第4章 プロジェクトの評価

4-1　事業実施のための前提条件

バイニ地区サイトの樹木等の伐採（根の掘り起し、除去を含む）、及び本プロジェクトの実施に係る環境許可の取得が事業実施のための前提条件となる。

4-2　プロジェクト全体計画達成のために必要な相手方投入（負担）事項

(1)　前提条件

プロジェクトの全体計画を達成するために「ト」国側が実施すべき事項は以下の通りである。

1) 本プロジェクトで日本側が調達・据付を行う機材が最大限に利用されるよう、日常の維持管理を適切に行う必要がある。

2) 本プロジェクトで調達される機材の運転・維持管理に必要となる要員の配置や教育・訓練を計画的に実施し、同機材の運転が円滑に開始されるよう配慮する必要がある。

3) 本プロジェクトで調達される機材の維持管理のために必要となるスペアパーツ、消耗品類を遅滞なく調達・補充し、定期的なメンテナンスを確実に実施する必要がある。

4) マイクログリッドシステムの継続的な維持管理を可能とするため、機器メーカーと維持管理契約を締結する必要がある。

5) 蓄電設備の更新費用を賄うため、TPL の収益の一部を積み立て、確保しておく必要がある。

4-3　外部条件

TPL が上記の投入を行うためには、太陽光発電により削減されたディーゼル燃料費の全てを電気料金の値下げ原資として使用するのではなく、減価償却費を計上して将来の設備更新に必要な資金を積み立てる会計処理を行うこと、また、そうすることで削減されたディーゼル燃料費の全てが電気料金の低減には寄与しないことについて、関係機関や国民の理解を得る必要がある。

4-4　プロジェクトの評価

4-4-1　妥当性

以下に示す通り、本プロジェクトは「ト」国の開発計画やエネルギー政策の実現に資するとともに、一般国民に裨益するものであることから、協力対象事業の妥当性は高いと判断される。

(1)　裨益人口

本プロジェクトの実施により、トンガタプ島の住民約 75,100 人に対し、再生可能エネルギ

一起源の電力が供給され、石油燃料への依存度や価格変動リスクが軽減される。本プロジェクト対象地域の電力需要家数は、一般家庭が約 12,800 軒、その他約 50 軒である。

(2) 緊急性

「ト」国では、2008 年に発生した世界的な原油価格の高騰により電気代が急騰し、住民の生活や経済への打撃が深刻となったことから、本プロジェクトの実施によりエネルギー消費における石油燃料への依存を緊急的に改善することが求められている。

(3) 公共福祉施設の安定した運営への貢献

「ト」国の電力供給は 98%以上をディーゼル発電に依存しており、燃料価格の上昇に伴う電気料金の高騰が度々発生していることから、高額な電気代が公共福祉施設の運営を圧迫している。

本プロジェクトの実施によりディーゼル発電への依存が緩和されることで、電気料金の高騰リスクが軽減され、公共福祉施設の安定した運営に貢献する。

(4) 運営・維持管理能力

TPL の発電部門は、ディーゼル発電機の運転・維持管理を日常的に実施しており、比較的技術レベルが高い。TPL はマイクログリッドコントローラーや蓄電設備の取扱いには慣れていないものの、本プロジェクトで実施される初期操作・運用操作指導やソフトコンポーネントにより技術移転を行えば、本プロジェクトで調達される機材の運転・維持管理は問題なく実施できる。

(5) 「ト」国の開発計画に資するプロジェクト

「ト」国の開発計画である TSDF では、「従来の方法及び再生可能エネルギーを利用することにより、全てのコミュニティへの信頼性が高く経済的な電力供給を継続・拡大する」ことが戦略の一つとして挙げられており、再生可能エネルギーの導入拡大を図る本プロジェクトは、TSDF の目標達成に資するものと位置付けられる。また、「ト」国のエネルギー政策である TERM では、「2020 年までに電力供給の 50%を再生可能エネルギーで賄う」ことを目標としており、再生可能エネルギーの導入を促進する本プロジェクトは、TERM の目標達成に貢献する。

