non-governmental national and local stakeholders. GoH feedback to UNEP is reported in Chapter 6. In summary, the feedback was overall positive, but declined after Q2 2012 due to a lack of project progress.

8.3.2. International stakeholders

At the international level UNEP has consulted with many key multilateral and bilateral organizations active in Haiti in order to gain an understanding of their respective positions on the Phoenix project. Both direct enquiries and background email correspondence linked to a stakeholder meeting held in Washington DC in April 2012 indicated that opinions on the project were sharply divided, with some clear signals of a lack of support from some organizations.

In this context, UNEP convened a meeting in Washington DC on 15 February 2013 to discuss the project and research the position of the following key stakeholders: the Government of USA, the Government of Spain, the WB and the IDB. As agreed the meeting was not minuted, however it was clear that opinions on the project were sharply divided and multiple stakeholders had multiple concerns. During the meeting UNEP distributed a request for follow up to each organization with a focus on determining the extent and rationale for any opposition to the project.

On 8 May 2013, a representative of the State Department of the Government of USA emailed UNEP a short statement on behalf of the State Department, the WB and the IDB. The statement is unsigned, undated and without letterhead, however UNEP considers that it is the valid presentation of the agreed and combined views of the three organizations at that time. For clarity, the entire statement is reproduced below in italics:

Joint donor statement on Phoenix project
May 8, 2013

- **Context:** Donor support from public sources to the Haiti Energy sector is primarily oriented towards: (i) the sustainable rehabilitation of sector infrastructure; (ii) the modernization and financial viability of the state power company EDH; and (iii) the strengthening of the capacity of Haitian institutions to manage the energy sector within a competitive and transparent market. The objective of this support is to improve the health of the sector in order to expand access, ensure financial viability, and attract private investment.
- **Power Sector status:** The major issues facing the power sector today include: the absence of a coherent and comprehensive energy policy, poor overall governance of the energy sector resulting in high costs, and the lack of commercial viability of EDH (losses currently around 60%). Resources are available to support the development of a strong energy policy and GOH has taken encouraging first steps to improve the governance of the sector. Also, management reforms are underway at EDH and need to continue to ensure the company's return to commercial viability. These include performance improvement in billing and collection; metering and payment of large customers; and investments to strengthen a weak distribution system and reduce technical losses. EDH may also need to reassess its demand and tariff structure to ensure sustainability of the sector. EDH's primary goal for the next several years should be to improve its operations and reduce system losses with any new capacity additions based least cost options, and sustainability analyses.
- **Principles:** In light of the fragility of the power sector, future growth in generation capacity should be based on least-cost planning, realistic and sustainable demand projections, and sequenced so as to minimize financial impacts of new commitments to buy from generators on EDH and on the economy. The procurement of such generation should seek to minimize its cost to the Haitian State (i.e. be competitively procured) and be consistent with Haitian law.
- **Solid Waste Sector Status:** Donors recognize that waste collection, disposal, and treatment are a priority for Haiti. They believe WM projects must be evaluated on their own merits and effectiveness, and recommend that Government also seek least-cost solutions in the WM sector. The major solid waste issues facing the Port-au-Prince area include low collection rates, inadequate disposal facilities, and social issues involving informal recyclers at the Truitier site.

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- **Electricity generation:** Donors are committed to supporting a more viable power sector, which includes defining and supporting sustainable and responsible expansion in generation capacity. However, donors do not consider that the Phoenix Project meets the criteria set out for capacity expansion above. Donors believe the choices made by GOH with regard to waste collection and processing should not undermine its least cost objectives in the context of energy capacity expansion. Donors are ready to assist GOH in procuring new generation, transmission, and distribution, based on robust planning studies, prudent sequencing of capacity expansion, and transparent and competitive procurement processes.

Understanding of the Power Sector Dialogue: The principles of least-cost planning and appropriate sequencing of additional generation lie at the heart of donors' commitment to provide and continue to provide financial support to the power sector, and notably to EDH. Such an approach is necessary to provide a sound basis for future expansion, to encourage private investment in the sector, and to achieve GOH's goals of achieving a robust and financially sustainable sector and modernizing the sector, as foreseen by the CMEP law. [end of statement]

This statement of course pre-dates this report and major changes to both Project Phoenix and the Haitian national context. Hence the position of these stakeholders may have changed in the interim and/or may change upon receipt of this report. However as of January 2014, these views are interpreted by UNEP as remaining in force, pending the release of the UNEP report and/or changes in the fundamental plans and issues of concern.

8.3.3. The material impact of key international stakeholder views

The negative position of the three key international stakeholders has two material and direct impacts upon the feasibility of Project Phoenix:

1. GoH support As of October 2013, the GoH remains highly dependent upon donor governments including the USA and the development banks such as the WB and the IDB to part finance the ongoing deficit in its operations and the ongoing post-earthquake reconstruction programme. A donor instrument of importance to the GoH is direct budgetary support. The organizations currently providing direct budgetary support to the GoH include the WB, the IDB and the Government of USA. From 2010 to 2012 budget support totaled US\$2,898 million, although it has shrunk dramatically each year and in 2012 was only US\$27.2 million^(8.8).

This type of financing is voluntary and can be reduced or withdrawn at donor discretion. As such, the GoH normally consults with its multilateral and bilateral donors on major financial decisions and is heavily influenced by the feedback provided. From UNEP consultations with the GoH the feedback provided by the US Department of State, the WB and the IDB clearly has influenced its position. Its early support of Project Phoenix has eroded given the potential consequences and it is now uncertain as to the appropriate way forward, hence the request to UNEP for TA.

2. Access to development financing. As set out in Chapter 2 the financial viability of Project Phoenix is fully dependent upon access to private sector development bank-led project financing for up to 70 percent or more of the capital cost. This form of financing is very low cost compared to the commercial lending market. It also provides a form of risk reduction to junior financing partners, allowing for more risk-averse financial institutions to help fill any remaining financing gaps.

The negative positions of the US Department of State, the WB and the IDB will have a significant influence on the three largest multilateral and bilateral private sector development banks active in the Caribbean region. Each of the former organizations is closely associated with one such bank as follows:

- The Department of State and OPIC are both part of the Government of USA.
- The WB (specifically the International Bank for Reconstruction and Development) and the IFC are both part of the World Bank Group.
- The IDB and the Inter American Investment Corporation are both part of the IDB Group.

The charters of these organizations are different, but there are nonetheless clear and strong organizational linkages in all three cases. Hence the stated negative positions of the US Department of State, the WB and the IDB materially reduce the potential for Project Phoenix to secure low cost project financing.

UNEP considers that as a result of the above impacts, Project Phoenix is not feasible unless the noted concerns listed in the donor statement are resolved – irrespective of UNEP views or the quality or otherwise of the project including its compliance with Haitian law. Even full GoH approval and support will not resolve this as project financing decisions are outside of their control.

8.4. Transparency and corruption prevention

8.4.1. Transparency

The assessment of UNEP in this review is that IEP and its private sector partners have acted with a high and commendable degree of transparency, but overall the process was flawed.

The key flaw noted was that independent oversight of the negotiating parties and record taking only started very late and in a limited manner, with the appointment of UNEP as an independent reviewer.

UNEP cannot work retrospectively, so the record of the early development of Project Phoenix is now based almost solely on IEP and GoH records.

IEP provided UNEP with a very extensive electronic and hard copy record of its correspondence with virtually all of its key stakeholders including the Governments of Haiti, USA and Spain, the WB, the IFC, the IDB, the IHRC and the UN. IEP has also responded positively and in detail to the numerous queries presented by UNEP in the course of the review.

To date UNEP counts over 100 messages and files provided. The notes include full correspondence chains with many key project stakeholders. What has remained out of UNEP view is the correspondence between IEP and the members of the Phoenix consortium – however this is to be expected given the commercial confidentiality issues involved.

The GoH position is mixed but overall only moderately transparent. In the course of the review, UNEP has sought the views of CNMP, SMCRS, EDH and the Minister Delegate for Energy Security. Informal enquiries to CNMP confirmed that this organization was not formally engaged in the Phoenix procurement process. The latter parties were willing to discuss the project and present views.

The principal gap in transparency on the GoH side is linked to coordination and project record management – essentially it appears that IEP and its commercial partners kept detailed and organized records but the GoH did not. This appears to be more an issue of competence, limited motivation and resources rather than a deliberate approach to reduce transparency.

In summary, the key and irresolvable flaw with respect to transparency was the lack of independent and documented oversight at the early stages – which is important given the sole source procurement issues noted in Chapter 3 and the corruption prevention issues noted below. A lack of adequate government record keeping has not assisted in this respect.

8.4.2. Corrupt prevention

The potential for corrupt practices in large-scale public procurement in developing countries is a well acknowledged risk. Haiti is rated as 165 out of 176 in the Transparency International Corruption Perceptions Index edition 2012 (176 is the worst)^(8.9). In the case of Phoenix, these risks were and are real and visible.

The senior management of Phoenix reported in writing and verbally to UNEP that GoH officials had attempted to coerce IEP and its partners into malpractice a minimum of 12 times during the early development period of the project in 2010. In contrast, since the Martelly administration has taken control, IEP has not received any overtures for payment from government officials.

IEP is to be commended for clearly speaking out to UNEP regarding these practices. These reports of attempted corrupt practices are nonetheless damaging, as they undermine external stakeholder confidence in the project as a legitimate venture. Whilst UNEP has not found any obvious evidence that the corruption attempts were successful, in the absence of a fully auditable and transparent process, there is now no way of ever confirming this in retrospect.

In mitigation of these damaging findings, UNEP notes four important points:

- Each case needs to be considered on its individual merits. This is an apparent but non-validated case of public disclosure by the private sector of unsuccessful attempts by government officials to corrupt the private sector.
- IEP and GoH preliminary agreements are now signed, however there has to date been no government expenditure, only private sector expenditure at risk.
- The project is not yet fully launched. The proposed renegotiation process provides an important window of opportunity for improvement.
- Corrupt practices can be linked to both sole source and competitively bid projects – the latter process by itself provides no guarantee of probity, it simply reduces the risk and forces corrupt parties to attempt other tactics.

8.5. Findings summary

Stakeholder engagement and transparency	
B. International stakeholder engagement	Substantive efforts have been made in international stakeholder engagement, but clearly more needs to be done.
D. Key international stakeholder feedback and positions	Three key international organizations have stated their concerns in writing. This action has eroded GoH support and indirectly blocked access to low cost project financing. UNEP considers that as a result Project Phoenix is not feasible unless these concerns are resolved.
C. Transparency during project development	The level of transparency displayed during project development has been insufficient, principally on the side of the GoH. This deficiency has been exacerbated by limited correspondence and poor record keeping by the GoH.
D. Corruption prevention	Cases of attempted corruption have already been reported by IEP and at present no mechanisms are in place to prevent further occurrences.
D. Independent oversight	Independent oversight of the project development process has been lacking, due to the non-involvement of the CNMP and the absence of an independent international counterpart.

8.6. Chapter references

8.1 Accountability AA1000 Stakeholder Engagement Standard 2011 – Final Draft <http://www.accountability.org/images/content/3/6/362/AA1000SES%202010%20PRINT.PDF>

8.2 IFC Performance Standards on Environmental and Social Sustainability 2012 http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/publications/publications_handbook_pps

8.3 IFC Stakeholder Engagement – A good practice handbook for companies doing business in emerging markets

http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/publications/publications_handbook_stakeholderengagement__wci__1319577185063

8.4 OPIC Environmental and Social Policy Statement

http://www.opic.gov/sites/default/files/consolidated_esps.pdf

8.5 UN Office of the High Commission on Human Rights Guiding Principles on Business and Human Rights (2011)

http://www.ohchr.org/Documents/Publications/GuidingPrinciplesBusinessHR_EN.pdf

8.6 IEP (2014). Stakeholder Engagement and Transparency Information for Project Phoenix

8.7 Applus (2011). “Characterization of waste in Truitier landfill, Port-au-Prince Haiti.”.

8.8 Office of the Special Envoy for Haiti (2012). “Can more aid stay in Haiti and other fragile settings?”

8.9 Transparency International Corruption Perceptions Index edition 2012

<http://www.transparency.org/cpi2012/results>

9. Greenhouse gas emissions and climate funding

9.1. Introduction

9.1.1. An issue and funding opportunity

The greenhouse gas (GHG) emissions from both the current WM situation in Haiti and Project Phoenix represent both an issue and a climate change funding opportunity.

In general WtE projects have positive GHG impacts due to the replacement of fossil fuels and the avoidance of methane emissions from un-managed landfills. Phoenix is overall more complex due to the proposed dual fuel system.

9.1.2. Phoenix treatment of GHG emission issues

In theory, Project Phoenix should qualify for climate change funding related to its projected reduction in GHG emissions. In practice this is a complex area and low carbon prices, high transaction costs and uncertainty may preclude this.

The 2010 and 2011 plans for Project Phoenix^(9.1) included securing Certified Emission Reduction certificates as an important source of revenue. When the carbon market collapsed in 2011 this component of the project was dropped. At present Phoenix assumes zero revenue from climate funding sources and has not developed an updated GHG emissions forecast.

9.1.3. The UNEP analysis

UNEP has undertaken its own analysis of both GHG emissions and the potential for climate change funding and integrated its findings into the report in the following manner:

- The GHG baseline and general discussion points are presented in this chapter.
- The GHG emissions for each project component are presented in Chapters 11 to 16.
- A further analysis of project GHG emissions and climate funding is integrated into Chapter 17.
- GHG model summaries and associated detailed references are presented as Annex G.

The analysis uses both Clean Development Mechanism (CDM) and voluntary carbon market references. The forecast GHG emissions for the status quo and the project components must all be regarded with some caution, given the limitations on both the current data and the validity of extrapolation. Nonetheless, similar assumptions and industry standard parameters have been used to generate the forecasts, so it is valid to compare the forecasts to each other, even if the absolute values have low inherent accuracy.

9.2. GHG emissions without the project

9.2.1. Waste management GHG emission model

The WM sector in the catchment area of Project Phoenix is currently a significant emitter of GHGs. In the absence of corrective action these emissions will grow over time in line with the quantity of generated waste.

The key input parameters and assumptions used for the baseline are as follows:

- UNEP waste characteristics survey are used.
- Current waste generation rate is estimated at 2,000 TPD, rising at 2.5 percent per annum to a maximum of 4,100 TPD after 30 years. The model average generation rate used is 2,900 TPD.
- 50 percent (1,450 TPD) of the total quantity of waste generated is collected and transported to Truitier.
- 50 percent (1,450 TPD) is not collected and is either burnt in an uncontrolled manner or decays via a combination of aerobic and anaerobic processes. The fate of each component depends upon its characteristics. Organic matter is assumed to decay 20 percent via anaerobic processes and 80 percent via aerobic processes. Wood is assumed to decay 50 percent via aerobic processes and for the remaining 50 percent to be burnt. Plastics are assumed to be 50 percent burnt and 50 percent recycled.
- Truitier is assumed to be a deep landfill and Intergovernmental Panel on Climate Change (IPCC) default parameters are used.
- Ongoing decay of waste already deposited in Truitier is included.
- The decay process is assumed to run to completion for all waste from all years.
- The anaerobic GHG of concern is methane CH₄ and the burning GHGs of concern are CO₂ and N₂O.
- The physical process of collecting waste also generates GHG emissions, particularly from diesel fuel consumption. A non-optimized (inefficient) route is assumed, which generates an estimate of 1.264 million truck km per annum.
- Black carbon emissions and impacts are ignored due to a lack of data and robust parameters.

Decay of waste is a long-term and variable process so forecasts of GHG emissions per tonne of waste are limited in accuracy. In addition, as discussed in Chapter 6, waste generation and collection tonnage estimates and forecasts for Haiti are clouded with uncertainty.

9.2.2. Power generation GHG model – standby generators

Project Phoenix will burn waste and potentially lignite or black coal to generate electricity. The simplest base case is that this is only extra generation – not replacement and the GHG power generation base case is therefore zero. However Haiti electricity sector research and policy reports^(9.2) indicate that there is up to 200MW of suppressed demand, which is currently serviced by self-generation by business and some residences.

The dominant form of self-generation is the ad hoc use of diesel-powered standby generators, which generally cost more to operate than EDH grid supplies. Hence if Phoenix was able to boost EDH supplies and increase its reliability, there is the strong probability that the need for self-generation would be reduced. In this context an extra 30MW to 50MW of power from Phoenix is forecast to replace approximately 25MW of self-generation.

9.2.3. GHG model results

Using the United Nations Framework Convention on Climate Change (UNFCCC) and other credible references combined with engineering judgment, the no-project baseline for GHG emissions is roughly estimated at 18.4 million tonnes CO₂ equivalent over the 30-year life of the facility. The dominant inputs to this figure are anaerobic decay of waste and the use of standby generators. The level of accuracy of this estimate is considered to be no better than +/- 30 percent.

9.3. Climate funding

9.3.1. Potential emission reductions eligible for mitigation funding

Climate change mitigation (CCM) or carbon market funding for energy and infrastructure projects are targeted at GHG emissions relative to the no-project baseline. For the current design of Project Phoenix the potential CCM funding avenues relate to the following:

- Stopping ongoing methane production from the decay of waste deposited in future in Truitier.
- Reducing N₂O generation through reducing open waste burning.
- Replacing electricity generated by diesel engines with electricity generated from waste combustion.

A further avenue for CCM funding is stopping methane production from waste already deposited in Truitier. This would however require an expansion of scope for Project Phoenix to properly close Truitier and operate a methane gas capture system for up to 30 years.

Assuming that the Truitier landfill was started in 1990, has received on average 900 TPD of municipal solid waste and closes in 2015, UNEP's preliminary calculation gives an estimate of 1.3M tCO₂e emission reductions over a 30-year period (2015-2045) from methane capture starting from year 2015. The gas could be simply flared or used to generate power.

Both the compliant and voluntary markets have methodologies for such projects (e.g. CDM ACM0001 large-scale methodology "Flaring or use of landfill gas")^(9.2). Their relative lack of complexity and obvious additionality led to numerous projects registrations in recent years (226 registered CDM projects for ACM0001 as of May 2014, including in DRC, Nigeria, Cameroon and Iran).

9.3.2. CDM carbon market status and pricing 2014

As of January 2014, the global carbon markets are in a state of flux following the severe price crash for Certified Emission Reduction certificates (CERs) over the period 2010 - 2013. The price crash and regulatory changes together with uncertainty regarding the global policy framework post Kyoto 2015 means that the creation of new CDM projects essentially stopped in 2013. Some financial analysts ^(9.3) forecast that the CDM-linked market itself may break down or close to new entrants before 2015. CER prices in January 2014 were in the order of US\$0.50/tonne ^(9.4).

UNEP estimates that the transaction costs for CER application and certification for Phoenix would exceed US\$500,000 over the life of the project.

9.3.3. CDM Project eligibility

Eligibility for CDM standard carbon market funding is a difficult issue for Project Phoenix.

A number of real CC mitigation impacts of the project would not be eligible for CDM standard carbon credits simply due to the CDM regulations. This includes the replacement effect of Phoenix on the use of standby generators.

The principle of additionality is key for the Clean Development Mechanism and major voluntary carbon standards. In summary of the principle for CDM, carbon credits can be used to provide financial support to a project that otherwise would not be economically viable. In theory they cannot be used to make a viable project more profitable.

A desk review of approved CDM projects indicated that the median change in project IRR resulting from CDM standard Certified Emission Reductions, ranged from 2.2 to 19.4 percent ^(9.5). The strongest changes in IRR were associated with landfill gas, biogas and biomass energy projects.