(6) 環境社会面への影響

「ト」国の環境関連法並びに JICA 環境社会配慮ガイドラインに基づき検討を行った結果、本プロジェクトが自然環境、社会環境に与える影響は軽微である上に、温室効果ガスの排出削減に寄与するものであることから、環境社会面において特段の影響を与えるものではない。

(7) 我が国の無償資金協力のスキーム

本プロジェクトは、主要な機材の調達国が日本であること、E/N 期限内にプロジェクトが終了すること、といった無償資金協力スキームの枠内で無理のない事業内容と工程計画を策定しており、特段の困難なく実施可能である。

4-4-2　有効性

本計画の実施により期待される効果は、以下のとおりである。

(1)　定量的効果

指標名	基準値（2011 年）	目標値（2018 年） 【事業完了 3 年後】
ディーゼル燃料削減量 (kℓ/年)	-	327
CO_2 排出削減量* (t-CO_2/年)	-	886
1MWp 太陽光発電による年間発電電力量* (MWh/年)	0	1,308

［備考］*本プロジェクトによる効果のみを対象とし、既設太陽光発電の効果は含まない

(2)　定性的効果（プロジェクト全体）

現状と問題点	本計画での対策 （協力対象事業）	計画の効果・改善程度
1.　「ト」国では電力供給の98％以上をディーゼル発電に依存しているため、燃料価格の変動に対して脆弱である。	太陽光発電所の建設を行う。	電力供給におけるディーゼル発電への依存度が軽減され、燃料価格変動のリスクが緩和される。
2.　「ト」国では再生可能エネルギーの導入を促進しているが、出力変動を伴う太陽光、風力発電等を大量に導入した場合、電力系統の安定度が損なわれる。	マイクログリッドシステムを導入する。	蓄電設備及びマイクログリッドコントローラーにより再生可能エネルギーの出力変動を補償することで、電力系統の安定化が可能となる。

【添付資料】

1. 調査団員氏名・所属 A-1

2. 調査日程 A-2

3. 関係者リスト A-3

4. 協議議事録(M/M) A-4

5. 技術協議録(Field Report) （環境チェックリストを含む） A-5

6. ソフトコンポーネント計画書 A-6

7. 電力潮流解析の検討 A-7

8. 土質・測量調査報告書 A-8

9. 風力発電のポテンシャル評価報告書 A-9

10. 概略設計図 A-10

11. 収集資料リスト A-11

A-1　調査団員氏名・所属

1. 調査団員氏名・所属

(1) 第 1 次現地調査

氏名	担当分野	派遣期間	所属
住吉 央	総括	2012 年 8 月 25 日 ～9 月 1 日	JICA 産業開発・公共政策部
坂元 芳匡	協力企画	2012 年 8 月 25 日 ～9 月 1 日	JICA 産業開発・公共政策部
西川 光久	業務主任/配電系統計画	2012 年 8 月 14 日 ～9 月 1 日	八千代エンジニヤリング株式会社
不二葦 教治	副業務主任/ディーゼル発電設備運用	2012 年 8 月 23 日 ～9 月 1 日	八千代エンジニヤリング株式会社
佐藤 秀一	マイクログリッドシステム(1)系統制御/蓄電設備計画	2012 年 8 月 14 日 ～9 月 1 日	八千代エンジニヤリング株式会社 (補強)
近藤 伸也	再生可能エネルギー(2)	2012 年 8 月 14 日 ～8 月 28 日	西日本技術開発株式会社
野上 一成	資機材調達計画/積算(1)	2012 年 8 月 14 日 ～9 月 1 日	八千代エンジニヤリング株式会社
小原 研二	自然条件調査/積算(2)	2012 年 8 月 14 日 ～9 月 1 日	八千代エンジニヤリング株式会社
高嶋 繁生	環境社会配慮	2012 年 8 月 14 日 ～9 月 1 日	八千代エンジニヤリング株式会社
山川 正雄	業務調整/マイクログリッド計画補助	2012 年 8 月 14 日 ～9 月 1 日	八千代エンジニヤリング株式会社

(2) 第 2 次現地調査

氏名	担当分野	派遣期間	所属
西川 光久	業務主任/配電系統計画	2012 年 9 月 18 日 ～10 月 7 日	八千代エンジニヤリング株式会社
不二葦 教治	副業務主任/ディーゼル発電設備運用	2012 年 9 月 18 日 ～10 月 7 日	八千代エンジニヤリング株式会社
佐藤 秀一	マイクログリッドシステム(1)系統制御/蓄電設備計画	2012 年 9 月 18 日 ～10 月 7 日	八千代エンジニヤリング株式会社
倉嶋 省造	再生可能エネルギー(1)	2012 年 9 月 18 日 ～10 月 7 日	八千代エンジニヤリング株式会社
近藤 伸也	再生可能エネルギー(2)	2012 年 9 月 18 日 ～9 月 30 日	西日本技術開発株式会社
野上 一成	資機材調達計画/積算(1)	2012 年 9 月 18 日 ～10 月 7 日	八千代エンジニヤリング株式会社
小原 研二	自然条件調査/積算(2)	2012 年 9 月 18 日 ～10 月 7 日	八千代エンジニヤリング株式会社
高嶋 繁生	環境社会配慮	2012 年 9 月 18 日 ～10 月 7 日	八千代エンジニヤリング株式会社
勝田 雄介	経済財務分析	2012 年 9 月 18 日 ～10 月 13 日	八千代エンジニヤリング株式会社
山川 正雄	業務調整/マイクログリッド計画補助	2012 年 9 月 25 日 ～10 月 7 日	八千代エンジニヤリング株式会社

(3) 第 3 次現地調査

氏名	担当分野	派遣期間	所属
田中 啓生	総括	2012 年 12 月 16 日 ～12 月 22 日	JICA 産業開発・公共政策部 次長兼資源・エネルギーグループ長
坂元 芳匡	計画管理	2012 年 12 月 16 日 ～12 月 22 日	JICA 産業開発・公共政策部 資源・エネルギー第二課
西川 光久	業務主任/配電系統計画	2012 年 12 月 14 日 ～12 月 22 日	八千代エンジニヤリング株式会社
倉嶋 省造	再生可能エネルギー(1)	2012 年 12 月 14 日 ～12 月 22 日	八千代エンジニヤリング株式会社
野上 一成	資機材調達計画/積算(1)	2012 年 12 月 14 日 ～12 月 22 日	八千代エンジニヤリング株式会社