Hence CDM-standard carbon market funding eligibility for Phoenix depends upon the project being marginally uneconomic. If it is demonstrably viable without support, it will not be eligible. If it is very uneconomic then the relatively low levels of income currently possible through carbon credits will not be sufficient to support the project.

The issue of what qualifies as viable without CDM support is unfortunately also unclear. Literature research indicates reported IRRs ranging from 8 percent to 15.6 percent - in non fragile states ^(9.6).

With this highly negative background, the rationale for currently pursuing CER certification appears questionable.

As discussed in Chapter 10, Project Phoenix may indeed be uneconomic with the current business case. As such it would be rational to re-assess the potential for carbon market financing in the event project development is re-started – and if the health of the CDM carbon market improves significantly.

9.3.4. Voluntary carbon markets

The national and voluntary carbon markets in contrast are in an overall much better condition than the CDM CER market. In addition voluntary schemes commonly have more adaptable criteria than CDM.

There are several schemes or different standards in operation and catering for different types of projects in different countries. The weighted average voluntary credit price in 2013 was \$US5.9 per tonne^(9.7). Prices are nonetheless currently very low for projects that do not also exhibit strong co-benefits. Current Voluntary Carbon Standard transactions are in the order of US\$0.70 – US\$1.50 per tonne, whilst Gold Standard (a standard focusing on strong environmental and social safeguards and benefits) prices were in the order of US\$4 – US\$5 per tonne ^(9.8).

With this price and process differential, it is clear that:

- Phoenix should first review the potential voluntary carbon market before CDM.
- Irrespective of the scheme selected, carbon funding is anticipated to have only a relatively small positive impact on the economic viability of Project Phoenix.

9.4. Findings summary

GHG emissions and climate funding	
A. GHG emissions	The project footprint is not climate neutral but is considered very efficient in terms of benefits/kg of GHG emissions.
B. Climate funding	The high GHG emissions associated with the status quo indicate scope for investment in emissions reduction and securing carbon credit funding. However the purely economic case for such investment currently appears very weak due to technical eligibility issues and very low carbon trading prices.

9.5. Chapter references

9.1 IEP website August 2011. Project Summary. Public information package

9.2 UNFCCC CDM ACM0001 large-scale methodology - Flaring or use of landfill gas
<http://cdm.unfccc.int/methodologies/DB/D44X8FH8SFCXREE6037AXJSBGGFVDO>

9.3 CDC Climat Research. Climate Brief. 2012

9.4 Quandl Website 7 Feb 2014. CER Emissions Futures
<http://www.quandl.com/futures/cer-emissions-futures>

9.5 Au Yong, H.W 2009. Technical Paper. Investment Additionality in the CDM

9.6 UNFCCC CDM Project Register
<http://cdm.unfccc.int/Projects/registered.html>

9.7 Ecosystem Marketplace 2014. Maneuvering the mosaic: State of Voluntary Carbon markets 2013
<http://www.forest-trends.org/vcm2013.php>

9.8 Carbon Trade Exchange 7 Feb 2014. VCS latest trades
<http://carbontradexchange.com/>

Further GHG model references are provided in the annex.

10.Economics

10.1.Introduction

10.1.1. Scope of the assessment

This chapter presents an assessment of the economics of the project, including an evaluation of cost estimates, value, financial exposure and benefits, balance, affordability and financial risks. Virtually all of the analysis focuses on Scenario 2, which is the most cost efficient, the most technically robust and has the lowest negative social impact.

Phoenix provided UNEP with a copy of its financial model, which is used as the basis for much of the analysis. In addition, for benchmarking purposes UNEP researched the capital and operating costs of WM, WtE and coal-fired energy projects undertaken in other countries. What was not done was a bottom up building of an independent cost model. Instead UNEP utilized collated figures from industry literature.

As a general note, any economic assessment within Haiti needs to take into account a wide range of nationally specific issues including: the small size of the economy, the somewhat limited level of development, the important role of humanitarian and development aid and the limited access to capital. What is applicable in the USA for example, is not necessarily applicable in Haiti.

10.1.2. Financial scale and complexity of the project

When compared to WtE projects in Europe and the USA, Phoenix is a medium scale project. When compared to the global average for project finance, Phoenix is also only a medium size project (the largest single project finance deal to date at the global level was in excess of US\$20 billion and had 32 participating lenders and guarantors)^(10.1). Hence no special analysis is required due to the size of the project – it may be large for Haiti, but it is not unusual on a global scale.

Phoenix is however a relatively complex project, due principally to its three interlinked components (coal/lignite, WM + WtE), proposed complex pricing/revenue structure and complex linkages with the State of Haiti via the MSA. The proposed project financing structure in contrast is relatively simple, with a single lead financier and limited mezzanine finance and equity.

The following table sets out the key financial parameters of the project for Scenario 2 – target cost, based upon the terms proposed in the IEP Best and Final Offer of January 2014 and the Phoenix Financial Model 50MW Imported Coal V 31 December 2013^(10.2). As such the figures will become obsolete, but nonetheless provide a useful sense of scale.

Capital cost: Estimated by IEP at US\$315 million, including a 10 percent contingency
Project development cost up to financial close: Estimated by UNEP at up to US\$10 million
Project and mezzanine finance: Proposed by IEP at US\$265 million
Private sector and GoH equity: Proposed by IEP at US\$61 million

Initial annual operating cost: Estimated by IEP at US\$35.8 million
Energy contract duration: Thirty years, with potential for extension
Energy production: 50MW operating at 65 percent annual average capacity = 285,000 MW hrs/year
Forecast annual capacity sales (non indexed): US\$38.175 million
Forecast annual energy sales (Year 1, indexed at 2 percent): US\$31.338 million
Forecast annual revenue from sales of recyclables not combusted: US\$4.604 million
Forecast Year 1 revenue: US\$74.117 million
Forecast 30-year PPA revenue excluding inflation index and recyclables: US\$2.085 billion
Shareholder target internal rate of return: Proposed by IEP – 21 percent
Government shareholding: 10 percent as agreed in the MSA (+50 percent revenue share for recyclables)

Table 10.1.2 Key project figures

10.2. Cost and return estimation

10.2.1. Impact and risk sharing of estimated costs

The revised IEP offer and the whole viability of the project are closely linked to the eventual capital and operational costs of the project. Whilst cost estimation and containment is generally an issue for the project developer to manage, it is also of concern to the GoH. A margin of error is always expected and tolerated for complex projects of this nature, however large differences between the estimated and actual costs of the project generally cause severe problems and can trigger project failure.

In this context, UNEP undertook its own independent cost estimation work, using IEP specifications and industry literature ^{(10.3), (10.4), (10.5) (10.6) (10.7) (10.8) (10.9)}. The results in summary are:

- Waste collection cost estimates are considered comparable.
- Waste processing capital and operating costs are very difficult to quantify and compare due to a current lack of definition on the proposed plant for Scenarios 1 and 2. IEP has allocated a capital cost of US\$9 million, which is considered by UNEP to be probably a slight under-estimate.
- Combustion plant capital cost estimates are not fully comparable. This is a topic where IEP and UNEP agree to disagree. The top-down research cost estimate results found by UNEP indicated a very wide range and the IEP estimates are near the bottom of the noted ranges and hence are considered non-conservative.

In detail, IEP estimate the capital cost of the 50MW power plant to be approximately US\$220 million, which corresponds to a cost/installed MW of US\$4.4 million. With contingencies this increases to a maximum of \$5.3 million per MW or US\$265 million.

The UNEP-sourced references which are based on power output indicate a very wide cost/installed range of MW of US\$3.6 to US\$8.3 million/MW (without contingencies). Applying this to the 50MW plant generates an estimated capital cost range of US\$180 to US\$415 million, a difference from Phoenix of -19 to +88 percent.

The UNEP-sourced references which are based on the WtE tonnage processed are all in costs including all on-site WM systems. The annual per tonne cost ranged very widely from US\$310 to US\$840. For the Phoenix facility this corresponds to a total facility cost range of US\$226 to US\$613 Million, a difference from Phoenix of -2 to +350 percent.

This extremely wide range of top-down cost estimates indicates that a strict comparison of top-down (UNEP approach) vs. a bottom up approach (IEP) is not possible. Instead an independent bottom up approach would be needed to develop a robust comparison. Nonetheless the fact that the IEP estimate is close to the bottom of a cost estimate range collated by UNEP from seven different sources indicates some cause for concern.

- Coal and lignite fuel costs are not considered fully comparable, due to differences in the estimated tonnage requirements (see Chapter 15). Both lignite and black coal are sourced at a relatively low cost and generate high levels of saleable energy so the impact of this difference is not considered critical.

10.2.2. Shareholder return and Levelized Cost of Energy estimations

IEP are basing their revised offer on the concept of a target Internal Rate of Return (IRR) of 21 percent. Given the very high-risk investment status of Haiti, an IRR of 20 percent to 25 percent is considered reasonable, if the investors are taking on the majority of the risk and are investing upfront. If the risk is transferred onto others and the upfront investment is limited, then an IRR in the range of 15 percent to 20 percent is more appropriate.

The impact of this high IRR on the economics of the project and the benefits to Haiti can be balanced by high leverage (a high debt:equity ratio). Development bank interest rates vary according to the project and country and can range from 2 percent to 10 percent. Even at the highest expected interest rate there are clear benefits to maximizing the project finance (debt) and minimizing the shareholder equity requirements. The GoH has a major role to play in this as an assessment of country risk is one of the main criteria used by development banks for loan approval.

At present however the IRR is only a target, with the actual rate of return dependent upon performance of the project during both construction and operation. At this stage, UNEP predicts that this IRR will not be met with the revised offer – returns are likely to be lower in practice.

UNEP has undertaken its own quick economic analysis, using the Levelized Cost of Energy (LCOE) approach. The LCOE for a project accounts for both capital and operating costs and also the cost of capital (interest on the loan). For a shareholder to secure a sustainable return the energy tariffs charged must exceed the LCOE.

UNEP forecast the LCOE for Scenario 2 to be in the range of US\$0.24 to US\$0.35 per kW/hr, using the key input parameters listed below.

	Capacity Factor	WtE Plant Capex	F u e l Efficiency	C o s t o f Capital %
Optimistic	85	200	90	5
Average	75	229	80	7
Pessimistic	65	260	70	10

Table 10.2.2 UNEP economic model – key variables

It is important to note the critical impact of the plant capacity factor and the cost of capital. In order to stay economic, the WtE plant needs to be built at the lower end of UNEP budget estimates (see

above) and operate at a high capacity. In addition the project needs access to low-cost development finance.

10.2.3. Climate change mitigation funding

At present Project Phoenix assumes zero revenue from CCM funding sources. UNEP has undertaken its own analysis of the potential for securing climate change (CC) funding and concludes that there is a strong potential for CC funding specifically for closure of the Truitier landfill, but a weak case for Project Phoenix overall unless the base case (without CC funding) is uneconomic. The potential revenue is also highly unpredictable due to both eligibility issues and the variability of traded carbon credits.

In general the assumption of zero revenue from CCM funding sources is considered valid. Given the current low prices for carbon credits, eligibility issues and transaction costs, any such revenue should be considered as probably marginal – except in the case of Truitier landfill, as discussed in Chapter 9.

10.2.4. Cost and return summary

In summary, UNEP and IEP do not agree on the likely economics of the project. IEP has signaled that it is willing to take on substantial cost risks, however the revised offer of IEP may not be economically supportable, principally due to an under-estimation of the capital and operating costs.

10.3. Value

10.3.1. Value and benchmarking for fragile state and Small Island Developing States economies

Accurately assessing the value of a project in Haiti as large and novel as Phoenix is difficult, as most of the benchmarks come from other countries with much larger and more stable economies. In general projects with a high technical content in Haiti are expected to cost more than the global average, more than in the neighboring economy of the Dominican Republic and much more than in the USA.

The root causes of this cost penalty include:

- The small size of the national economy, with associated limited competition.
- The very limited manufacturing sector, resulting in a need to import the majority of goods and expert services.
- A lack of domestic energy resources, resulting in high energy-import costs.
- The island effect, resulting in high import-transport costs for the imported goods.
- The general difficulty of doing business, due principally to weaknesses in governance and ongoing instability.
- Limited access to capital, particularly for large-scale and long-term debt.
- The distorting effect of humanitarian and development grant aid.

10.3.2 National energy benchmarks

Relatively accurate national energy benchmarking is possible due to the public disclosure of PPA costs by EDH. The following table is collated from an EDH presentation of its master plan in January 2013^(10.10), combined with a daily scheduling report from June 2013. All costs are for the PaP grid. Note that some important details are not public: such as the capacity and energy breakdown, general indexing and fuel import price indexing.

Facility	Nameplate MW	Total cost per kW/hr US\$
Phoenix	50	0.153 energy service
Phoenix	50	0.247 collated energy + WM
Carrefour II	30	0.25
E-Power	30	0.25
Carrefour I	39.5	0.28
Varreux III	20	0.28
Varreux I	35	0.36
Varreux II	15	0.37

The inferred tariff for energy only is based upon the UNEP calculation that approximately 30 percent of the project lifecycle costs are linked to the waste collection service – as presented in Chapter 2. Hence the contracted tariff is a bundled WM and energy service tariff, with the energy service-only tariff estimated to be approximately 70 percent of the total tariff.

It is clear that the collated revised tariff of the Phoenix revised offer provides good value compared to the existing national PPA alternatives and the energy service-only tariff offers excellent value.

This analysis however is based upon the Phoenix project cost model, which UNEP considers to be an under-estimate.

10.3.3. International energy benchmarks

Haitian wholesale power tariffs are very expensive compared to international averages. The lowest real cost of power is found in the USA, but this market is not very relevant for benchmarking to Haiti given its much greater size and maturity. The most relevant benchmarks for Haiti are considered to be Jamaica and the Dominican Republic.

Jamaica has a very deregulated power market, so any commercial operation can act as a distributor or reseller and sell to anyone at any price. This has enabled a high level of electricity access including extension into high cost rural areas. The researched PPA price range of US\$0.115 to US\$0.32 per kW/hr reflects this variability^(10.11).

The Dominican Republic market is partially deregulated, with a researched PPA price range of US \$0.111 to US\$0.215 kW/hr^(10.12).

In summary the Phoenix inferred energy service tariff of US\$0.153 kW/hr and the proposed collated price of US\$0.247 kW/hr appear reasonable compared to relevant international benchmarks. This analysis however is based upon the Phoenix project cost model, which UNEP considers to be an under-estimate.

10.3.4. National waste management benchmarks

There are no robust Haitian national WM cost benchmarks which can be used for comparison with Project Phoenix.

The only moderately valid benchmark found is that SMCRS reported an annual operating cost in 2013 of approximately US\$11 million, for a UNEP-estimated waste collection rate of very approximately 1,000 to 1,200 TPD. In comparison, the Phoenix financial model estimates an annual operating cost of approximately US\$18 million for the waste collection and landfill management activities (excluding initial capital cost payback). This higher cost however includes operation of a landfill to modern standards and amortization of collection equipment to allow for regular replacement (every five to ten years).

In summary, the limited Haitian national data for WM costs indicate that the Phoenix proposal offers reasonable value.

10.3.5. International waste management benchmarks

Extensive international information is available for WM cost benchmarking, however a wide range of costs are noted and there are some issues with comparing like for like.

The WB 2012 report entitled “What a Waste”^(10.3) presents a range of SWM costs, with very different cost ranges presented for low-income countries compared with high-income countries. In addition the waste collection rate ranged from 43 percent in lower income countries to 98 percent in high-income countries.

In the case of Haiti and Project Phoenix, it is a low-income country with a project aiming for an 80 percent+ collection rate, hence it is a hybrid of low-income and middle-income characteristics. In that context UNEP has selected the Lower Middle Income band for cost comparison, yielding the following rates, in US\$/tonne:

Collection	30-75
Sanitary landfill	15-40
WtE incineration	40-100

Estimated collection costs for Phoenix are a mixture of the capital and operating cost. For benchmarking purposes, the cost of the initial capital investment is integrated into the operating cost at a rate of 10 percent per annum excluding land. Using this structure the annual collection cost for Phoenix is approximately US\$16 million + 10 percent of US\$30 million = US\$19 million.

An annual cost of US\$19 million for collection of 1,200 TPD translates to a cost of US\$43.3/tonne, which fits in the lower half of the WB figures.

Back-calculating the cost of the WtE plant to compare with the WB figures is difficult for Scenario 2 due to the impact of the dual fuel model. As a crude comparison, the waste in Year 1 is estimated (by UNEP) to supply approximately 50 percent of the calorific value of the total fuel consumption and the annual revenue of Phoenix can be used as a rough proxy for annual cost to the GoH (including the cost of finance and profit).

The forecast Year 1 waste derived energy capacity and sales revenue (according to the Phoenix model) is very approximately US\$35 million. The UNEP forecast waste quantity for Year 1 is 1,400 TPD, yielding a very rough estimated cost of WtE incineration of US\$68.4/tonne, which sits in the middle of the WB figures.

In summary, international benchmarking provides only limited assurance, however indications are that the revised offer of Project Phoenix fits within the lower half of relevant international benchmarks.

10.3.6. Coal and Waste-to-Energy transfer pricing

It is not appropriate to directly benchmark Project Phoenix against conventional coal-fired plants, as much of the cost of the latter is linked to its capacity to utilize waste. It is clear however, that coal-fired plants on their own are significantly lower in cost than the Phoenix facility.

As a simple comparison, the International Energy Association reports that the average levelized cost of power from a conventional coal plant in 2010 is in the range of US\$0.08 to US\$0.12 kW/hr^(10.5). In the absence of more detailed information UNEP is using the mid-range figure of US\$0.10 kW/hr, approximately 64 percent of the US\$0.153 kW/hr cost of the Phoenix Scenario 2 power cost (excluding the waste collection and disposal costs).

In this sense, in the Phoenix project, coal is being used to subsidize the cost of the WtE system as well as increase its technical viability. In the Haitian context, UNEP considers this to be appropriate, given the absence of other viable solutions for financing a WM system.

10.3.7. Indexing and the potential for value erosion or improvement

The value discussions noted above focus on Year 1 economics, which need to be adjusted to account for indexation and changes in quantities over the project life cycles. UNEP has reviewed the factors expected to change over the project lifecycle to assess the potential for value erosion or improvement:

- Energy charges indexed at 2 percent - May either erode or improve value dependent upon the actual rate of inflation.
- Increased Phoenix waste collection and treatment volumes – Adjustment to be negotiated, so currently neutral.
- Coal fuel costs/tonne – Proposed as a pass through cost, with currently a flat forecast for the medium term, so value positive at present but to be conservative should be considered value neutral.
- Increased coal tonnage – Increased ratio of coal-to-waste reduces the scale of the coal-waste transfer price without reducing the tariff, so represents value erosion (if it actually occurs).
- Increased plastic recycling, with the energy production replaced with imported coal – mixed impact but overall a slight erosion in value, dependent upon the international plastics market.

In summary, the single most important time variable influence on the value of the project is the fixed rate 2 percent energy price indexing, which is simple and caps the risk for the GoH, but may represent poor value, if the real rate of inflation in Haiti remains below 2 percent for extended periods. This subject may warrant further analysis in the context of any renegotiation.

IEP point out that current projections on fuel price inflation are much more aggressive for fuel oil than coal – the former is likely to increase significantly in price over the life of the project and so the competitiveness of coal should increase.