A-2　調査日程表

２．調査日程表

(1)　第１次現地調査

No.	月日(曜日)	調査内容		宿泊地
		官ベース	コンサルタント	
		住吉、坂元	西川、不二葦、佐藤、近藤、野上、高嶋、小原、山川	
1.	14Aug(Tue)		移動｛東京(19:00) – ｵｰｸﾗﾝﾄﾞ(08:45+1) by NZ-090｝	機内
2.	15Aug(Wed)		移動｛ｵｰｸﾗﾝﾄﾞ(11:00) – ﾇｸｱﾛﾌｧ(14:50) by NZ-272｝ ① 団内協議	ﾇｸｱﾛﾌｧ
3.	16Aug(Thu)		① 表敬訪問（在トンガ日本大使館、JICA トンガ(事)、TERM (Tonga Energy Road Map)、 ② Ministry of Land Environment and Climate Change、TPL (Tonga Power Limited)、 ③ インセプションレポート(IC/R)の提出と説明(要請内容の確認並びに無償資金協力 ④ の仕組み説明) ⑤ 既設発電所（Popua 発電所）調査（発電設備仕様、運転記録の収集）	ﾇｸｱﾛﾌｧ
4.	17Aug(Fri)		① TPL との協議(太陽光・風力発電設備設置用地、配電系統、維持管理体制、予算等 ② の確認) ③ TERM との協議 ④ 廃棄物処理業者（Geo Recycling）調査(蓄電池の処理方法の確認)	ﾇｸｱﾛﾌｧ
5.	18Aug(Sat)		① Popua 発電所調査（発電設備仕様・制御方法の確認、運転記録の収集） ② 現地踏襲調査(太陽光・風力発電設備設置用地の確認、日射・風況データの取得状 ③ 況確認、配電線の確認、海底ケーブルの状況確認) ④ 協力設備基本計画(案)の作成（Power System Standards、系統連系点、配電系統、需 ⑤ 要予測の確認）	ﾇｸｱﾛﾌｧ
6.	19Aug(Sun)		① 団内協議 ② 収集資料整理 ③ 市場調査 ④ 協力設備基本計画(案)の作成（概略 PV 及び風力発電の規模、蓄電池設備、 ⑤ Micro-Grid System）	ﾇｸｱﾛﾌｧ
7.	20Aug(Mon)		① 国土・環境・気候変動・天然資源省(MoLECCNR)調査 ② 地図資料収集 ③ 団内協議 ④ Popua 発電所調査（資料収集及び協議）	ﾇｸｱﾛﾌｧ
8.	21Aug(Tue)		① 地図資料収集 ② MoLECCNR（サイト所有者確認及び登記手順確認） ③ JICA 中間報告 ④ TERM との協議 ⑤ 配電系統確認現地調査 ⑥ 現地工事会社調査 ⑦ 協力設備基本計画(案)の作成（概略 PV 及び風力発電の規模、蓄電池設備、 ⑧ Micro-Grid System、他）	ﾇｸｱﾛﾌｧ
9.	22Aug(Wed)		① Popua 発電所調査（パワーメーターの取り付け） ② Geo Recycling 調査(蓄電池の処理方法の確認) ③ 現地工事会社調査	ﾇｸｱﾛﾌｧ
10.	23Aug(Thu)		① 団内協議 ② TPL との協議（中間報告及び方針の確認） ③ Popua 発電所調査（パワーメーターによる測定）	ﾇｸｱﾛﾌｧ
11.	24Aug(Fri)		① TERM との協議（中間報告及び方針の確認）	ﾇｸｱﾛﾌｧ

			② Popua 発電所調査（パワーメーターによる測定） ③ 資料収集（地図、気象情報、他ドナーの支援状況等）	
12.	25Aug(Sat)	移動｛東京(19:00) – ｵｰｸﾗﾝﾄﾞ(08:45+1) by NZ-090｝	① Popua 発電所調査（パワーメーターによる測定、制御方法調査、資料収集等） ② 資料収集(現地コントラクター情報、気象情報等) ③ Field Report 作成	ﾇｸｱﾛﾌｧ
13.	26Aug(Sun)	移動｛ｵｰｸﾗﾝﾄﾞ(11:00) – ﾇｸｱﾛﾌｧ(14:50) by NZ-272｝	① Popua 発電所調査（パワーメーターによる測定、制御方法調査、資料収集等） ② Field Report 作成	ﾇｸｱﾛﾌｧ
14.	27Aug(Mon)	① 大使館表敬訪問 ② JICA 表敬訪問 ③ 団内協議 ④ Minutes of Discussions(MD)（案）作成	① Field Report 作成 ② 団内協議 ③ MD（案）作成 ④ Popua 発電所調査（パワーメーターによる測定、制御方法調査、資料収集等）	ﾇｸｱﾛﾌｧ
15.	28Aug(Tue)	① MD（案）団内協議 ② Field Report 作成 ③ TERM 訪問（MD 協議） ④ Popua 発電所調査（パワーメーターによる測定、制御方法調査、資料収集等） ⑤ 資料収集（系統情報等） ⑥ サイト調査		ﾇｸｱﾛﾌｧ ﾊﾞｲﾆ
16.	29Aug(Wed)	① TERM において MD 協議 ② 資料収集（制御方法、系統情報等） ③ Field Report 作成 ④ Field Report の TPL への提出・説明 ⑤ 高嶋団員：ｵｰｸﾗﾝﾄﾞへ移動		ﾇｸｱﾛﾌｧ
17.	30Aug(Thu)	① TREM において MD 署名 ② 帰国報告(大使館、JICA) ③ TPL において Field Report の TPL への説明と合意取得 ④ 高嶋団員：蓄電池リサイクル工場調査(ｵｰｸﾗﾝﾄﾞ)		ﾇｸｱﾛﾌｧ
18.	31Aug(Fri)	① 移動｛ﾇｸｱﾛﾌｧ(12:10) –ｵｰｸﾗﾝﾄﾞ (14:10) by NZ-973｝ ② オークランドにおいて現地測量会社の調査		ｵｰｸﾗﾝﾄﾞ
19.	01Sep(Sat)	移動｛ｵｰｸﾗﾝﾄﾞ (08:25) –東京 (16:50) by NZ-099｝		帰国