10.4. Financial exposure, benefits and balance

10.4.1. Financial exposure

The financial exposure of the GoH to Project Phoenix has two components:

- **The obligation to purchase the electricity on a take or pay basis.** EDH has the purchase obligation and the GoH is the owner and guarantor of EDH, hence the GoH has this obligation. Over the 30-year lifetime of the PPA, the total payment obligation is forecast to be in the order of **US\$2 billion**, excluding the counterbalancing impacts of inflation and the 2 percent payment indexation.
- **The obligation to secure or purchase land for the project.** The MSA details the requirement of the GoH to supply all land needs of the project, including 161 hectares for the main site, four urban waste transfer stations and 20 small community collection centers. UNEP has no details on the value and current formal occupancy of all of the required land, but speculates that in total this is an obligation of well in excess of US\$2 million. In the context of the project, this is a relatively small sum, however it is needed before financial close and cannot be taken as project debt. This is because confirmed land availability is always a requirement for financial close and thus pre-dates access to project finance.

10.4.2. Direct and indirect financial benefits

Project Phoenix has quantified the anticipated direct financial benefits of the project to Haiti within its public presentation material from 2012. These benefits are listed below by UNEP but not quantified:

- Lower cost wholesale energy supplied to EDH.
- Approximately 1,000 construction jobs for one to three years
- Direct permanent jobs (Scenario 1: 1,260; Scenario 2: 1,000 approximately; Scenario 3: 1,000 approximately.)
- Company taxes – after cessation of the agreed tax concessions.
- Mining royalties (Scenario 1).
- Dividends paid to the GoH as a SAM 10 percent shareholder.
- 50 percent profit share on the sale of recycled metals or other byproducts of operations.

UNEP does not dispute any of these claimed benefits, but has not validated their scale. In general, they are considered positive and substantial, with the exception of the tax concessions.

10.4.3. The balance of financial obligations, benefits and risks between the parties

Balance in the context of Project Phoenix refers to the balance or sharing of financial obligations, benefits and risk between the two parties to the legal agreements. A well-balanced agreement could be considered “fair”, which is a partly different parameter from value (a fair agreement can still represent poor value).

Any assessment of balance is partly subjective and mainly qualitative. In the case of Project Phoenix the details of the agreement are very open for review, but the complexity of the agreement, several areas of uncertainty and the potential for important changes during the project lifecycle make it difficult to provide a definite assessment.

Notwithstanding the above caveats, UNEP considers the balance of financial obligations, benefits and risk between the two parties to be **overall fair, with a heavy risk loading on the side of the Phoenix consortium and a significant obligation on the part of the GoH.**

The project has secured very substantial tax benefits within the terms of the MSA. Clearly these terms were part of a wider negotiated package including the offered energy tariffs and government shareholding. Notwithstanding the interpreted overall balance of the package, it needs to be recognized that in the absence of tax income, the importance of the government shareholding becomes a very important factor in the overall benefits package.

10.5.Affordability

10.5.1. Phoenix Project clients and their financial status

Affordability in the context of Project Phoenix focuses on the capacity of the clients of the services provided to pay for those services. In the revised offer from IEP, there are only two proposed sources of revenue a) the sale of capacity and energy and b) the sale of recycled metal.

The sale of recycled metal occurs on the open market, so affordability is not an issue, even though the spot price may vary considerably over the 30-year operating life of the project.

The affordability of the capacity and energy charges of Project Phoenix is a major issue. At present the only identified buyer of the capacity and energy is EDH. The GoH is the owner and the financial guarantor of EDH, so it is at present also the de facto buyer.

EDH. As of January 2014, EDH is in very poor financial condition and is suffering from a range of chronic and structural problems. These issues are well described in numerous GoH and external reports ^(10.13) ^(10.14) ^(10.15) and are summarized as follows:

- Energy production costs are extremely high, with the majority of costs in the form of external US\$ payment obligations to several Independent Power Producers (IPPs).
- Energy retail tariffs are close to or less than the average energy wholesale purchase price, resulting in chronic structural losses.
- A significant fraction of energy produced is lost through the transmission and distribution network as a result of old, overstretched and damaged equipment.
- EDH does not efficiently manage its retail client base, resulting in low payment ratios and a significant number of defaulting households and disconnection.
- There are high levels of electricity theft and fraud.

The cumulative impact of all of these factors results in EDH operating at a significant loss. In January 2013, EDH publicly reported that it lost approximately US\$130 million in 2012. In June 2013, EDH started to default on payment to some of its IPPs and this situation was unresolved in January 2014, with approximately US\$60 million in arrears in total noted for at least two IPPs.

E-Power. E-Power, which is the newest IPP and has a 30MW PPA, stopped production in July 2013 due to payment default. This is a serious situation as the E-Power project was financed by IFC, a WB organization. A default on a WB project loan caused in effect by the GoH will probably have serious consequences for GoH capacity to secure debt and guarantee project finance agreements in future.

The GoH has historically always supported the chronic losses of EDH with an annual payment from the Ministry of Finance and an implicit payment guarantee for the IPPs. This system has broken down since June 2013, however the obligations of the GoH remain.

10.5.2. Short and medium term affordability

Given the noted financial status of EDH, it is clear that **as of January 2014, EDH cannot afford the forecast capacity and energy payments for Project Phoenix**. It is also clear that this is not a short-term issue, as the root causes of the financial difficulties of EDH are deep seated and will require both investment and reform to resolve.

Energy sector reform and national utility turnaround operations in other countries have generally been multi-year processes. The first payment from EDH to Project Phoenix would be due approximately 30 months after financial close. In theory this provides some time for the GoH to improve the situation for EDH and affordability before the first payment is due.

In practice however it does not, as the key milestone for improvement is financial close. UNEP anticipates that project financing will be impossible to secure in the absence of marked and stabilized improvements in affordability, or at least good early progress. Therefore without improvements in EDH the project may never reach financial close.

10.6. Findings summary

Economics	
D. Cost and return estimation	Phoenix and UNEP estimates of the costs of the project differ by up to 40 percent for individual parameters and 25 percent overall. The revised offer is not considered supportable based on the UNEP pessimistic case estimates.
A. Value	National and international benchmarking indicate that the project overall represents good value, if the revised offer can be maintained.
B. Financial exposure and benefits	The extent of financial exposure appears reasonable compared to the benefits.
B. Balance	The balance of obligations, benefits and risks between the GoH and Phoenix shareholders appears overall to be fair, with a heavy risk loading on the side of Project Phoenix and a significant obligation on the part of the GoH.
D. Affordability	At present EDH cannot afford the capacity and energy payment obligations of Project Phoenix. Both energy sector reform and major improvements in EDH are required to resolve this situation.

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Section C – Project component technical assessment

11. Waste Management – collection, processing, recycling and disposal

11.1. Subproject description

11.1.1. Introduction

This chapter presents an assessment of the WM components of Project Phoenix, comprising collection, processing, recycling and disposal, including disposal of ash from the WtE plant. The assessment applies to all three design Scenarios: 1, 2 and 3 as this part of Project Phoenix is nearly identical for all cases.

The assessment is based largely upon the following materials:

- A technical waste report developed by Ros Roca and the consulting firm IDEMA^(11.1).
- A waste characterization report provided by the consulting firm Applus^(11.2).
- The UNEP-UNOPS waste characterization report 2011^(11.3).
- The Phoenix Business Plan version March 2012^(11.4).
- A number of references used mainly for benchmarking.

11.1.2. Phoenix waste collection

The Phoenix consortium proposes a traditional system of urban waste collection, with a network of routes and facilities feeding into a single-end destination – the WtE facility at Aubry. The technology proposed is proven and includes small and large bins, compactor trucks and transfer stations.

IDEMA conducted a detailed Geographic Information System (GIS)-supported analysis of waste generation and routing options in order to generate an equipment and route list^(11.1). The collection strategy is based upon a combination of collection along routes and dedicated collection infrastructure for 28 markets. The proposed list of infrastructure is presented in table form below.

Item	Number
Transfer stations	4
Community collection centers	20
25m ² compactor truck	26
21m ² compactor truck	8
16m ² compactor truck	35
12m ² compactor truck	23
5m ² compactor truck	14
Roll on /Roll off trucks	6
Dump trucks	16
Front end loaders	4
3m ³ containers	2,096
1.1m ³ containers	6,216

The majority of waste collection road movement would take place at night to avoid the heavy traffic. Within insecure areas collection would take place only during daylight hours. The collection system would operate six days a week.

11.1.3. Waste processing and recycling

The extent and complexity of the proposed waste processing components of Project Phoenix have varied over time as the design team has grappled with waste characterization and cost issues. The original full-scale process included two main waste processing lines with the following features:

- Oversize and under-size material separation;
- Ferrous and non-ferrous metal recovery;
- Plastic recovery via conveyor picking lines;
- Shredding;
- Organic waste drying prior to use as fuel.

The latest design iteration does not aim to initially recycle plastic and cost engineering is still pending, hence the final design may have fewer features than listed above. The full system is highly mechanized, with direct manual labor applied only to the waste-picking conveyor lines.

11.1.4. Landfilling and ash sales

A new sanitary landfill is proposed to be built adjacent to the WtE plant at Aubry. This will receive ash and the small proportion of waste that is neither burnt nor recycled. The project aims to sell on the furnace ash as binder for cement works, so the final volume to be landfilled is highly uncertain and could change as market demands are uncertain. The current design is based upon the maximum foreseeable volumes and so ash sales will reduce actual versus estimated costs.

The different scenarios will result in different volumes and types of ash. The largest volume of ash will be generated by Scenario 1, as the Haitian lignite has a very high mineral (clay, silt and sand) content. Due to the expected relatively inert nature of the mineral fraction, this increased volume of ash is not expected to have a major environmental or social impact relative to the other scenarios. The lignite also contains sulfur in the form of pyrites, but this is expected to be burnt then converted into calcium sulfate via lime injection into the combustion process.

11.2. Technical feasibility

11.2.1. Waste collection

The waste collection technology proposed is fully proven, so its technical feasibility is not questioned. Accurately and cost-effectively matching the collection infrastructure and the operational investment to the workload will be a major challenge, which is however technically routine.

11.2.2. General waste processing, recycling and landfilling

All of the proposed general waste processing, recycling and landfilling technologies are fully proven, so their technical feasibility is not questioned. With difficult waste there is the risk of frequent stoppages and/or high maintenance costs for the sorting equipment, particularly the screens. This however is a routine design issue and not specific to the Haitian setting.

11.2.3. Management of wet waste

The MC within the waste is found in two general forms:

- Entrained moisture, which is originally blended into the materials, found within sealed containers and within the cells of plant matter. This moisture is only moderately mobile.
- Absorbed moisture, generally rainwater and run-off, which results from waste sitting in the open or being collected from drains and canals. This moisture is highly mobile.

The first method of managing absorbed moisture is to avoid it occurring in the first instance. In the case of Project Phoenix, extensive use of collection containers and regular collection is proposed. This should significantly assist in reducing absorbed moisture levels, particularly in the rainy seasons. Hence the annual average MC of the collected waste for Phoenix is expected by UNEP to be below 61 percent, the MC noted in the UNEP sampling study.

The second method of management is for drying to occur in parallel with the general management processes. The mechanical processes of unloading, stockpiling, screening, conveying and separating all provide opportunities for the waste to be separated, exposed and manipulated, thereby promoting drainage and evaporation. The high annual average temperatures prevalent in Haiti will assist in this regard – if the collected waste is protected from rain.

In summary, absorbed moisture is expected to remain an issue for Project Phoenix, however the project design and planned collection processes are expected to result in processed waste arriving at the furnace entrance with a somewhat lower absorbed MC than noted in the waste characterization studies. At this stage the difference is difficult to accurately estimate. The Phoenix consortium estimates that this process would reduce the 84 percent organic waste MC noted in the UNEP study to approximately 70 percent - which is still very high.

11.2.4. Management and treatment of organic wastes and entrained moisture

One significant area of uncertainty is in the management and treatment of organic wastes. The fundamental feasibility of the proposed technology is not in question. The uncertainty is instead linked to the cost-effectiveness and benefit of investing in separation and pre-drying of the organic wastes prior to incineration.

The organic matter is rich in carbon and so represents an important potential energy source. However it also has a generally low density, which translates to a low energy density and the need for significant materials-handling compared to the energy output. The organic matter also has significant amounts of entrained moisture. In the UNEP study the noted total MC (in organic matter) was 84.3 percent and in the Applus study it was 69 percent. Levels of over 70 percent indicate that the UNEP organic waste also had significant absorbed moisture.

At present the Phoenix proposal includes an option for pre-screened organic waste-rich fraction to be dried within a closed building equipped with an automated mechanical mixer. This mixer will frequently turn the waste, promoting evaporation and partial aerobic decay, which removes part of the organic carbon fraction as decay products and volatiles but also results in further water loss.

The mechanical mixing is an energy and equipment intensive process, which in the current design aims to reduce the MC of the pre-screened organic fraction from over 68 percent to 53 percent^(11.5). This results in significant emissions of highly odorous and water vapor laden air, which in turn needs to be passed through a biomass filter.

It is entirely feasible for such a system to dry organic matter to a MC well below 53 percent. This includes the UNEP-recorded organic wastes with an initial MC of 84.3 percent. However clearly drying this much wetter waste to the same end state will require more effort.

The key variables with regard to the drying process are the input MC, the retention time, the atmospheric temperature and the frequency of mechanical mixing. At present the Phoenix design is using the Applus data, which indicates a much easier organic waste drying task than the UNEP data.

Both the capital and the operating costs are linked to the amount of drying effort and the tonnages expected. In summary, drying high tonnages of very wet waste will be expensive, particularly given the low-end heat value of this material.

The Phoenix consortium has also developed a simpler waste processing design without drying. This would reduce the capital cost but also reduce energy production from the waste.

All of this indicates to UNEP that there is still scope for design improvement on waste pre-treatment.

11.2.5. The anaerobic digestion option for treatment of organic wastes

The Phoenix consortium, UNEP and NREL have all independently investigated the potential for employing the technology of AD, commonly known as biogas, for treatment of the organic wastes. UNEP has also investigated the option of landfill gas production.

AD technology is completely proven on a medium to large industrial scale, with hundreds of facilities throughout Europe, USA, Asia and Latin America. However it is also well-known as a relatively sensitive and capital intensive technology. Landfill gas technology is also very well proven and much lower in cost, however it has a lower energy output and a much greater land use as well as a residual waste issue.

AD and landfill gas systems produce a mixture of methane, nitrogen and trace amounts of other gases. A further investment is required in order to convert this biogas into either electricity or saleable high purity methane.

The consensus between UNEP and the Phoenix consortium on this issue is that AD or landfill gas treatment of the organic waste fraction needs to be considered as a potential upgrade to the project and not the primary WtE technology.

An AD unit on its own is not viable as the main treatment process as a) this still leaves a substantial part of the burnable waste stream with no treatment or disposal solution, b) the projected energy output is forecast by UNEP to be in the order of 7MW to 10MW only. This level of energy production does not generate enough revenue to finance the WM activities and provide a profit.

Hence on its own, AD is simply too limited. It may however be viable as one component of the total WM and WtE package, particularly as the quantity of waste grows over time whilst the furnace and boiler capacity remains fixed. This could allow for the combustion system to focus on burning the high calorific content and drier wastes (plastic, paper, carton, textiles, wood) whilst the difficult wet organic fraction is diverted to AD. The produced methane could either be co-fired in small amounts, used to fuel gas engine generators or upgraded and sold as bio-methane, as appropriate dependent upon the business case.

The timing of the potential upgrade to include AD is mainly a business decision for the Phoenix consortium. To date the Phoenix team has indicated a preference to progress with the combustion option for the first project-financing round and review the business case for an add-on AD system at a later date.

11.3.Environmental impact and risks

11.3.1. Waste collection

Compared to the status quo, the waste collection processing and disposal components are expected to generate significant environmental benefits. The anticipated benefits include:

- A reduction in water pollution;
- A reduction in marine garbage;
- A reduction in air pollution due to a reduction in uncontrolled open burning of waste;
- Localized reductions in flooding risk due to less waste being dumped in ravines and canals.

The waste collection vehicle traffic will add slightly to the existing heavy traffic in the region, however the plan to conduct most collection work at night will significantly mitigate this impact. The construction of community collection centers and transfer stations will result in some local changes in air pollution, specifically odors. Odors surrounding the transfer stations are a potential issue, but overall the increased emphasis on containerization of the waste is expected to result in a major reduction of odor compared to the status quo.

11.3.2. Waste processing, recycling and landfilling

The impact of the project compared to the status quo for waste processing, recycling and landfilling is difficult to assess due to the lack of data on the status quo. The most important issue is on recycling of plastic – at present some plastic recycling is happening but also an unknown percentage is burnt in open air at low temperatures, resulting in serious air pollution. During its early years of operation the Phoenix consortium is expected to burn all plastics in a high temperature incinerator. Overall this is anticipated to represent a major improvement, which however can never be quantified given the lack of data on the status quo.

The waste processing at Aubry is expected to generate significant odors. The nearest settlement is a small village located 300m west of the site, hence odor control measures will be required.

The proposed sanitary landfill is anticipated to contain mainly furnace and baghouse ash. The Project Phoenix team has not specified the standard to which this landfill will be built but have specified that it will include a liner and leachate control infrastructure. The proposed landfill site is dry and the Aubry area is a low rainfall region.

The status quo with respect to landfilling is the Truitier site. This site has no liner or drainage works, no methane management system, no waste separation and a chronic problem with landfill fires and vermin. In this context, the early indications are that the Phoenix landfill will represent a major improvement on the status quo.

11.4.Greenhouse gas emissions

11.4.1. Methodology and model inputs

GHG emissions have been calculated for the WM component of Project Phoenix. IPCC methodologies have been utilized to the extent feasible^(11.6). Details of the parameters used and assumptions made are provided in Annex G. The model inputs in summary were as follows:

- The decay of Truitier legacy waste is included, based on an average generation rate of 900 TPD in the 15 years before the start of Project Phoenix.
- Current waste generation rate is estimated at 2,000 TPD, rising at 2.5 percent per annum to a maximum of 4,100 TPD after 30 years. The model average generation rate used is 2,900 TPD.

- The average Phoenix waste collection and processing rate is estimated at 2,000 TPD, approximately 70 percent of average waste generation.
- Thirty percent is not collected and is either burnt in an uncontrolled manner or decays via a combination of aerobic and anaerobic processes. The fate of each component depends upon its characteristics. Organic matter is assumed to decay 20 percent via anaerobic processes and 80 percent via aerobic processes. Wood is assumed to decay 50 percent via aerobic processes and for the remaining 50 percent to be burnt. Plastics are assumed to be 50 percent burnt and 50 percent recycled.

11.4.2. GHG model outputs

An Excel model using the above noted list of inputs generated the following summary outputs.

Source	Tonnes CO annum	Tonnes CO years
Uncollected decay	51,600	1,548,000
Uncollected burning	34,000	1,020,000
Truitier legacy waste decay	43,600	1,308,000 - mainly in the 10 years
Phoenix waste collection	2,700	81,000
Total TCO	App. 132,000	App. 3,957,000

The accuracy of this forecast is considered to be no better than +/- 30 percent. Note that dominant sources of GHG emissions are from the uncollected wastes and the Truitier legacy wastes. The impact of waste collection activities is negligible in comparison.

11.5. Social impact and risks

11.5.1. Waste collection

The increased and improved waste collection provided by Project Phoenix is anticipated to generate major and lasting social benefits including the following:

- A reduced disease burden through a reduction in polluted water, rats, flies, mosquitoes and toxic smoke.
- Improved pedestrian and vehicle traffic flow through a reduction in waste piled in paths and streets.
- Improved amenability and attractiveness of public spaces.
- Reduced flood damage due to a reduction in blocked drains, canals and ravines.
- New formal jobs in waste collection.

The key social risk noted is linked to purchase of land and the associated resettlement for the transfer stations and community collection centers. At present the MSA places all of the responsibility for this activity with the GoH. The capacity and motivation of the GoH to conduct the compulsory purchase, resettlement and compensation process to international standards is questionable. Hence this is considered a high social risk.

11.5.2. Waste processing, recycling and landfilling

The social impact of the waste processing recycling and landfilling components of Project Phoenix are anticipated to be very mixed.

On the positive side, the modern and sanitary treatment of the collected waste will generate benefits very similar to those from waste collection, specifically:

- A reduced disease burden through a reduction in polluted water, rats, flies, mosquitoes and toxic smoke.
- New formal jobs in waste processing, recycling and disposal.

On the negative side, the startup of Project Phoenix will have a significant once-off negative effect on the existing cadre of informal waste-pickers, both in the streets and on Truitier. The livelihoods of this waste-picking population are very insecure, unhealthy and not very profitable, but they are nonetheless livelihoods, in a city with a major and chronic unemployment problem.

In mitigation, IEP has included plans to enable the waste-pickers to create small recycling businesses in its Community Collection Station model, which centralizes recycling for specific items and allows for independence and guaranteed offtake contracts. A subset of this population would be given the opportunity to work in the project in various roles, and eligible for Phoenix STARS, a Phoenix-sponsored vocational training programme.

It is impossible to accurately quantify the net impact of this issue as there is little solid data on the number of informal waste-pickers. Anecdotal reports from Phoenix on Truitier^(11.6) indicate that approximately 300 families rely on waste-picking the site for their livelihoods. There is no real data on the number of informal waste-pickers operating in the streets.

The social risk for purchase of the Aubry site is much lower than noted for the transfer stations and collection centers. The proposed Aubry site currently has only a very low density of dwellings and no commercial center and so resettlement is not expected to be a significant issue.

An additional negative is the impact of the construction and operation of the urban waste transfer stations. Even with modern equipment and high standards of operations, these sites will represent a permanent noise, traffic and odor nuisance to their neighbors.

11.6. Findings Summary

Waste collection, processing, recycling and disposal	
C. Technical feasibility	The technology proposed is proven, but with significant further work required on cost and performance optimization for management of wet organic wastes.
A. Environmental impacts and risks	An overall positive environmental impact is anticipated.

Greenhouse gas emissions	The UNEP model indicates a project component lifetime GHG emission total of approximately 4 million tonnes CO Over 99 percent of those emissions are generated by uncollected waste and Truitier legacy waste emissions.
C. Social impact and risks	Social impacts are anticipated to be overall highly positive, however some of the existing informal workforce of waste-pickers will lose their livelihoods. Inadequate GoH management of the compulsory purchase and resettlement process is noted as a high-risk.

11.7. Chapter references

11.1 IDEMA Waste collection study (2011)

11.2 Applus (2011). "Characterization of waste in Truitier landfill, PaP Haiti"

11.3 UNEP-UNOPS (2011). "Waste Sorting in the Truitier Landfill"

11.4 IEP. Phoenix Business Plan version March 2012

11.5 IEP (2012) Waste Summary Analysis Report

11.6 IPCC Guidelines (2006). Table 5.3, chapter 5, volume 5,
http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_5_Ch5_IOB.pdf

11.7 IEP (2014). Stakeholder Engagement and Transparency Information for Project Phoenix

12. The Haitian lignite mining and transport option

12.1. Subproject description

12.1.1. Introduction

This chapter presents an assessment of the proposed Maissade lignite mining and transport option. The assessment applies only to Scenario 1 and is based largely upon the following materials and sources:

- The Phoenix Business Plan version March 2012 – Project Description Section 3 ^{12.1)}
- The Phoenix MSA.
- Google Earth.

UNEP did not visit the Maissade site.

12.1.2. The Maissade lignite deposit

The lignite resource proposed as fuel for Project Phoenix is located in the Central Plateau of Haiti, 12 km northwest of the small town of Maissade. The lignite is located at a depth of 2m to 25m with a clay rich overburden. The lignite itself has a mineral content of 25 percent to 40 percent, with predominantly clay and up to 6 percent sulfur in the form of finely divided iron sulphide (pyrites).

The region is fully agricultural, with no remaining natural forest cover. Farming is mainly subsistence, with many very small plots and a mixture of crops, grazing and agroforestry. The highly degraded Canot River runs west to east within the area. The topography is relatively flat, with the deposit located in a basin structure.

The lignite deposit has been extensively studied, with numerous borehole logs and reports available. The latest evaluation was conducted by the German Cooperation with Haiti Institute in 1982^(12.2). In global terms, the deposit is considered by UNEP to be a small and low-grade resource of marginal value. No mining has occurred to date.

12.1.3. Maissade mine operation and rehabilitation

The Phoenix consortium proposes to develop an open-cut mine and extract up to 730 tonnes of processed lignite per day for the lifetime of the project (30 years or more). The mine will be operated using conventional medium-sized excavation equipment: front-end loaders, bulldozers and dump trucks. A bucket wheel excavator and conveyor system or dragline excavator are also under consideration. Mining activity would be more intense during the drier months but would continue all year round.

UNEP and the Phoenix consortium disagree on the amount of lignite or imported coal required to supplement the waste fuel in order to reliably deliver 50MW of power and avoid emission problems. There is agreement that collected waste volumes will be lower than the target in the first two years as the collection fleet is mobilized and trained. Together these factors indicate a need for more than 730 TPD. UNEP has not undertaken the engineering studies required to generate a robust estimate – the required increase is speculated to range to up to 30 percent, yielding a maximum mining rate of 1,000 TPD at the start of the project and steadily declining thereafter.

The extracted lignite would be partly processed on-site to remove much of the mineral waste. This will entail high volume soil washing, with large volumes of process water and large settling basins.

Mine site rehabilitation is proposed as a continuous process within the mining cycle. The lignite would be excavated in cells and each cell would go through the following process:

- Soil removal.
- Overburden removal.
- Lignite removal.
- Overburden replacement and grading.
- Soil replacement and replanting.

The final use of the rehabilitated land is not confirmed however the Phoenix team indicates that it is anticipated to revert to agriculture and agroforestry.

12.1.4. Lignite haul road construction

The proposed mine site is located approximately 110km from the proposed WtE plant site. Only small local roads exist at present in the Maissade region. Accordingly, the Phoenix team proposes to build a dedicated mine haul road southeast for 25km to connect to the main Highway 300, 4km south of the city of Hinche.

The haul road will have two lanes with a bitumen surface and edge drains. It will include two major river crossings and eight stream crossings. The road will be built on currently agricultural land. The Phoenix team has requested a 75m wide right of way for the road, although the actual width impacted is expected to be less than this.

12.1.5. Lignite road transport

All of the lignite destined for the power plant will be transported by road. The Phoenix consortium calculates that 730 TPD of fuel requirements translates to the transport of 2,270m³ five days a week. The Phoenix team proposes to use 27m³ capacity tractor-trailer trucks, with a total of 84 return trips per day. If the UNEP forecasts of increased lignite needs are correct, then a maximum 30 percent increase in volumes will result in up to 110 trips per day.

The transport route consists of the proposed new road for 25km followed by 84km of public highways. The public highways are moderately busy and include several steep and winding sections. Like all Haitian highways, the routes experience a large number of vehicle breakdowns and accidents.

12.2. Technical feasibility

12.2.1. Lignite mining and washing

The proposed lignite mining and washing process is all established technology and so its feasibility is not in question. Two technical issues arise from the mine environment:

- Working with large-scale clay pits during wet season. This is acknowledged as a challenge, with stockpiling proposed to limit the need for work during the wettest periods.
- Water needs and water purification associated with washing the clay from the lignite. Clay has a very extended settling time, so very large settling ponds will be required.

The proposed new mine road and the road transport require only basic technology and so are considered entirely feasible.

In summary, the lignite mining and transport operations are considered entirely feasible, however water management operations may result in increased costs and/or lower productivity.

12.3.Environmental impact and risks

All lignite mines have significant localized environmental impacts and risks. In this context the proposed Maissade mine exhibits the normal range of impacts and risks, within a relatively low sensitivity environment.

The key environmental impacts noted include:

- Loss of agricultural land – mitigated in part by future rehabilitation.
- Disturbance of surface drainage and local groundwater patterns.
- Dust and sediment distribution.

The key environmental risk noted is massive discharge of clay rich sediment into the Canot River in the event of a clay settling pond breach or regional flooding. The sensitivity of the Canot River to such a sediment load is however considered low, as it already carries a very high sediment load due to regional erosion and deforestation.

Construction of the 25km of new road will have an environmental impact equivalent to the mine itself due to the permanent land loss (estimated at over 1km²). The impact of road transport of the lignite is covered in the social impacts and risks subchapter.

12.4.Greenhouse gas emissions

12.4.1. Methodology and model inputs

Greenhouse gas emissions have been calculated for the lignite mining and transport component of Project Phoenix. IPCC methodologies have been utilized to the extent feasible^(12.3). Details of the parameters used and assumptions made are provided in Annex G.

The key input parameters and assumptions used for the baseline are as follows:

- Phoenix mining rate estimates are used (730 processed TPD, seven days a week)
- Road transport of processed lignite to the WtE plant, with 420 return trips per week and a 109km road distance between the mine and the processing site.

Emissions resulting from the combustion of the lignite are covered in Chapter 15.

12.4.2. GHG model outputs

An Excel model using the above noted list of inputs generated the following summary outputs.

Source	TCO	TCO
Mine operation	19,300	579,000
Lignite road transport	5,100	153,000
Total TCO	App. 24,400	App. 732,000

The accuracy of this forecast is considered to be no better than +/- 30 percent. Note that dominant source of GHG emissions is in the mining and processing effort.

12.5.Social impact and risks

The social impact of the lignite mining and transport operations are anticipated to be very mixed and highly dependent upon the manner in which the scheme is developed and operated rather than the design. The key positive and negative impacts anticipated include:

- Agricultural job loss - mitigated by compensation and eventual land rehabilitation of the mine site.
- Job creation – positive and substantial.
- Road traffic dust and noise nuisance – substantial but mitigated by the rural setting.
- Public road degradation.
- Increased road accidents – expected to be substantial, due not to the mine road fleet (if the drivers are well trained) but the poor road discipline of Haitian drivers. This is expected to be a particular issue on the steep and winding parts of the public highways.

The key social risk noted is linked to purchase of land and the associated resettlement for both the mine and the new haul road. At present the MSA places all of the responsibility for this activity with the GoH. The capacity and motivation of the GoH to conduct the compulsory purchase, resettlement and compensation process to international project finance standards is questionable. Hence this is considered a high social risk.

12.6.Findings Summary

Lignite mining and road transport	
B. Technical feasibility	The technology proposed is proven, with further work required on wet season materials management and dewatering.
B. Environmental impacts and risks	The normal range of open cut coal mining impacts and risks are anticipated, however overburden ratios are low and the rural environment is generally of moderate to low sensitivity.
Greenhouse gas emissions	The UNEP model indicates a project component lifetime GHG emission total of approximately 0.7 million tonnes CO Over 85 percent of the emissions are generated by the mining operation.
C. Social impact and risks	Social impacts are anticipated to be very mixed. Employment benefits are expected to be positive. Road transport impacts and risks are expected to be significant. Inadequate GoH management of the compulsory purchase and resettlement process is noted as a high-risk.

12.7.Chapter references

12.1 The Phoenix Business Plan version March 2012 – Project Description Section 3

12.2 German Cooperation with Haiti institute (1982). Evaluation of the Maissade lignite deposit

12.3 IPCC Guidelines (2006). Volume 5, Chapter 5, Table 5.3

http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_5_Ch5_IOB.pdf

13.The coal importation option

13.1.Subproject description

13.1.1. Introduction

This chapter presents an assessment of the coal importation option. The assessment applies only to Scenario 2 and is only based upon the Phoenix revised offer and a UNEP site visit. At present there is very little design detail available on this option.

13.1.2. Black coal mining in Colombia or the USA

The current proposal made by the Phoenix consortium is to purchase black coal from either Colombia or the USA. The proposed volume will depend upon variable demand from the Phoenix Project and the energy content of the coal. At present the Phoenix consortium proposes to import the equivalent of 320 TPD of 10,000 BTU/lb low sulfur coal (a relatively standard black coal specification).

UNEP and the Phoenix consortium disagree on the amount of lignite or imported coal required to supplement the waste fuel in order to reliably deliver 50MW of power and avoid emission problems. There is agreement that collected waste volumes will be lower than the target in the first two years as the collection fleet is mobilized and trained. The Phoenix team has undertaken a supplementary study and estimates that 600 TPD will be needed at project startup and decline to 500 TPD within the first ten years of operation. As long as sufficient imported coal is available (which is assumed), then the only impact of increased coal imports is a slight increase in costs.

For the purposes of this assessment, note that the overseas mining and national transport operations are excluded from the assessment of feasibility, environmental, climate and social impacts and risks.

The rationale for the exclusion is that the quantity of coal proposed for import is too small to warrant opening a new mine – hence the demand from Project Phoenix will simply be amended to an existing large operating mine. Colombia is a middle-income country with moderate environmental governance including a process of environmental assessment and management. The USA is a high-income country with relatively strict environmental governance. In this context, it is anticipated that incremental effects from the Phoenix coal demand will be limited and practically impossible to quantify.

13.1.3. Coal import

The import of coal to Haiti is however a completely new operation and so is assessed as part of Project Phoenix. At present the coal importation operation has only been designed in outline.

The Phoenix consortium proposes to construct a jetty for offloading the coal on the coast directly adjacent to the WtE plant. Conveyors will transport the coal from the jetty to the plant, with some stockpiling expected. The frequency of ship movements is not yet confirmed – for review purposes UNEP assumes a 6,000 tonne capacity barge or a small coal bulk carrier will offload at the jetty every ten days (for the Phoenix forecast volumes).

13.2. Technical feasibility

13.2.1. Coal importation

Coal importation is a technically basic activity and so its feasibility is not in question. The only engineering issue of potential concern is the extent of works required for jetty construction and dredging (if needed) to accommodate the coal barge/bulk carrier.

13.3. Environmental impacts and risks

13.3.1. The Aubry site marine environment

The coastal environment at the proposed Aubry site consists of a gravel beach backed by steep and semi-arid open land. Offshore the most important features are several shoals and a small island, all of which have small scale, intermittent and highly degraded coral reefs. Sea grass beds are visible in the shallower regions.

The proposed site is within the zone of marine environmental impact from PaP and the rivers flowing into the Hispaniola valley. The regional marine environmental issues noted by UNEP include over-fishing, marine trash, sewage and sedimentation. Overall the marine environment is considered moderately degraded^(12.1).

13.3.2. Environmental impacts and risks

Black coal is a low hazard solid material so the associated open water shipping risks are considered equivalent to general cargo. The principal environmental impacts and risks are associated with the jetty and docking process and include:

- Construction of the jetty.
- Dredging of the channel from the jetty to deep water.
- Shipwreck risk in the shallow coastal zone, which includes shoals and fringing coral reefs.

13.4. Greenhouse gas emissions

13.4.1. Methodology and model inputs and results

GHG emissions have been calculated for the coal importation component of Project Phoenix. IPCC methodologies have been utilized to the extent feasible^(13.2). Details of the parameters used and assumptions made are provided in Annex G.

Coal import quantities are based upon Phoenix estimates. Only shipping emissions are considered for the coal importation project component. Emissions from coal burning are considered to be part of the impact of the WtE plant. Emissions from mining and transport to the port for export are excluded as there is an inadequate base for estimation.

An Excel model using the above noted list of inputs generated the following summary outputs.

Source	TCO	TCO
Sea transport Colombia to Haiti -	21,000	630,000

The accuracy of this forecast is considered to be no better than +/- 30 percent.

13.5.Social impacts and risks

13.5.1. The coal jetty and unloading operations

The Haitian social impacts and risks associated with coal importation are considered to be negligible.

13.6.Findings Summary

Coal importation	
B. Technical feasibility	The technology proposed is routine, with further work required on jetty and channel design.
B. Environmental impacts and risks	Environmental risks to the coastal environment are noted, however the risks and sensitivity of the local environmental are considered moderate. Further work is needed on minimization of impact on any remaining fringing coral reefs.
Greenhouse gas emissions	The UNEP model indicates a project component (shipping) lifetime GHG emission total of approximately 0.6million tonnes CO Equivalent.
A. Social impact and risks	Social impacts are anticipated to be negligible.

13.7.Chapter references

13.1 UNEP (2010). Global Environment Outlook Haiti: State of the Environment Report 2010”

13.2 IPCC Guidelines (2006). Volume 5, Chapter 5http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_5_Ch5_IOB.pdf

14. Waste-to-Energy production – The 30 MW Plant option

14.1. Subproject description

14.1.1. Introduction

This chapter presents an assessment of the Scenario 3 option – the 30 MW WtE plant which does not use either lignite or coal. The assessment is based largely upon the design presented in the Phoenix Business Plan version March 2012^(14.1).

Scenario 3 is not preferred by Phoenix, but is presented first as it sets the scene for the more complex dual fuel Scenarios 1 and 2 presented in Chapter 15.

14.1.2. Proposed plant inputs and performance

The proposed WtE plant inputs in the latest Phoenix offer are:

- 2,000 TPD of municipal solid waste, pre-treated by shredding with some metals removal.
- Topping fuels, proposed as either fuel or tires dependent upon price and availability.
- Emission control inputs (limestone, activated carbon) and fuel bed recharge (sand).
- Steam process and washing water from local groundwater.
- Once through cooling water from seawater.

The proposed performance is 30MW peak power, with a 65 percent capacity factor and at least 80 percent availability.

14.1.3. Proposed plant

The proposed plant is a conventional modern WtE incinerator. The key components of the proposed plant include:

- A hopper and conveyor-based fuel supply system, feeding shredded waste.
- A bubbling fluidized bed (BFB) furnace and boiler feeding a single large steam turbine.
- Emissions controls including a fly ash particulates baghouse, activated carbon injection, an ammonia-based catalytic reducer and an electrostatic precipitator.
- A process cooling system using once-through seawater.

14.2. Technical Feasibility

14.2.1. Feasibility issues and studies

Technical feasibility and performance are major issues for Scenario 3. Key points of potential concern include:

- Waste tonnage variability
- Waste characteristics
- Energy production and reliability
- Emissions management
- Groundwater availability

Both the Phoenix consortium and UNEP have been well aware of the potential performance issues for WtE in the Haitian context and so this has been extensively studied and debated. Key studies include:

- The Phoenix Applus waste characterization study^(14.2).
- The UNEP waste characterization study^(14.3).
- A Monte Carlo modeling study of potential performance based upon variable inputs, conducted by the NREL on behalf of the USA Department of State (confidential)^(14.4).
- A second Monte Carlo modeling study, conducted by the Phoenix consortium on the request of UNEP ^(14.5).
- Separate analyses of potential WtE performance conducted by UNEP.

14.2.2. Waste tonnage variability and shortfall

The Phoenix Scenario 3 design assumption on waste inputs is for up to 2,000 TPD in order to achieve 30MW peak power and 65 percent capacity.

As set out in Chapter 4.2 UNEP has concluded that a conservative estimate of waste collection tonnage from the proposed waste catchment is 1,400 TPD (at startup in 2016). Using the Phoenix consortium analyses this corresponds to a potential for 21MW peak power at startup. There is also the lack of agreement between UNEP and the Phoenix consortium on the performance of a waste-only plant due to MC issues. Hence UNEP considers that the WtE only model will not be able to initially achieve 30MW at over 65 percent capacity, due to both reduced waste volumes and waste characteristics (see below).