(2) 第 2 次現地調査

No.	Date	コンサルタントメンバー 西川、不二葦、佐藤、倉嶋、近藤、野上、高嶋、小原、勝田、山川	宿泊先
1.	18 Sep.(Tue)	① 移動｛東京(19:00) – ｵｰｸﾗﾝﾄﾞ(08:45+1) by NZ-090｝	機内
2.	19Sep.(Wed)	① 移動｛ｵｰｸﾗﾝﾄﾞ着(09:00) by NZ-090 ｵｰｸﾗﾝﾄﾞ発(15:30) – ﾇｸｱﾛﾌｧ(19:20) by NZ-974｝ ② 地質調査業者との契約、日程調整（Transit 時間）	ﾇｸｱﾛﾌｧ
3.	20 Sep.(Thu)	① **09:00** 表敬訪問 - JICA トンガ(事) - 調査内容/日程等説明 ② **11:00** 表敬訪問 - TERM (**Mr. Inoke**) - 調査内容/日程等説明 ③ **14:00** 表敬訪問 - TPL (**Mr. John**) - 調査内容/日程等説明 ④ Popua 発電所調査（発電設備仕様、運転記録の収集） ⑤ 測量業者との協議、契約	ﾇｸｱﾛﾌｧ
4.	21 Sep.(Fri)	① TPL との協議 1) 国内解析結果の説明(系統解析結果、風力発電ﾎﾟﾃﾝｼｬﾙ等) 2) 環境調査打合せ（ｾﾞﾛｵﾌﾟｼｮﾝを含む比較案説明等） 3) 組織/財務関連打合せ ② Popua 発電所調査（発電設備仕様、運転記録の収集） ③ Vaini サイトの測量ﾎﾟｲﾝﾄ及び伐採状況確認・調査（TPL 立会い要）	ﾇｸｱﾛﾌｧ
5.	22 Sep.(Sat)	① TPL との協議 1) 国内解析結果の説明(系統解析結果、風力発電ﾎﾟﾃﾝｼｬﾙ等) 2) 環境調査打合せ（ｾﾞﾛｵﾌﾟｼｮﾝを含む比較案説明等） 3) 組織財務関連打合せ ② Popua 発電所調査（発電設備仕様・制御方法の確認、運転記録の収集） ③ 日射量 Data の収集 ④ Popua 発電所レベル確認及び建設単価徴収	ﾇｸｱﾛﾌｧ