A second issue with waste tonnage variability is the extreme difficulty in correctly sizing the facility given the very low accuracy of waste generation and collection estimates. The difference between future actual generation and collection and current forecasts could conceivably be up to +/- 30 percent. If the WtE plant is initially undersized then it will not be able to manage all of the waste collected. If it is initially oversized then it will be much less economic due to a lower capacity factor. The difficulty is increased by the high uncertainty for the growth rate in waste generation.

A potential mitigation strategy for dealing with this uncertainty is to build the facility close to the predicted capacity and then increase the scale of plastics recycling over time as the tonnage of waste collected increases. However, as explained below, this is not considered viable for a WtE only plant due to the very low energy content of the waste stream when plastic is excluded.

A WtE only facility is not considered viable as the only solution for waste treatment and disposal. To be economic the facility would need to be undersized and an overflow facility such as a general landfill would also be needed. At present the Phoenix landfill is proposed only for ash and non-burnable, non-recyclable waste disposal.

14.2.3. Waste characteristics

Both Phoenix and UNEP have used both the Applus and UNEP waste characterization data to determine the potential WtE performance of the plant. The results indicate the scale of the challenge in burning Haitian municipal waste for energy recovery. The key variables of concern are the percentage of organic waste, water and plastics. MC is linked to organic waste content, which has a high percentage of entrained water.

Water within the waste consumes energy through evaporation during the combustion process. Above 50 percent MC it is more difficult to burn waste. When burnt the constant drawdown of energy from evaporation suppresses the combustion temperature thereby reducing efficiency and increasing emissions. Above 70 percent MCs, wastes will actually extract energy from a combustion process due to the very high-energy drawdown from evaporation and the smothering effect. The BFB systems

reviewed by UNEP quoted 55 to 65 percent as the maximum manageable feedstock MC^(14.6) ^(14.7). High MC is a particular issue for starting the firing sequence.

With reference to Chapter 11, the Phoenix consortium proposes to pre-process the wet wastes to reduce their MC and improve the uniformity of the feedstock. The target MC of the waste at the furnace entrance is not clear – figures noted range from 53 percent to 33 percent. The upper figure is close to the performance limits of the BFB boiler systems.

In contrast, plastic is a high-energy density fuel compared to general mixed municipal wastes, so slight changes in plastic content can have a major impact on overall waste energy yields.

The input data from the Phoenix Monte Carlo energy analysis shows the potential extreme variability of the waste stream energy content and its dependence upon moisture and plastic content. For illustration, UNEP has extracted a sample of input figures from the Phoenix Monte Carlo analysis. The figures shown are Higher Heat Value in British Thermal Units (BTUs) per lb of wet (as received) waste.

Input\Case	Low	Medium	High
Applus data – All plastic burned	3740	4987	6234
UNEP data – All plastic burned	3558	4745	5931
Applus data – All plastic recycled	2689	3025	3781
UNEP data – All plastic recycled	1293	1724	2155

These values need to be put into context against the proposed Phoenix black coal minimum energy content of 10,000 BTU/lb. One industry source building BFB boilers indicated that 2,800 BTU/lb was the practical lower limit for low energy/high MC fuels^(14.8).

14.2.4. Energy production from general waste

UNEP and the Phoenix team have been unable to fully agree on the likely performance of a WtE facility using Haitian municipal waste. What is quite clear is that the performance of the 30MW facility in practice would vary very significantly with changes in waste inputs.

UNEP considers that the plant would probably not operate at all if all plastics were removed and would be inherently relatively inefficient and difficult to operate even if all plastics are included. Variable production is predicted due to variable but overall high moisture and organic matter content. Extensive drying of the organic matter may reduce this issue, however the substantial parasitic load of the mechanical mixing and drying process will detract from the net/useful power production.

Given the UNEP-forecast initial 1,400 TPD of waste input, it is forecast that actual net energy production from the WtE-only facility at project startup would be in the order of 15MW to 20MW (if all plastics are used as fuel).

14.2.5. Waste tires as a topping fuel

The purpose of a topping fuel is to raise the average energy density of the mixed fuels. This raises the combustion temperature in the boiler and thereby increases both the energy efficiency and the completeness of waste combustion. The Phoenix team proposes to use waste tires as a topping fuel for Scenario C. Waste tires have a very high BTU content, up to 15,000 BTU/lb^(14.9).

This is considered technically feasible (and environmentally beneficial if conducted at high temperatures), however the viability of this solution depends fully upon the availability of sufficient quantities of tires – that are not already part of the general waste stream.

At present there is no data whatsoever on the scale of waste tire generation in Haiti, so it is not possible to comment on the viability of this option.

14.2.6. Fuel oil as a topping fuel

The Phoenix consortium proposes to also use injected fuel oil as a topping fuel for Scenario C. This is considered technically feasible but relatively inefficient and thus not very economic. Fuel oil will of course burn very well, with a typical BTU content of 18,000 to 20,000 BTU/lb equivalent^(14.10), however the net energy output performance of injecting fuel oil in the WtE plant will be lower than using the same oil in a reciprocating heavy engine directly driving a generator.

14.2.7. Stack air emissions and waste destruction

The air emissions of a WtE plant are closely linked to its operational efficiency and its operating temperature in particular. The Phoenix team proposes that the facility is built to comply with USA Environmental Protection Agency (EPA) standards on air emissions, which are very strict^(14.11). UNEP considers these standards to be more than adequate.

The UNEP concern for the WtE facility is instead that the forecast issues with the low energy and wet waste inputs will result in general combustion performance problems, which in turn will result in air emission performance problems. Burning waste, particularly plastic, at low temperatures generates a great deal of smoke. This smoke can contain small but important quantities of dioxins, furans and polyaromatics which are quite damaging to health.

A related issue with low temperature combustion is incomplete waste destruction. There is very limited segregation of chemical wastes in Haiti and so it is assumed that these wastes will be burned as part of the general waste stream. Incomplete combustion of chemical wastes can result in toxins, including toxic byproducts, escaping as air emissions or remaining within the furnace ash.

Both of these problems can generally be avoided by burning uniform fuels with a high average energy content. However this implies that to ensure adequate air emissions performance, the Phoenix 30MW facility may need to continually co-fire significant quantities of fuel oil and/or tires. In the revised offer, the Phoenix team proposes that less than 10 percent of the energy is provided by topping fuels to maintain the adequate combustion temperatures within the boiler. UNEP considers that this is an under-estimate of what would be required to avoid episodic air emission problems.

14.2.8. Groundwater availability for process water

The Scenario A 50MW dual fuel facility had a proposed purified water use rate of 40,000 US gallons/day (approximately 150 m³/day). This water is used to make up steam losses resulting from routine operation. There are currently no details on the water needs of the 30MW facility, so UNEP has assumed a pro rata requirement of 90 m³/day.

The groundwater resource in the vicinity of the site has not been well studied, so UNEP has based its assessment on rainfall charts, a site inspection, the national hydrogeological map^(14.12) and UNEP technical advice notes on the 2010 construction of the nearby National Water and Sanitation Directorate (DINEPA) sewage treatment plant^(14.13).

The Aubry region is semi-arid and relatively steep. The main source of shallow groundwater is a small and shallow aquifer linked to a transient stream flowing 200m west of the site boundary. This is

however considered too small to sustainably support extraction of 90m³ per day. Outside of this resource groundwater is likely to be relatively scarce in the immediate vicinity of the site.

The nearest edge of the nearest large scale shallow aquifer is located 6km south-east in the Hispaniola Valley. This region has large-scale alluvial (gravel and sand) aquifers however the water is expected to be partly saline and would require purification prior to use in power generation. With such large-scale extraction, there is also the risk of saline intrusion.

Groundwater scarcity is not considered a technical feasibility obstacle for the WtE plant, however securing an adequate and sustainable supply without impacting other users is anticipated to be relatively costly.

14.2.9. Technical feasibility summary

In summary, the proposed 30MW WtE incineration plant using only Haitian municipal waste and topping fuels of tires and fuel oil is anticipated to be technically feasible. It is however expected to be **economically non-viable and non-competitive**.

14.3.Environmental impacts and risks

14.3.1. Key impacts and issues

The proposed plant is a major energy project that is anticipated to have a wide range of local environmental impacts and risks. At the scale of the UNEP review, the most important of these impacts and risks are considered to be the following:

- Plant air emissions.
- Groundwater extraction.
- Cooling water marine biodiversity impacts.

One routine issue not listed for further discussion is the loss of agricultural land or terrestrial biodiversity. This is because the proposed Aubry site is semi-arid, devegetated and severely eroded. Agricultural production is limited to a small number of roaming goats and sheep. Hence the anticipated impact on agriculture and terrestrial biodiversity is negligible.

14.3.2. Plant air emissions

Phoenix has yet to complete the detailed EIA or associated air emission modeling, which is required for project financing. The detailed design of the plant itself is also pending, so there is insufficient data available to predict the impact of air emissions from the facility. What is possible to discuss is the potential issues of concern based upon the history of WtE plants elsewhere, the list of key proposed emission controls and the nature of the Haitian waste stream.

The key emissions of concern are boiler stack emissions. Other emissions of note include steam (a mainly aesthetic issue) and waste odors (noted also in Chapter 11).

The nearest sensitive receptors to air emissions from the plant are the small village located 300m directly west of the plant and the small towns/villages of Aubry, Titanyen and Lafiteau, which are all located within 3km of the plant.

The stack emissions of modern WtE and MSW incineration plants operating correctly have relatively limited and local air quality impacts^{(14.11) (14.14)}. The main stack emissions of concern are very similar to coal or oil-fired plants and include particulates and oxides of nitrogen and sulphur (NO_x and SO_x). In modern facilities these are controlled by emission control systems such as activated carbon addition

(mercury and dioxin scavenging) precipitators and baghouses (particulates), limestone addition (for SO_x reduction) and catalytic reduction (NO_x reduction). All of these systems are proposed for the Phoenix WtE plant.

Problems with stack emissions noted elsewhere have virtually all been linked to a) older municipal waste incineration facilities lacking emissions controls and operating at low temperatures and b) facilities not operating correctly, resulting in incomplete combustion, lower operating temperatures or non functional emission controls. Such facilities can generate intermittent high levels of emissions, resulting in local concern and nuisance and health impacts in the worst cases^(14.15).

Problems with facilities not operating correctly are often episodic, such as upon startup or upon processing a particular batch of difficult or wet waste. Given the difficult characteristics of Haitian municipal waste, episodic emissions may be a problem for the Phoenix facility if only burning waste.

14.3.3. Groundwater extraction

As set out above, groundwater scarcity is expected to be an issue for the facility. In this context, there is a risk that large-scale groundwater extraction via wellfields will impact both other users and the environment. This is a particular risk for local groundwater users as the Phoenix wellfield is expected to consist of several relatively deep wells and may result in water table lowering across a large area and salt water intrusion.

14.3.4. Cooling water biodiversity impacts

The Scenario 1 50MW dual fuel facility had a proposed seawater cooling use rate of 144 million US gallons/day (approximately 550,000 m³/day). This water is extracted offshore and passed once through the cooling system before being returned to the sea. The Phoenix team proposes that the return seawater is heated to a maximum of three degrees Celsius above the inlet temperature and that the inlet and outlet avoid coral reefs.

Once-through cooling systems using seawater are known to kill marine organisms through impacting intakes, abrasion, overheating and chlorination (when the latter is used to limit biofouling of the piping). The scale of the damage is however completely dependent upon the scale and design of the system and the sensitivity of the inlet and outlet ecosystems – it can range from negligible to highly significant on a local scale.

A permanent rise of three degrees Celsius is more than sufficient to damage coral reefs and other sensitive shallow marine ecosystems, so as a minimum the outlet at least will need to be located well offshore, beyond the fringing reefs located 400m offshore of the site. UNEP estimates that an outfall pipe of at least 700m to 1000m will be required. This is completely feasible but will increase costs.

A definitive view on the environmental impact of the cooling water on marine biodiversity will need to await a robust baseline study on the local marine environment and a technical design and impact study. It is too early and there is insufficient data for UNEP to provide a definitive opinion on this topic.

14.3.5. Cooling system selection process

The proposed SEIA must assess this issue to the appropriate level of detail. In the event that an independent expert forecasts an unacceptable impact on the marine environment, then Phoenix would need to change its cooling system strategy to closed-loop systems.

Closed-loop systems are fully feasible but have a higher capital and operating cost than once-through cooling systems. Closed-cycle wet cooling systems also have environmental impacts, as they consume fresh water and can generate small amounts of concentrated effluent. Closed-loop dry

systems are feasible and have only low impacts but are very expensive and less efficient in hot climates.

Hence a closed-loop system should not be a default, but instead the Phoenix consortium and the GoH should make an informed decision on the basis of environmental and cost engineering studies.

14.4.Greenhouse gas emissions

14.4.1. Methodology and model inputs

GHG emissions have been calculated for the WtE component of Project Phoenix. IPCC methodologies have been utilized to the extent feasible^(14.16). Details of the parameters used and assumptions made are provided in Annex G.

The key input parameters and assumptions used for the model are as follows:

- UNEP waste survey characteristics are used.
- A project lifetime average of 2,000 tonnes of waste collected per day.
- No emissions from wastes received but not incinerated.
- Topping fuel emissions estimated at 10 percent of waste combustion emission estimates.

14.4.2. Greenhouse Gas model outputs

An Excel model using the above noted list of inputs generated the following summary outputs.

Source	TCO	TCO
Waste combustion	343,400	10,302,000
Topping fuel – 10% of waste emissions	34,300	1,029,000
Total TCO	App. 377,700	App. 11,331,000

The accuracy of this forecast is considered to be no better than +/- 30 percent.

14.5.Social impacts and risks

The social impact of the WtE plant construction and operation is anticipated to be overall highly positive. The largest positive impact will be direct and indirect job creation, both skilled and unskilled.

The most important social risk is local nuisance and health problems if the facility continually underperforms on emissions controls. This in turn is anticipated only if the facility has significant operational issues with burning wet waste, as noted above.

14.6. Findings Summary

30MW WtE Plant	
D. Technical feasibility	The plant is expected to operate very inefficiently due to the low energy content and variability of the waste, which may also result in emission problems. The plant will be very difficult to size correctly in order to economically manage all of the collected waste. Groundwater scarcity may increase costs.
C. Environmental impacts and risks	Significant environmental risks from air emissions, groundwater extraction and seawater once-through cooling are noted. Detailed studies and significant infrastructure commitments would be required. The air emission concerns are fully linked to the process efficiency concerns.
Greenhouse gas emissions	The UNEP model indicates a project component lifetime GHG emission total of approximately 11.3 million tonnes CO
B. Social impact and risks	Apart from the significant emissions risks noted separately above, the social impacts are anticipated to be positive.

14.7. Chapter references

- 14.1 IEP. Phoenix Business Plan version March 2012
- 14.2 Applus. Characterization of waste in Truitier landfill, Port-au-Prince, Haiti, 2011
- 14.3 UNEP/UNOPS (2011). "Waste Sorting in the Truitier Landfill"
- 14.4 NREL (2012). NREL's analysis of Haiti's Project Phoenix WtE Proposal (confidential)
- 14.5 IEP (2013). Project Phoenix. Analysis of 30MW and 15MW WtE plants and plant selection process
- 14.6 UNEP (2007). Technical study on biomass-fired fluidized bed combustion technology
- 14.7 The Andritz Group. High performance biomass boilers for green energy performance
- 14.8 Babcock & Wilcox Power Generation Group (2008). "Bubbling Fluidized-Bed Boilers"
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- 14.10 Engineering Toolbox. Energy contents of common fuels
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- 14.11 US EPA Air Emissions from MSW Combustion
<http://www.epa.gov/waste/nonhaz/municipal/wte/airem.htm#5>
- 14.12 GoH. Haiti Hydrogeological Map 1990

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14.14 The Joint Institute for Strategic Energy Analysis (2013). "Waste Not, Want Not: Analyzing the Economic and Environmental Viability of Waste-To-Energy (WtE) Technology for Site-Specific Optimization of Renewable Energy Options"
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14.15 UNEP Division of Technology, Industry and Economics (2013). Newsletter and Technical Publications. Municipal Solid Waste Management. Sound Practices. Incineration
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14.16 IPCC Guidelines (2006). Table 5.3, chapter 5, volume 5
http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_5_Ch5_IOB.pdf

15. Dual fuel energy production – The 50MW Plant options

15.1. Introduction

This chapter presents an assessment of the two dual fuel plant options proposed in Scenarios 1 and 2. The assessment is based largely upon design presented in the Phoenix Business Plan version March 2012^(15.1) and follow up discussions with IEP engineers.

15.1.2. Proposed plant inputs and performance

Scenario 1 proposes to use up to 720 TPD of processed lignite transported by truck from the Maissade lignite mine described in Chapter 11. The anticipated energy content of the processed lignite is 7,300 BTU/lb.

Scenario 2 proposes to use up to 320 TPD of imported black coal with a minimum energy content of 10,000 BTU/lb. The coal would be imported via a new jetty as described in Chapter 12.

Note that UNEP considers the proposed volumes of both the lignite and black coal to be under-estimates.

The proposed WtE plant inputs in the latest Phoenix offer are:

- 2,000 TPD of MSW, pre-treated by shredding with some metals removal.
- Either processed lignite (Scenario A) or black coal (Scenario B) as per above.
- Emission control inputs (limestone, activated carbon) and fuel bed recharge (sand).
- Steam process and washing water from local groundwater.
- Once-through cooling water from seawater.

The proposed performance is 50MW peak power, with a 65 percent capacity factor and at least 80 percent availability.

15.1.3. Proposed plant

The proposed plant is effectively the same for Scenarios 1 and 2. The higher energy density and lower ash content of the black coal will result in some space and efficiencies improvements, but the basic components for coal injection and ash handling will be the same.

The proposed plant is a conventional modern dual fuel WtE incinerator very similar to the proposed 30MW model. The key components of the proposed plant include:

- A waste biological and mechanical pre-treatment and separation train, consisting of trammel sieves, magnetic and eddy current metal separation, organic material drying and potentially plastics separation.
- A conveyor-based fuel supply system, feeding pre-processed waste (Refuse Derived Fuel)
- A BFB furnace and boiler feeding a single large steam turbine.
- Emissions controls including a fly ash particulates baghouse, activated carbon injection, an ammonia-based catalytic reducer and an electrostatic precipitator.
- A process cooling system using once-through seawater.

The revised offer includes downsized and less technical waste pre-treatment before incineration to save on costs and energy usage. The mechanical pre-treatment and separation train would consist of magnetic and eddy current metal separation, shredding and potentially plastics separation.

15.2. Technical feasibility

15.2.1. Feasibility issues and studies

Technical feasibility and performance are important issues for Scenarios 1 and 2, but not as problematic as for Scenario 3. Key points for discussion include:

- Waste tonnage variability.
- Waste characteristics.
- Energy production.
- Emissions management.
- Groundwater availability.

As per Chapter 13, the energy performance issues have been extensively studied and debated.

15.2.2. Waste tonnage variability and waste characteristics

The Phoenix Scenario 1 and 2 design assumption on waste inputs is for up to 2,000 TPD whilst operating at 50MW peak power and 65 percent capacity. The balance of the energy needs required to achieve up to 50MW would be supplied by co-firing either lignite or black coal.

The ability to co-fire highly variable amounts of lignite or black coal means that the 50MW plants will have the ability to manage highly variable volumes of waste, both in the short and long-term. This is a very positive feature given the problems of predictability discussed in Chapter 13.

The initial plan is for use of 100 percent of the plastics for fuel, with plastic recycling starting only when economically rational. Again, this is fully feasible with the ability to replace the high-energy content plastics with high-energy content lignite or black coal.

The relatively low energy content of the waste will remain an issue for Scenarios 1 and 2, however the ability to inject variable amounts of lignite or black coal is expected to fully mitigate this, as discussed below.

15.2.3. Energy production from dual fuel firing and lignite/coal needs

A critical benefit of the dual fuel model is that the presence of the high energy density fuels will enable the operators to reliably maintain a high furnace and boiler temperature. This dramatically increases energy and overall process efficiency and also reduces air emissions.

The Phoenix consortium has studied the required coal-waste energy balance and generated the following table.

Anticipated Waste and Coal Requirements					
Year of Operation	Average Annual Waste Available for Collection (TPD) with 1.6% pop growth	Waste Collected (IEPWM + SMCRS + Private Collectors) (TPD)	Coal Imported to Achieve 50MW Base Load at 16 Heat Rate (TPD)	Percent of Energy Output from Waste versus Coal (55MW)	
				Waste %	Coal %
1	2011	400+400+70% of 1200 = 1640	595	24 mw (43%)	31 mw (56%)
2	2011	400+400+75% of 1200 = 1700	576	25 mw (45%)	30 mw (55%)
3	2011	400+400+80% of 1200 = 1760	556	26 mw (47%)	29 mw (53%)
3 - 5	2011	400+400+85% of 1200 =1820	537	27 mw (49%)	28 mw (51%)
10 - 20	2177-2551	400+400+95% of 1200 = 1940	499	29 mw (53%)	26 mw (47%)
20 - 30	2551-2990	400+400+95% of 1200 =1940	499	29 mw (53%)	26 mw (47%)

Table 15.2.3 IEP Projections of coal and waste requirements for the 50MW unit

UNEP has not undertaken an engineering validation of the table, however it does match general expectations of the required energy balance. The two caveats noted by UNEP are:

- The collected waste volume at project startup could be as low as 1,400 TPD compared to the Phoenix estimate of 1,640 TPD. Therefore an additional 10 percent of coal may be needed to cover the volume shortfall in the early years of the project.
- The high organic MCs noted in the UNEP waste characterization studies may require additional coal to maintain optimum boiler temperatures. The required extra tonnage in this case is speculated to be between 5 percent and 20 percent and may vary on a seasonal basis and over time as the collection and management systems are improved and expanded.
- Introducing large scale plastic recycling into the process will again increase the need for lignite or black coal.

Note that all of the above estimates are of a relatively low accuracy. Improving the accuracy of the estimated waste – coal/lignite blends over the life of the plant is considered an important pending design task for Phoenix and will be an ongoing operational need.

BFB systems are generally able to manage relatively wide variations in fuel composition as long as the overall heat content remains high and the fuel particle size range is appropriate. As such, the anticipated high lignite or coal inputs are not considered to be a feasibility issue. Given that process efficiency and pollution controls work best at high temperatures, which correspond to high lignite/coal inputs, there is a clear technical incentive to maximize the lignite/coal inputs.

What is impacted is the economics of the Scenario 2 project. With a PPA tariff of approximately US \$0.25kW/hr, the economic margin from burning black coal is anticipated to be much higher than either waste or lignite. Hence increased black coal use improves the financial viability of the project. Given the expected economic challenges and risks facing the project overall, this is positive – as long as the WM goals are also achieved in full.

15.2.4. Performance differences between lignite and black coal

The heat content of the processed Maissade lignite is estimated by Phoenix to be 7,300 BTU/lb^(15.1). The heat content of the imported coal is proposed at no less than 10,000 BTU/lb, with an expected content of 11,200 BTU/lb^(14.2) if Colombian coal is selected.

The most basic difference between Scenario 1 (lignite) and Scenario 2 (black coal) is that approximately 40 percent more of the former fuel is required to deliver equivalent performance. The second difference is in the materials handling challenge – lignite is prone to absorbing water during transport and storage, whilst black coal is not. Finally there are major differences in ash generation.

The ash content of the lignite is very high and estimated by Phoenix at 40 percent. The ash content of the black coal is not specified, but is expected to be in the range of 6 to 10 percent^(15.2).

Lignite firing will result in a significant ash-handling burden. Unless sold, the ash will also take up a significant part of the landfill void space. This is not considered a feasibility issue, however it will increase costs.

15.2.5. Stack air emissions and waste destruction

The stack air emissions of a WtE plant are closely linked to its operational efficiency and its operating temperature in particular. In that context, the concerns noted for Scenario 3 are greatly reduced for Scenarios 1 and 2. If the routine operations are stable and at a high temperature, then the potential problems are confined to startup and breakdowns. Emission problems at startup could be significantly reduced by appropriate phasing of fuel inputs (black start using fuel oil, then lignite/black coal and then waste).

In summary, stack air emissions and waste destruction are important issues, but not considered problematic in the case of Scenarios 1 and 2. Air emissions modeling studies would be required to validate these early predictions.

15.2.6. Groundwater availability

All of the groundwater availability issues noted in Chapter 13 apply to Scenarios 1 and 2 and in fact are increased in scale by 60 percent. Extracting 150m³/day of good quality groundwater on a sustainable basis is expected to be a major challenge.

15.2.7. Technical feasibility summary

In summary, the proposed 50MW dual fuel plants are anticipated to be technically feasible and relatively efficient, with Scenario 2 (black coal) operating more efficiently than Scenario 1 (lignite) due to the higher energy density and the lower ash content of black coal. Scenario 2 is also expected to be more economically viable.

15.3.Environmental impacts and risks

15.3.1. Key impacts and issues

The proposed 50MW plants have the same type of local environmental impacts and risks as the 30MW plant, with discussion limited to the following three items:

- Plant air emissions.
- Groundwater extraction.
- Impact of cooling water on marine biodiversity.

15.3.2. Plant air emissions

As discussed in Chapter 13, air emission issues are expected to occur principally upon startup and in the event of performance problems. A definitive assessment cannot be made in the absence of an air pollution modeling study, however air emissions are not anticipated to be problematic. Again the village located 300m west of the site is the most affected by any issues.

Scenario 1 is expected to result in larger air emission issues due to the lower energy density and higher sulphur content of the fuel. High sulphur fuel can result in high SO_x emissions in the absence of sufficient emission controls. In the case of Project Phoenix limestone injection is proposed, which is anticipated to greatly reduce but not eliminate SO_x emissions.

15.3.3. Groundwater extraction for process water

Groundwater scarcity is expected to be an issue for both Scenarios 1 and 2, with the same issues but on a significantly larger scale than for Scenario 3.

15.3.4. Cooling water biodiversity impacts

The impact of the seawater cooling system on marine biodiversity is anticipated to be important for Scenarios 1 and 2, with the same issues but on a significantly larger scale than for Scenario 3. UNEP estimates that an outfall pipe of at least 1,000m will be required. This is entirely feasible but will increase costs.

As per Scenario 3, a definitive view on the environmental impact of the cooling water on marine biodiversity will need to await a robust baseline study on the local marine environment and a technical design and impact study. It is too early and there is insufficient data for UNEP to provide a definitive opinion on this topic.

As per Scenario 3, the cooling system strategy may need to be changed to wet or dry-closed loop systems. This decision cannot be made with current information.

15.4.Greenhouse gas emissions

15.4.1. Methodology and model inputs

GHG emissions have been calculated for the WtE component of Project Phoenix. IPCC methodologies have been utilized to the extent feasible^(15.3). Details of the parameters used and assumptions made are provided in Annex G.

The key input parameters and assumptions used for the baseline are as follows:

- UNEP waste survey characteristics are used.
- A project lifetime average of 2,000 tonnes of waste per day.
- No emissions from wastes received but not incinerated.
- Scenario 1: Co-firing of 730 TPD of lignite
- Scenario 2: Co-firing of 320 TPD of black coal

15.4.2. GHG model outputs

An Excel model using the above noted list of inputs generated the following summary outputs.

Source	TCO	TCO
Waste combustion	343,000	10,290,000
Lignite option	460,000	13,800,000
Black coal option	263,000	7,890,000
Total TCO Scenario 1	App. 803,000	App. 24,090,000
Total TCO Scenario 2	App. 606,000	App. 18,180,000

The accuracy of this forecast is considered to be no better than +/- 30 percent.

15.5.Social impacts and risks

The social impact of the 50MW plant construction and operation is anticipated to be overall highly positive. The largest positive impact will be direct and indirect job creation, both skilled and unskilled.

The most important social risk is local nuisance and health problems if the facility continually under performs on emissions controls. This in turn is anticipated only if the facility has significant operational issues with burning wet waste, as noted above. Given the benefits of the dual fuel system this is regarded as a low risk.

15.6. Findings Summary

50MW Dual fuel Plants Scenarios 1 and 2	
B. Technical feasibility	<p>The plant is expected to be feasible and operate relatively efficiently, albeit with high lignite/black coal inputs. Groundwater scarcity may increase costs.</p>
C. Environmental impacts and risks	<p>Significant environmental risks from groundwater extraction and seawater once-through cooling are noted. Air emissions are anticipated to be important but not problematic. Detailed studies and significant infrastructure commitments would be required.</p>
GHG emissions	<p>The UNEP model indicates a project component lifetime GHG emission total of approximately 24.0 million tonnes CO for the 50MW lignite co-fired WtE plant and approximately 18.2 million tonnes CO WtE plant. The lower energy density and higher MC of lignite results in a lower useful energy output/tonne of combusted carbon.</p>
A. Social impact and risks	<p>Apart from the limited air emissions risks noted separately above, the social impacts are anticipated to be positive.</p>

15.7. Chapter references

15.1 IEP. Phoenix Business Plan version March 2012

15.2 Genesis Capital Management. Colombia Coal specifications
<http://www.genesisny.net/Commodity/Coal/Coal.html>

16. Grid Interconnection

16.1. Subproject description

16.1.1. Introduction

This chapter presents an assessment of the grid interconnection component of Project Phoenix. It applies to all design scenarios and is based largely upon the following materials:

- An electrical engineering study developed in 2011 by the consulting firm PE on behalf of Phoenix^(16.1)
- The Phoenix Business Plan version March 2012^(16.2)

The PE study noted that the information supplied by EDH was insufficient for a rigorous analysis, hence several assumptions were made, which may or may not remain valid for 2014 and beyond.

16.1.2. Transmission and interconnection infrastructure

The PE study concluded that the nearest fully suitable connection point for receiving the extra 50MW produced by Project Phoenix would be the Croix des Missions substation. This substation is located 14km from the Aubry site and is linked via a 69 kilovolt (kV) transmission line to the larger New Delmas substation. The shortest viable transmission line from the Aubry site to the Delmas substation is estimated to be approximately 21km in length. This line could be 115kV as New Delmas has the capacity to receive and transmit this voltage.

At both substations a range of routine items are required for interconnection to the PaP grid (buses, bays, switchgear and breakers).

16.2. Technical feasibility

16.2.1. Demand and supply balance and grid stability

Both the Phoenix and the UNEP assessment indicate that there is a medium to long-term demand-supply gap and so overall it is anticipated that the 30MW to 50MW supplied by Phoenix will be accepted by EDH or other future buyers.

However in the short to medium term it is anticipated that the instability currently seen in the PaP grid will continue. Therefore it is anticipated that there will be periods when power from Phoenix is available but some or all of it cannot be accepted. Some but not all of these periods will be linked to lower demand in the off-peak hours and during the weekends.

In the latest offer the Phoenix consortium has explicitly accounted for this issue with the proposed 65 percent capacity factor, whilst the proposed guaranteed plant availability is actually over 80 percent. Phoenix provided the following provisional schedule to UNEP as a clarification to the latest offer.

Target availability	90%
Peak power production (100%)	12 hours
Intermediate production (70%)	4 hours
Off peak (40%)	8 hours

In summary, there is some flexibility built into the Phoenix commercial offer which will assist in the technical feasibility of matching supply and demand. Nonetheless grid instability is expected to result in some take or pay charges to EDH.

16.2.2. Transmission

The Phoenix offer includes construction of the transmission line and the required connection equipment at either Croix des Missions or New Delmas substations. Transmission line construction and high voltage interconnection is a routine process and so its feasibility is not in question.

What has not been examined in any detail to date is the potential for optimization of the investment in transmission by integrating it into a larger master plan for the PaP grid. A particular point to note is that the Aubry site is on the well-populated strip between Titanyen and St Marc, which is a planned corridor for grid expansion.

16.3. Environmental impact and risks

16.3.1. Transmission lines

Only very limited environmental impacts are anticipated for the transmission line between Aubry and either Croix des Missions or New Delmas. Some very limited land take is required for the transmission towers. The bulk of the land along the route is agricultural or urban fringe.

16.4. Social impacts and risks

16.4.1. Transmission lines

The social impact of the interconnection including transmission lines is anticipated to be very minor. Some very limited resettlement may be required for locating the transmission towers.

16.5 Findings Summary

Grid Interconnection	
B. Technical feasibility	Grid interconnection is expected to be feasible, however EDH grid instability is expected to cause some problems and take or pay costs to EDH. The potential for improved integration of the plant into an EDH/transmission master plan has yet to be explored.
A. Environmental impacts and risks	Environmental impacts and risks are expected to be negligible.
Greenhouse gas emissions	Negligible
A. Social impact and risks	Social impacts are expected to be minor.

16.6.Chapter references

16.1 PE and Atkins (2011). Technical memorandum: Preliminary Load Analysis, Haiti

16.2 The Phoenix Business Plan version March 2012

Section D - Integrated Analysis and Recommendations

17.Integrated Analysis

17.1.Introduction

17.1.1. Analysis scope and structure

The analysis is structured into three parts:

- Collation and basic analysis of the project level findings.
- Collation and ranking of the assessment results for all project components, resulting in a ranking of Scenarios 1, 2 and 3.
- A broad discussion of noted trends, interlinkages and strategic issues.

17.1.2. Collated project level findings

All of the finding summaries from Chapters 2 to 10 have been collated in table form below.

The project development model	
A. The overall development model	The debt-financed private sector development model appears well-suited to the project context. The alternatives look less viable.
B. Shareholding	The proposed shareholding appears reasonable, although the GoH and Haitian private sector shares could be increased.
A. Operational planning	Operational planning is sufficiently detailed for this stage and includes a range of positive features.
C. Waste collection management model	The rationale and benefit of SMCRS retaining a substantial role in waste collection is unclear. This arrangement appears inefficient.
A. The bundled service model and transfer pricing	The bundled waste energy service model appears sound and the extent of transfer pricing appears reasonable and entails a slight benefit transfer towards the poorest population.
Legal issues	
D. Legislative compliance of the original Phoenix sole source procurement process	The original procurement process is interpreted as partially flawed and not good practice and exposes the project and the government to legal challenge. Due to some space for interpretation in the relevant legislation, it may be legally compliant even if partially flawed, however this is not an issue where UNEP can provide a definitive ruling.

B. Legislative compliance of the revised offer for open-book partial competitive bidding	The revised offer is a positive change, which partially mitigates the original flaws. It is however yet to be delivered and should be subject to CNMP input and approval.
A. Legislative compliance of the proposed SAM structure	The proposed SAM structure is in compliance with Haitian legislation and a good example of securing government shareholding and influence in a public-private partnership.
E. The lack of contingency terms and expiry dates	The lack of contingency terms and expiry dates indicates a risk of legal disputes and constrains the options of the GoH.
E. The potential to worsen the FDI risk perception of Haiti	The need to avoid worsening the FDI risk perception of Haiti constrains the options of the GoH and the need to be transparent and adhere to Haitian procurement law.
D. Government land obligations in the MSA and PPA	The land provision obligations appear beyond the current capacity of the government to deliver in a timely manner. No requirements for free, prior and informed consent to be given by local communities prior to granting of concessions. No clear benefit sharing requirements with local communities hosting mining sites.
C. Government permitting obligations in the MSA and PPA	The permitting obligations appear beyond the current capacity of the government to deliver in a timely manner.
C. MSA and PPA clarity	The MSA and PPA have a number of items where clarification and/or extra detailing are a priority.
B. Validity and integration of the revised offer	Integration of the revised offer into the original MSA and PPA is a substantive task requiring specialist support.
E. The legal monopoly of EDH	The EDH monopoly constrains options for improving the financial viability of Project Phoenix.

Waste sector needs and feedstock	
A. The waste collection catchment	The proposed Phoenix waste collection catchment appears viable, although covering slightly different areas from the UNEP assessment.
C. Waste collection tonnage design criteria	The Phoenix design criteria of initially 1,640 tonnes of waste collected per day appears slightly optimistic – with UNEP estimating initially 1,400 TPD as being more reasonable. This is very important for Scenario 3 but has limited impact on Scenarios 1 and 2.
A. Future management of collected wastes	Phoenix offers a full spectrum solution for WM – it is designed to receive and manage a large volume of practically all forecast waste types.
C. Current management of collected wastes at Truitier	Phoenix will in practice fully remove the need for the continued operation of the Truitier landfill. However current IEP proposals include for ongoing limited operation of Truitier by the GoH.

D. Truitier landfill legacy	The current scope of Project Phoenix does not include any funds or works to enable closure of Truitier in a responsible manner. A minimum of US\$3 to US\$5 million is needed for this work. There is the potential for CDM funding.
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Electricity demand	
A. Electricity demand model results	Simple estimates and forecasts based upon available information indicate a substantial and growing supply-demand shortfall that Phoenix can help address.
D. Electricity demand model assurance	At present inadequate planning and communication by EDH and the GoH critically undermine the confidence of any Haitian electricity sector demand assessment. The level of assurance at present is expected to be insufficient to secure project financing.
A. Generation scheduling by financial merit	A current IPP cost comparison indicates that Phoenix generation should be scheduled at a high priority and that the MSA-PPA take or pay terms do not result in a major practical or financial risk for the GoH (with respect to demand and scheduling).

GoH policy, political support and the counterpart role	
B. Alignment with national energy policy	There is a good fit between Project Phoenix and the GoH draft policies and ambitions for energy development. Deficiencies in the latter result in ongoing uncertainty.
B. Alignment with national WM policy	There is a good fit between Project Phoenix and the GoH draft policies and ambitions for WM. Deficiencies in the latter result in ongoing uncertainty.
A. Alignment with national foreign investment policy	There is an overall very good fit between Project Phoenix and the GoH policies and ambitions for foreign investment.
B. High level political support	High-level political support has varied but overall is high.
D. Government counterpart role	Further development of the project is not viable in the absence of significant performance improvements by the GoH in its role as a key project partner – returning to the level of support it provided between 2011 to Q1 2012.

The project organization	
A. Organizational structure and shareholding	The consortium shareholding and structure is clear. Shareholding includes national content and ten percent government ownership.

B. Lead developer capacity and focus	Very strong capacity in general power project entrepreneurship and core business focus. Three clear experience gaps noted, which are partly mitigated through the consortium partners and evolving experience.
B. Project Phoenix development and consortium composition, capacity and coherence	A strong consortium with a full project development skill set and appropriate Haitian national content and roles. However IEP relies very heavily on outsourcing and the extended project development schedule has probably stress-tested the cohesion of the consortium.
A. Project consortium investment to date	The consortium has clearly already invested several million in equity and finance in project development. UNEP has not verified whether or not the consortium has the means to continue to fund development until financial close and/or cover remaining funding gaps.
B. Project consortium capacity to finance further project development	There are reasonable indications that the consortium will be able to finance further project development prior to securing project finance.
B. Project financiers	Discussions with potential project financiers have been started and the current preferred financier (OPIC) is a very strong USA government-backed organization.

Stakeholder engagement and transparency	
B. International stakeholder engagement	Substantive efforts have been made in international stakeholder engagement, but clearly more needs to be done.
D. Key international stakeholder feedback and positions	Three key international organizations have stated their concerns in writing. This action has eroded GoH support and indirectly blocked access to low cost project financing. UNEP considers that as a result Project Phoenix is not feasible unless these concerns are resolved.
C. Transparency during project development	The level of transparency displayed during project development has been insufficient, principally on the side of the GoH. This deficiency has been exacerbated by limited correspondence and poor record keeping by the GoH.
D. Corruption prevention	Cases of attempted corruption have already been reported by IEP and at present no mechanisms are in place to prevent further occurrences.
D. Independent oversight	Independent oversight of the project development process has been lacking, due to the non-involvement of the CNMP and the absence of an independent international counterpart.

GHG emissions and climate funding	
A. GHG emissions	The project footprint is not climate neutral but is considered very efficient in terms of benefits/kg of GHG emissions.
B. Climate funding	The high GHG emissions associated with the status quo indicate scope for investment in emissions reduction and securing carbon credit funding. However the purely economic case for such investment currently appears very weak due to technical eligibility issues and very low carbon trading prices.

Economics	
D. Cost and return estimation	Phoenix and UNEP estimates of the costs of the project differ by up to 40 percent for individual parameters and 25 percent overall. The revised offer is not supportable based on the UNEP pessimistic case estimates.
A. Value	National and international benchmarking indicate that the project overall represents good value, if the revised offer can be maintained.
B. Financial exposure and benefits	The extent of financial exposure appears reasonable compared to the benefits.
B. Balance	The balance of obligations, benefits and risks between the GoH and Phoenix shareholders appears overall to be fair, with a heavy risk loading on the side of Project Phoenix and a significant obligation on the part of the GoH.
D. Affordability	At present EDH cannot afford the capacity and energy payment obligations of Project Phoenix. Both energy sector reform and major improvements in EDH are required to resolve this situation.

Table 17.1.1 Project Level findings

Rating	Description	Number of findings
All		45
A.	Positive : No concerns and positive features noted in some cases.	13
B.	Neutral: No major concerns noted, but more detailed work anticipated.	13
C.	Concern: Concerns, risks or uncertainties noted that would need to be adequately addressed to enable the project to proceed to financial close. Also clear and major opportunities for improvement not yet highlighted as such.	6
D.	Negative: Clear and major concerns and uncertainties that will completely stop the project well before financial close unless resolved.	10
E.	Strategic Issue: A clear and major concern that has implications well beyond the success or failure of the project.	3
C+D+E	Project level concerns, risks and uncertainties that need early resolution	19

Table 17.1.2 Project level findings statistics

17.2. Project Component Ranking

17.2.1 Collated findings for components and options

The summary findings for each project component and option are presented with comments in the table overleaf and with ratings only below.

Component Option	Status Quo	Waste Mgmt	Grid Inter-connect	Lignite Mining Option	Coal Import Option	30MW WtE plant Option	50MW Dual fuel plant Options
Technical feasibility		C	B	B	B	D	B
Environmental benefits, impacts and risks		A	A	B	B	C	C
Social impacts and risks		C	A	C	A	B	A
G H G emissions million tonnes CO	19.0	4.0	App. Nil	0.7	0.80	11.3	1) 24.3 2) 18.2

Table 17.2.1 Project Component summary

Component Option	WM – collection, recycling, disposal	Haitian lignite mining and transport option	Coal Importation option	Waste only 30MW plant option	Dual fuel 50MW plant options	Grid interconnection
Technical Feasibility	C. The technology proposed is proven, but with significant further work required on cost and performance optimization for management of wet organic wastes.	B. The technology proposed is proven, with further work required on wet season materials management and dewatering.	B. The technology proposed is routine, with further work required on jetty and channel design.	D. The plant is expected to operate very inefficiently due to the low energy content and variability of the waste, which may also result in emission problems. The plant will be very difficult to size correctly in order to economically manage all of the collected waste. Groundwater scarcity may increase costs.	B. The plant is expected to be feasible and operate relatively efficiently, albeit with high lignite/ black coal inputs. Groundwater scarcity may increase costs.	B. Grid interconnection is expected to be feasible, however EDH grid instability is expected to cause some problems and take or pay costs to EDH. The potential for improved integration of the plant into an EDH/ transmission master plan has yet to be explored.
Environmental impacts & risks	A. An overall positive environmental impact is anticipated.	B. The normal range of lignite mining impacts and risks are anticipated, however the rural environment is generally of moderate to low sensitivity.	B. Environmental risks to the coastal environment are noted, however the risks and sensitivity of the local environment are considered moderate. Further work is needed on minimization of impact on any remaining fringing coral reefs.	C. Significant environmental risks from air emissions, groundwater extraction and seawater once-through cooling are noted. Detailed studies and significant infrastructure commitments would be required. The air emission concerns are fully linked to the process efficiency concerns.	C. Significant environmental risks from groundwater extraction and seawater once-through cooling are noted. Air emissions are anticipated to be important but not problematic. Detailed studies and significant infrastructure commitments would be required.	A. Environmental impacts and risks are expected to be negligible.

Component Option	Waste Management – collection, recycling, disposal	Haitian lignite mining and transport option	Coal Importation option	Waste only 30MW plant option	Dual fuel 50MW plant options	Grid interconnection
Social impacts & risks	C. Social impacts are anticipated to be overall highly positive, however some of the existing informal workforce of waste-pickers will lose their livelihoods. Inadequate GoH management of the compulsory purchase and resettlement process is noted as a high-risk.	C. Social impacts are anticipated to be very mixed. Employment benefits are expected to be positive. Road transport impacts and risks are expected to be significant. Inadequate GoH management of the compulsory purchase and resettlement process is noted as a high-risk.	A. Social impacts are anticipated to be negligible.	B. Apart from the significant emissions risks noted separately above, the social impacts are anticipated to be positive.	A. Apart from the limited air emissions risks noted separately above, the social impacts are anticipated to be positive.	A. Social impacts are expected to be minor.
GHG emissions	The UNEP model indicates a project component lifetime GHG emission total of approximately 4.0 M tonnes CO Equivalent. Over 95 percent of those emissions are generated by uncollected waste and Truitier legacy waste emissions.	The UNEP model indicates a project component lifetime GHG emission total of approximately 0.7 M tonnes CO Over 85 percent of the emissions are generated by the mining operation.	The UNEP model indicates a project component (shipping) lifetime GHG emission total of approximately 0.8M tonnes CO Equivalent	The UNEP model indicates a project component lifetime GHG emission total of approximately 11.3M tonnes CO	The UNEP model indicates a project component lifetime GHG emission total of approximately 24.3M tonnes CO Equivalent for the 50MW lignite co-fired WtE plant and approximately 18.2M tonnes CO Equivalent for the 50MW black coal co-fired WtE plant. The lower energy density and higher MC of lignite results in a lower useful energy output/tonne of combusted carbon.	Negligible

Table 17.2.2 Project Component Collated Findings

17.3.Scenario ranking

17.3.1. Scenario comparisons

The three different scenarios are presented in the following tables.

Component Option	WM	Grid Inter-connect	Lignite Mining	50MW Dual fuel plant	Total
Technical Feasibility	C	B	B	B	
Environmental benefits, impacts and risks	A	A	B	C	
Social impacts and risks	C	A	C	A	
GHG gas emissions	4.0	0	0.7	24.3	29.0

Table 17.3.1A Scenario 1 summary

Component Option	WM	Grid Inter-connect	Coal Import	50MW Dual fuel plant	Total
Technical Feasibility	C	B	B	B	
Environmental benefits, impacts and risks	A	A	B	C	
Social impacts and risks	C	A	A	A	
GHG emissions	4.0	0	0.8	18.2	23.0

Table 17.3.1B Scenario 2 summary

Component Option	WM	Grid Inter-connect	30MW WtE plant	Total
Technical Feasibility	C	B	D	
Environmental benefits, impacts and risks	A	A	C	
Social impacts and risks	C	A	B	
GHG emissions	4.0	0	11.3	15.3

Table 17.3.1C Scenario 3 summary

17.3.2. Analysis and ranking

Scenario 2 has the highest ranking combination of options, followed by Scenario 1, with Scenario 3 ranked last, as UNEP considers it to be technically problematic, economically unfeasible and uncompetitive.

For Scenario 2, there are three key issues of concern:

- The need for design improvements in the pre-treatment of organic wastes.
- The environmental risks and impacts of power generation, particularly on marine biodiversity and groundwater resources.
- The social impact and risks of waste collection.

17.4.Greenhouse Gas emissions per Scenario

The forecast GHG emissions for the status quo and the three scenarios must all be regarded with some caution, given the limitations on both the current data and the validity of extrapolation. Nonetheless, similar assumptions and industry standard parameters have been used to generate the forecasts, so it is valid to compare the forecasts to each other, even if the absolute values have low inherent accuracy. The only caveat on this is that Scenario 2 has a positive bias on GHG emissions due to the omission of emissions linked to mining overseas and road/rail transport to the port prior to export. However even if an equivalent in-country mining effort to the lignite option was assumed, the net impact of GHG emissions is relatively low.

Scenario	Project Lifetime GHG Emissions million tonnes CO	Emission : energy efficiency tonnes CO
Status quo	19.0	Zero energy production
1 – 50 MW WtE+ lignite	29.0	2,213
2 – 50MW WtE + black coal	23.0	1,750
3 – 30MW WtE only	15.4	1,959
Benefit of adding the proper closure of Truitier to all 3 Scenarios	- 1.3	App. +5-8 percent overall improvement

The GHG modeling results indicate several important points:

- The GHG emissions from continuing with the status quo are estimated at 60 percent to 94 percent of the emissions of the various project scenarios. Therefore the energy and other benefits of Project Phoenix would come at a relatively low cost in GHG emissions. The most climate efficient option, Scenario 2, delivers energy at a stand alone rate of 1.75kg CO₂Eq per kW/hr and an incremental rate of 0.6kg CO₂Eq per kW/hr. Compared to reference tables from the International Energy Agency (IEA)^(17:1), this places the energy production - GHG footprint of the entire project compared to the no-project case as lower than a Heavy Fuel Oil plant (0.67kg) but higher than natural gas (0.4kg). Hence the project is not climate neutral, but it is efficient in terms of the combined energy and other benefits per kg of GHG emissions.
- The addition of lignite or imported coal has an important impact on GHG emissions as expected, but this impact is on the same scale as the projected emissions from the status quo.
- The lowest GHG emissions in total will be achieved from Scenario 3 (waste only), but the lowest GHG emissions per delivered MW/hr will be achieved from Scenario 2 (waste plus imported coal).
- A significant reduction in GHG emissions could be achieved through the proper closure of Truitier landfill.

17.5.Discussion

17.5.1. Initial appraisal of the collated findings

The collated project level and project component findings present a mixed picture.

Positive aspects There has clearly been substantive investment in solution development and the project has many positive features. Currently the project demonstrates good value and balance, and the potential for further improvement. The project development consortium appears overall sound. The project is relatively positive from a climate change perspective although it could be improved further.

The most recent Phoenix offer and development of different scenarios represents a significant improvement on the original proposal. For UNEP at least, there is a clear ranking of scenarios, with Scenario 2 being the obvious choice on economic, environmental, climate change and social grounds.

Negative aspects The project is clearly still at an early and high-risk stage of development and it has encountered a range of difficulties to date. Uncertainty remains over the project economics and hence the capacity of the Phoenix consortium to deliver on the revised offer. UNEP counts a total of 22 concerns, risks, uncertainties and opportunities for improvement that are expected to need resolution for the project to fully succeed (the sum of project level findings ranked either C, D or E plus 3 project component findings for Scenario 2).

Critically, many of these issues are out of the control of the Phoenix consortium and fall within the responsibility of the GoH. The original procurement process was flawed and transparency was insufficient, although these issues do have some potential for improvement as the project continues to develop.

Strategic aspects and agreement legacies Project Phoenix is a large potential project and it is also a highly visible test case for the GoH and for the ongoing potential for large scale foreign investment in Haiti. Notwithstanding the flaws in the sole source procurement process, the GoH and an international private sector investor have signed a major agreement in apparent good faith and the investor has as a result invested several million dollars, entirely at risk, in project development.

It is considered very important for the credibility of the GoH and the economic future of Haiti that major public-private agreements once signed are honored. Projects may advance, be altered or be dropped with mutual agreement as appropriate, however the core principles of trustworthiness and

professionalism need to be visibly demonstrated if Haiti wishes to attract large scale FDI and move away from aid dependency. At the same time, the noted flaws in the procurement process must be resolved if at all possible in order to ensure legal compliance, provide assurance to external parties and protect the project from future legal challenge.

17.5.2. The status quo and alternatives to Phoenix

The quality and potential of Project Phoenix is relative: it needs to be judged against the current situation and the viable alternatives. In this context UNEP has researched the current situation and searched for evidence of existing or emerging alternatives. Its findings in summary are as follows:

- Clearly the existing situation (the no-project case) is highly problematic and a major obstacle to the sustainable development of Haiti. In both the WM and energy sectors, the GoH is clearly struggling to even maintain the current poor levels of service and has negligible potential for improving the situation with its own financial and technical resources.
- UNEP has found no evidence of emerging credible alternative or competing solutions in the WM sector. The sector is clearly neglected by Haiti's international development partners and all other projects noted to date are very small sector specific solutions such as the promotion of small gas biogas units.
- There are multiple competing alternatives in the private electricity supply sector. According to the GoH Minister Delegate for Energy Security, there is no shortage of firms looking for a market opportunity and presenting speculative proposals to EDH and the GoH for power generation via gas, coal, wind, solar and hydropower. However UNEP considers that there are three important caveats to these alternatives:
 - Phoenix already has a signed agreement and has invested heavily in project development. Both legally and practically, Phoenix should take precedence if sequencing becomes an issue.
 - Many of the findings noted in this review are not linked to either the project consortium or the design. They instead reflect problems in the wider energy project investment environment of Haiti. Hence every proposed alternative is expected to strike many of the same issues noted in this review. The enthusiasm of some private sector promoters in part may reflect that they have yet to investigate in depth or practically encounter the issues already faced by the Project Phoenix consortium.
 - Speculative and caveated offers of low energy prices are not considered equivalent to firm offers linked to a signed agreement. The potential savings offered by some alternatives are expected in the end to prove illusory.

17.5.3. The extent and impact of poor EDH performance

The key finding that Project Phoenix is currently not financeable due to EDH financial difficulties is simply indicative of the broad-ranging damage inflicted on the economy of Haiti by EDH in its current form and the expected difficulty in resolving this issue.

In this specific case, the current status of EDH effectively excludes the implementation of a project that has the potential to:

- Lower EDH average power generation costs.
- Improve grid stability.
- Greatly reduce load shedding.
- Provide a cheaper and less polluting alternative to up to 50MW of power that is currently generated off-grid by literally thousands of standby generators.

Substantial reform of the energy sector and EDH is warranted to break this negative cycle.

17.5.4. International stakeholder engagement and patronage

The difficult history of Project Phoenix linked to its engagement with key international stakeholders illustrates the critical role of bilateral or multilateral political patronage for project development in Haiti.

The current trend in development aid allocation is clearly seen in the list of current and recent major energy projects funded by development aid in Haiti. These projects include:

- Grant funding of construction of a 10MW thermal plant and a 2MW solar photovoltaic plant in Caracol (funded by the Government of USA)^(17.2).
- Péligre hydroelectric scheme refurbishment (funded by IDB) ^(17.3).
- Transmission and distribution scheme upgrades (funded by the USA, IDB and the WB) ^(17.4).
- Early project development of the Artibonite 4C hydroelectric scheme (funded by IDB, the Government of Brazil and now the Government of China)^(17.5).
- Early project development of South Department small-scale hydroelectric schemes (Government of Norway and the Global Environment Fund)^(17.6).

All of these projects have a much smaller individual capital cost than Project Phoenix, but all also have some level of international political patronage – each project has or had the explicit backing of a member state or powerful multilateral institution.

The lesson for Phoenix is implicit but clear – project success is unlikely in the absence of a financially and/or politically powerful international patron organization: either a government or a multilateral institution. Note that UNEP can never play the role of such a patron, as it is both working in a neutral facilitation role and it is insufficiently powerful.

17.5.5. Investment coordination and catalysis of private sector investment

In September 2012, the GoH issued a shortlist of priority investments for the Haiti energy sector^(17.7). The total investment cost was in the order of US\$2 billion and included WtE. Whilst this list was never endorsed by the international development partners of Haiti, UNEP considers it nonetheless to be a valid order of magnitude estimate of the required scale of investment and a useful tool for coordination and investment prioritization.

Since then, the total of the grant investments allocated to date by international partners is very approximately US\$300 million, representing 15 percent of the government target. This is commendable, however there are no further plans in the public domain for vast increases in grant funding within the next two years. This still leaves 80 percent to 85 percent of the government list un-financed.

What is currently missing is a concerted effort to secure the missing 80 percent plus of investment from the private sector. At present, based on funding allocations, the experience of the Project Phoenix consortium and background communications between UNEP and several donors, the majority of donors are not highly motivated to assist the GoH in either securing appropriate private sector investment or accelerating privatization.

This is considered problematic, as the GoH has understandably become frustrated with this impasse and has attempted to fast-track private sector investment and partial privatization without international development partner assistance or endorsement. Many of the issues noted in the Project Phoenix review can be sourced to this break in working relations and lack of teamwork.

A relatively simple solution to this impasse would be for grant funding to support more substantive and high-level TA to the GoH in the field of energy policy and planning. Such assistance is planned in the WB project listed above, but has yet to be effectively accessed.

17.6. Chapter references

17.1 IEA - CO₂ emissions from fuel combustion, Highlights 2012

17.2 USAID Haiti Energy webpage <http://www.usaid.gov/haiti/energy>

17.3 IDB. Haiti Energy Project list – latest entry
<http://www.iadb.org/en/projects/project-description-title,1303.html?id=HA-L1083>

17.4 WB. Project information: Rebuilding Energy Infrastructure and Access Project
<http://www.worldbank.org/projects/P127203/rebuilding-energy-infrastructure-access?lang=en>

17.5 IDB Artibonite 4C Feasibility Study Terms of Reference
<http://www.iadb.org/en/projects/project-description-title,1303.html?id=HA-T1150>

17.6 UNEP (2012). Project Document, “Haiti Sustainable Energy – South Department, NMFA Project”

17.7 GoH (2012). Multi-Sectoral Committee for Energy Security. Electricity Action Plan

18.Recommendations

18.1.Introductions

18.1.1. Structure, audience and status of the UNEP recommendations

The UNEP recommendations are delivered at two levels and in sequence – first strategic and then detailed recommendations. The detailed recommendations are only relevant if the strategic recommendations are followed first.

The primary audience for the strategic recommendations is the senior leadership of the GoH including the President, Prime Minister, ministers and the director generals of SMCRS and EDH. In addition, the Project Phoenix consortium is a key part of the primary audience.

The primary audience for the detailed recommendations is the GoH and Phoenix teams empowered to implement the decisions taken by the senior leadership. The importance of the many other key project stakeholders is acknowledged, however only the parties listed above have recommended actions.

As per the whole report, the UNEP recommendations are delivered as TA: no party is under any obligation to respond to or implement.

18.2.Strategic recommendations

18.2.1. Sequenced recommendations and decisions

To progress and/or resolve the current issues related to Project Phoenix, the GoH will need to make and then implement a number of clear decisions. To facilitate this process, the strategic recommendations provided by UNEP are set out in the form of a decision tree, with a set sequence.

18.2.2. Progress, exit or abandon

The first decision required is on the overall direction of future development of the project. The three main choices are:

- **Progress.** Attempt to progress development of the project, whilst preparing contingency measures in case development of the project proves impossible within a reasonable timeframe.
- **Exit.** Attempt to cancel the project, to enable the timely development of alternative solutions for WM and energy production.
- **Abandon.** Take no further action related to Project Phoenix and react only as needed in the event that IEP takes legal action.

The recommendation of UNEP is to **Progress**. The rationale for this recommendation in summary is:

- Development of the project will be very challenging, but does appear feasible in the medium term.
- The project overall appears to be quite beneficial to Haiti.
- The current project plans, designs and agreements have potential for improvement.
- At this stage, there is no competing or proposed viable alternative WM solution.
- The Project Phoenix offer to move to open-book partially competitive tendering will partially mitigate the noted flaws in the original procurement process and may yield improved value.
- Submission of the project to CNMP approval (see below) will, if approved, further mitigate the procurement flaws.

- Unilateral exit or abandonment will expose the GoH to potential IEP legal action.
- Unilateral exit or abandonment will also harm the reputation of the GoH and may deter other FDI.

To enact this recommendation, it is suggested that the senior leadership of the GoH are provided with this report and are briefed and then convene a special meeting to communicate a clear unified decision and mandate follow-up for specific GoH authorities. UNEP would be pleased to attend such a meeting to answer any queries.

18.2.3. Procurement - Open-book partially competitive tendering and CNMP submission

The second high-level decision is on action to repair and improve the procurement process. The recommended actions are to **a) accept in principle the revised IEP offer of open-book partially competitive tendering; and b) engage and seek the formal approval of CNMP in progressing the revised offer.** Doing this will put the entire project at risk, as CNMP may or may not approve of it. If it does not then an orderly exit is the only viable scenario.

In this context the rationale for this recommendation is as follows:

- The revised offer is a significant improvement on the current obsolete offer;
- The project and associated procurement process needs to return to full and clear compliance with Haitian legislation. CNMP engagement is one key part of that process.

18.2.4. Scenario selection

The third high-level decision is selection of one of the three project scenarios presented by Phoenix and reviewed by UNEP:

Scenario 1 - Waste collection, lignite mining and WtE

Scenario 2 - Waste collection, coal import and WtE

Scenario 3 - Waste collection and WtE only

The recommendation of UNEP is to select **Scenario 2 and cease any further work on Scenarios 1 and 3.** The rationale for this recommendation in summary is:

- Scenarios 1 and 2 will deliver up to 50MW, and so would fill more of the noted electricity supply-demand gap of 85MW to 111MW than Scenario 3, which will deliver only 15MW to 30MW.
- However the environmental and social impact of Scenario 1 is significant, due to the distance of the lignite mine from the WM and WtE operations.
- Scenario 1 also includes substantial and difficult land purchase and resettlement obligations for the GoH and the Phoenix consortium.
- The lignite proposed for use in Scenario 1 is not a high-value fuel and the value of both mining and transporting is relatively marginal compared to the impacts.
- Scenario 2 has the highest technical performance and lowest technical and financial risk.
- Scenario 3 has a very high technical risk – with UNEP and the Phoenix consortium being unable to agree on its feasibility and likely technical performance.

18.2.5. Immediate or deferred and full or partial restart to project development

The UNEP review indicates that as at Q1 2014 the development of Project Phoenix is **not** feasible due to the poor financial state of EDH. The GoH has ambitions and outline plans for the reform of the electricity sector and improving the performance and financial status of EDH. However it is clear to all that major improvements will take two or more years to be delivered.

In this context, the next decision of both the GoH and the Project Phoenix consortium is whether to opt for an **immediate and full restart**, an **immediate and partial restart** or a **deferred restart** to project development.

The UNEP recommendation is for an **immediate and partial restart**. The rationale for this recommendation in summary is:

- The remaining project development work for Project Phoenix is substantial and may require up to two or more years. Significant time may be gained by progressing Project Phoenix and energy sector reform and EDH in parallel rather than in sequence.
- The high number of project showstoppers indicates that further investment should be limited until after many of these have been removed. In particular, further large investments in project development should be avoided until there is clear evidence that the GoH is succeeding in its energy sector reform, thereby improving the feasibility of the project.
- However many project development activities are time-consuming but relatively low in cost, and so can be progressed immediately with only a very limited increase in financial exposure for all parties.
- The GoH will gain experience and lessons learned during the development process, which could be applied well to other energy projects under early development.

18.2.6. Project development focus – removing showstoppers

The project has now progressed to the stage where virtually all of the key obstacles to its successful implementation have been identified. UNEP has developed its own list of 22 such obstacles, which includes a total of 14 “showstoppers” (issues that can completely stop the project).

Given the need to conserve scarce GoH and Project Phoenix resources, UNEP recommends that the ongoing focus of project development efforts is **strongly aimed at the resolution of the 14 issues noted at present as project showstoppers**, followed by resolution of the remaining eight significant issues of concern.

Broader investments in project development are probably only justifiable once it is clear that the majority of showstoppers have been resolved and the forecast is positive for resolution of the remainder.

18.2.7. International technical assistance

A further decision for the GoH is whether to seek further international TA. Prior to the appointment of UNEP in its review role, the GoH managed the project development responsibilities with only an in-house team.

The UNEP recommendation is **to seek international TA**. The rationale for this recommendation in summary is:

- Haiti has no prior experience of WtE technology, which however is in operation in many other countries.
- Haiti also has no prior experience in public-private partnerships of this scale and level of complexity.
- The UNEP review noted several areas where gaps in skills and experience on the GoH side resulted in a number of problems within the Phoenix development process.
- The direct cost of an appropriate level of TA during project development is very small compared to the savings to be gained and problems to be avoided.

18.2.8. Independent observation

The final high-level decision for the GoH is whether to seek independent international oversight during project development. Prior to the appointment of UNEP in its review role, there was no independent international oversight of any kind, although several key international stakeholders such as the Government of USA and the WB were active informal observers and commentators.

This is a recognized sensitive subject, as bringing in any form of international oversight implies a loss of sovereignty and the potential for conflict, if such an appointment is not designed and managed well.

Despite this, the UNEP recommendation is for the GoH to request one or more key international stakeholder organizations to act in an **independent observer role during project development, in partnership with CNMP and to help build the capacity of CNMP to manage such activities in future**. The rationale for this recommendation in summary is:

- The UNEP review found that a lack of independent oversight of the sole source procurement process has resulted in credibility problems for the project, that cannot be fully repaired retrospectively.
- Independent validation from this point on will improve the potential for project financing and co-financing, through improving transparency and key stakeholder relations.
- CNMP has the mandate for oversight of public sector procurement, however the Phoenix experience indicates that it requires significant support in order to fulfill its role for large-scale flagship projects.

Note that independent validation is in addition to international TA, as the process of providing in-depth assistance to the GoH will result in the TA provider partially losing their independent position.

18.3. Detailed Recommendations - Scenario 2

18.3.1. Recommendation table

The detailed recommendations are for Scenario 2 and cover both project level and component level issues. They are focused on resolving the 22 issues that are graded either C, D or E: i.e. only the most serious.

The recommendations are provided in a table format below, noting that one recommendation may solve several issues or several recommendations may be required to fix a single issue, hence there is not a direct 1-1 link. Nonetheless for completeness the full list of C, D and E issues are provided and any duplication or overlap on the recommendations is noted.

Subject	Finding	Recommendation
The project development model		
C. Waste collection management model	The rationale and benefit of SMCRS retaining a substantial role in waste collection is unclear. This arrangement appears inefficient.	Progress with the current design to avoid over-complicating the Phoenix project development process. In parallel the GoH should develop a plan for privatization of the remaining general collection duties of SMCRS. The privatization should be implemented via competitive tender, enabling the Phoenix consortium to bid if it wishes.
Legal issues		
D. Legislative compliance of the original Phoenix sole source procurement process	The original procurement process is interpreted as partially flawed and not good practice. Due to some space for interpretation in the relevant legislation, it may be legally compliant even if flawed.	Accept in principle the Phoenix revised offer for open-book partially competitive bidding. Procure international TA to support detailed negotiations and process planning. Seek approval of CNMP and appoint CNMP in the role of independent observer. Mandate an independent international organization to support CNMP in its observer role.
E. The lack of contingency terms and expiry dates	The lack of contingency terms and expiry dates indicates a risk of legal disputes and constrains the options of the GoH.	Negotiate a project development schedule with the Phoenix consortium and an associated exit plan if development milestones are not achieved. Suggest the key milestone is financial close, with a deadline of 24 months from the date of the revised agreement (including 12 months of delay due to EDH affordability issues).
E. The potential to worsen the FDI risk perception of Haiti	The need to avoid worsening the FDI risk perception of Haiti constrains the options of the GoH.	Manage the Phoenix project development process as a strategic issue and a test case in management of FDI. Apply appropriate high-level GoH resources and develop and implement a communications plan for the benefit of the public and other potential FDI investors.
D. GoH land obligations in the MSA and PPA	The land provision obligations appear beyond the current capacity of the GoH to deliver in a timely manner.	The land provision obligations are greatly reduced by selection of Scenario 2. Estimate the financial scale of the remaining obligations and set aside GoH budget in advance. Increase GoH resources for project development.
C. GoH permitting obligations in the MSA and PPA	The permitting obligations appear beyond the current capacity of the GoH to deliver in a timely manner.	Renegotiate the MSA and PPA. Extend the permitting timeframe. Increase GoH resources for project development.

C. MSA and PPA clarity	The MSA and PPA have a number of items where clarification and/or extra detailing are a priority.	Improve the clarity and detail of the MSA as part of the renegotiation process. The GoH should secure international TA, including contract law support.
Waste sector needs and feedstock		
C. Waste collection tonnage design criteria	The Phoenix design criteria of initially 1,600 tonnes of waste collected per day appears slightly optimistic – with UNEP estimating 1,400 TPD as being more reasonable. This is very important for Scenario 3 but has little impact for Scenarios 1 and 2.	Phoenix to review its basis of design for collection of 1,600 tonnes and adjust if appropriate.
C. Current management of collected wastes at Truitier	Phoenix will in practice fully remove the need for the continued operation of the Truitier landfill. However current IEP proposals include for ongoing limited operation of Truitier by the GoH.	Change the plan to ensure all waste goes to Phoenix. This will enable closure of the Truitier site and thereby remove an ongoing operational cost for the GoH.
D. Truitier landfill legacy	The current scope of Project Phoenix does not include any funds or works to enable closure of Truitier in a responsible manner. A minimum of US\$3 to US \$5 million is needed for this work. There is the potential for CDM funding.	Add US\$3 million to the Phoenix capital cost as a contingency measure, noting that this will result in an increase in electricity tariffs of approximately 1 percent to 2 percent. In parallel approach donors and investigate climate funding options for full or partial grant funding specifically for Truitier closure works. Adjust the plan to reflect the results of fundraising. If Truitier closure is incorporated within the Phoenix project, then negotiate appropriate clauses to enable Phoenix to manage the works on a cost-capped basis with competitive bidding.
Electricity demand		
D. Electricity demand model assurance	At present inadequate planning and communication by EDH and the GoH critically undermines the confidence of any Haitian electricity sector demand assessment. The level of assurance at present is expected to be insufficient to secure project financing.	The WB is planning to fund a comprehensive national demand study, with results expected in Q3 2014. Hence this issue may be resolved without further action from the Phoenix project team. In the case that the WB study does not go ahead, a similar study focused on the PaP region and the short to medium term will be required. The results of such studies should be made public and broadly communicated.

GoH policy, political support and the counterpart role		
D. GoH counterpart role	Further development of the project is not viable in the absence of significant performance improvements by the GoH in its role as a key project partner – returning to the level of support it provided in from 2011 to Q1 2012.	The President and/or the Prime Minister of Haiti should mandate a suitable senior individual within the GoH to recruit and lead the GoH project development team for a minimum period of two years. A small but dedicated budget is needed for GoH general expenses. Significant funds need to be secured for land purchase and resettlement. One of the first tasks is for the GoH to develop a Project Phoenix Development Plan, which should be a public document. Project progress against the plan should be reviewed by the GoH cabinet on a quarterly basis.

Stakeholder engagement and transparency		
D. Key international stakeholder feedback and positions	Three key international organizations have stated their concerns in writing. This action has eroded GoH support and indirectly blocked access to low-cost project financing. UNEP considers that as a result Project Phoenix is not feasible unless these concerns are resolved.	Ensure the project development process focuses on resolution of the key concerns – which in the opinion of UNEP are all noted and assessed in this review as C, D and E-rated issues. Full resolution of all concerns may not be possible, however this is not strictly necessary for the project to succeed. Improve communication with key international stakeholders through regular and well-organized briefing sessions managed by the GoH. Adjust the project development process as appropriate based upon the feedback received.
C. Transparency during project development	The level of transparency displayed during project development has been insufficient, principally on the side of the GoH. This deficiency has been exacerbated by limited correspondence and poor record keeping by the GoH.	The recommended GoH Phoenix Project Development Plan should include explicit measures and standards to improve transparency. These should include: <ul style="list-style-type: none"> - Independent oversight; - Robust document management; - Full and formally agreed minutes for all meetings; - Public release of key documents and progress reports.
D. Corruption prevention	Cases of attempted corruption have already been reported by IEP and at present no mechanisms are in place to prevent further occurrences.	Refer to the recommendations on transparency and independent oversight.

D Independent oversight	Independent oversight of the project development process has been lacking, due to the non-involvement of the CNMP and the absence of an independent international counterpart.	Integrate two levels of independent oversight into the project development process. At the national level CNMP should take up its formal responsibilities for oversight of the procurement aspects of the project. At the international level, a suitable bilateral or multilateral organization should be requested and mandated to act as independent observer and provide technical and logistical support to CNMP.
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Economics		
D. Cost and return estimation	Phoenix consortium and UNEP estimates of the costs of the project differ by up to 40 percent for individual parameters and 25 percent overall. The revised offer is not supportable based on the UNEP pessimistic case estimates.	Phoenix to undertake further project cost estimation including industry benchmarking and to present the results to the GoH prior to commencing any open-book negotiation or competitive tendering.
D Affordability	At present EDH cannot afford the capacity and energy payment obligations of Project Phoenix. Both energy sector reform and major improvements in EDH are required to resolve this situation.	<p>Divide the response to this issue into two parts a) national energy sector reform and b) Project Phoenix actions.</p> <p>a) Donors have made some resources available for improvements in national energy policy and governance capacity. A range of proposals has been drafted for the improvement of EDH, although implementation has only recently commenced. These efforts should be continued, noting that Project Phoenix has an important potential role to play in improving the scale and reliability of power generation for the PaP grid. Up to two years may be needed for the proposed investments and changes to improve EDH to the stage where it can afford to take on the Phoenix PPA obligations. Alternatively, sector reform may have enabled other parties, such as industrial energy users and regional electricity concession holders to buy direct from Phoenix.</p> <p>b) Phoenix should investigate options for selling some of its capacity and energy to other parties besides EDH. Once identified, Phoenix, EDH and the buyer could participate in a wheeling agreement, whereby EDH is paid a transmission fee and the PPA is between Phoenix and the end buyer.</p>

WM –collection, recycling, disposal		
C. Technical feasibility	The technology proposed is proven, but with significant further work required on cost and performance optimization for management of wet organic wastes.	Phoenix to invest in a robust cost engineering study to determine the most cost-effective design for management of the waste organic fraction. The study should review technical options and deliver a final preferred design with contingencies for dealing with worst-case waste scenarios. The study should also support robust studies on the actual likely amount of co-fired coal required to deliver the proposed 50MW at 65 percent capacity.
C. Social impacts and risks	Social impacts are anticipated to be overall highly positive, however some of the existing informal workforce of waste-pickers will lose their livelihoods. Inadequate GoH management of the compulsory purchase and resettlement process is noted as a high-risk.	Wherever appropriate integrate existing informal waste-pickers into the Phoenix waste collection workforce. Allocate appropriate training budgets. In addition, add up to US\$1 million to the Phoenix capital cost for social mitigation measures where re-employment is not viable. Outsource implementation of this activity to an appropriate non-profit organization or specialist company, with Phoenix consortium and GoH oversight. Ensure independent oversight of the GoH land purchase and resettlement process and sufficient budget allocations for resettlement.
Dual fuel 50MW plant options		
C Environmental impacts and risks	Significant environmental risks from groundwater extraction and seawater once-through cooling are noted. Air emissions are anticipated to be important but not problematic. Detailed studies and significant infrastructure commitments would be required.	Phoenix to invest at an early stage in the required environmental data collection and analysis studies and if needed alter the power plant design, before financial close.

18.4. Next steps

18.4.1. Strategic recommendations

To progress the strategic recommendations, it is suggested that the GoH:

- Absorb and discuss the findings of the final report on a confidential basis.
- Convene a high-level meeting (the President, Prime Minister and key ministers) to debate the findings and take the strategic decisions. UNEP can participate in such a meeting on request.

18.4.2. Detailed recommendations

The detailed recommendations can only be usefully progressed after the GoH has confirmed its strategic decision(s). To develop and implement the detailed recommendations thereafter, it is suggested that the GoH:

- Document the strategic decisions and mandate a single authority to coordinate all project partners.
- Convene and recruit the proposed full project team: the GoH, the Project Phoenix team, international TA and one or more independent international observers. This may take several months, particularly if there is a shortage of financial resources for this work.

Once the full team is in place, the recommended way forward is as follows:

- Work through the full list of UNEP recommendations presented above, to collate a list of agreed actions, changes and improvements.
- Develop, negotiate and sign a full set of revised legal agreements with IEP.
- Jointly develop an initial Project Management Plan.
- Review the status of controlling external factors such as EDH liquidity and energy sector reform and progress or defer individual activities as appropriate.
- When appropriate, progress on a routine (non-fast track) basis according to the agreed and updated plans.

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Acronyms and Abbreviations

AD	anaerobic digestion
BFB	bubbling fluidized bed
BTU	British Thermal Unit
CC	Climate Change
CCM	Climate Change Mitigation
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CFI	Centre for Facilitation of Investments
CNMP	National Commission for Public Procurement
DINEPA	National Water and Sanitation Directorate
EDH	Haiti Electricity Company
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EPCM	Engineering, Procurement, Construction, Management
Ex-Im Bank	Export-Import Bank
FDI	Foreign Direct Investment
FM	financial model
GHG	Greenhouse Gas
GIS	Geographic Information System
GoH	Government of Haiti
HFO	Heavy Fuel Oil
hr	hour
IDB	Inter-American Development Bank
IEA	International Energy Agency
IEP	International Electric Power LLC
IFC	International Finance Corporation
IHRC	Interim Haiti Recovery Commission
IHSI	Haitian Institute of Statistics and Informatics
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer

IRR	Internal Rate of Return
kg	kilogram
km	kilometer
kV	kilovolt
kW	kilowatt
LCOE	Levelized Cost of Energy
m	meter
MC	moisture content
MOU	Memorandum of Understanding
MSA	Master Service Agreement
MW	megawatt
NMFA	Norwegian Ministry for Foreign Affairs
NREL	National Renewable Energy Laboratory
OPIC	Overseas Private Investment Corporation
PaP	Port-au-Prince
PE	Power Engineers
PEI	Power Engineering International
PPA	Power Purchase Agreement
SAM	Société Anonyme Mixte
SEIA	Social-Environmental Impact Assessment
SMCRS	Service Métropolitain de Collecte des Résidus Solides
SPV	Special Purpose Vehicle
SWANA	Solid Waste Association of North America
SWM	Solid Waste Management
TA	technical assistance
TOR	Terms of Reference
TPD	tonnes per day
UN	United Nations
UNCITRAL	United Nations Commission on International Trade Law
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNOPS	UN Office for Project Services
USA	United States of America

WB	World Bank
WM	Waste Management
WtE	Waste to Energy

More technical information available at:
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