6.	23.Sep.(Sun)	① 団内協議 ② 収集資料整理 ③ 市場調査	ﾇｸｱﾛﾌｧ
7.	24 Sep.(Mon)	① TPL との協議 1) 国内解析結果の説明(系統解析結果、風力発電ﾎﾟﾃﾝｼｬﾙ等) 2) 環境調査打合せ（ｾﾞﾛｵﾌﾟｼｮﾝを含む比較案説明等） 3) 組織/財務関連打合せ ② Popua 発電所調査（発電設備仕様・制御方法の確認、運転記録の収集） ③ 日射量 Data の収集 ④ Vaini site の土質調査開始	ﾇｸｱﾛﾌｧ
8.	25 Sep. (Tue)	① TERM へ調査経緯報告と組織、財務協議 ② TPL との協議 1) Micro grid controller, capacity of Batteries etc. 2) 環境関連 Scoping（案） 3) 財務状況 ③ JICA 中間報告 ④ 配電系統確認現地調査 ⑤ 現地工事会社調査	ﾇｸｱﾛﾌｧ
9.	26 Sep. (Wed)	① 中間報告資料作成 ② 環境社会配慮打合せ (TPL, MLECCNR) ③ 現地工事会社・測量・地質調査等確認 ④ 団内打合わせ ⑤ JICA 表敬訪問(勝田、山川) ⑥ 積算準備(見積依頼)	ﾇｸｱﾛﾌｧ
10.	27.Sep. (Thu)	① TPL 中間報告 ② 財務省への無償スキーム説明・免税確認 ③ 環境社会配慮打合せ (TPL, MLECCNR) ④ 測量・地質調査等確認 ⑤ 積算準備(設計、見積依頼)	ﾇｸｱﾛﾌｧ
11.	28 Sep (Fri)	① TERM 中間報告 ② 測量・地質調査等確認 ③ サイト状況確認 ④ TPL との協議 ⑤ 積算準備(設計・仕様作成)	ﾇｸｱﾛﾌｧ
12.	29 Sep (Sat)	① Popua 発電所調査継続 ② Field Report 作成 ③ 積算準備(設計・仕様作成)	ﾇｸｱﾛﾌｧ
13.	30.Sep.(Sun)	① 団内協議 ② 収集資料整理 ③ Field Report 作成	ﾇｸｱﾛﾌｧ
14.	01 Oct.(Mon)	① 補足調査 ② Field Report 作成	ﾇｸｱﾛﾌｧ
15.	02 Oct. (Tue)	① 補足調査 ② Field Report 作成	ﾇｸｱﾛﾌｧ
16.	03 Oct. (Wed)	① 補足調査 ② Field Report 作成	ﾇｸｱﾛﾌｧ
17.	04 Oct. (Thu)	① Field Report 説明（To TERM & TPL） ② Field Report の修正 ③ 補足調査	ﾇｸｱﾛﾌｧ
18.	05 Oct. (Fri)	① Field Report の承認取得(From TERM & TPL) ② JICA(事)報告 ③ 大使館報告	ﾇｸｱﾛﾌｧ
19.	06 Oct. (Sat)	移動｛ﾇｸｱﾛﾌｧ (10:20) – ｵｰｸﾗﾝﾄﾞ (12:20) by NZ-273｝	ｵｰｸﾗﾝﾄﾞ
20	07 Oct. (Sun)	移動｛ｵｰｸﾗﾝﾄﾞ (09:25) – 東京 (16:50) by NZ-099｝	帰国

(3) 第 3 次現地調査

No.	月日(曜日)	調査内容		宿泊地
		官ベース	コンサルタント	
		田中、坂元	西川、倉嶋、野上	
1.	14 Dec.(Fri)		移動｛東京(18:25) – ｵｰｸﾗﾝﾄﾞ(09:15+1) by NZ-090｝	機内
2.	15 Dec.(Sat)		移動｛ｵｰｸﾗﾝﾄﾞ(14:30) – ﾇｸｱﾛﾌｧ(18:30) by NZ-974｝	ﾇｸｱﾛﾌｧ
3.	16 Dec.(Sun)	移動｛東京(18:25) – ｵｰｸﾗﾝﾄﾞ(09:05+1) by NZ-090｝	① 既設発電所（Popua 発電所） ② Vaini サイト調査 ③ 団内協議	ﾇｸｱﾛﾌｧ
4.	17Dec.(Mon)	移動｛ｵｰｸﾗﾝﾄﾞ泊｝	① 表敬訪問（JICA トンガ(事)） ② 協力準備調査報告書(案)及び機材仕様書の説明	ﾇｸｱﾛﾌｧ
5.	18 Dec.(Tue)	移動｛ｵｰｸﾗﾝﾄﾞ(09:40) – ﾇｸｱﾛﾌｧ(12:30) by NZ-970｝ ① TPL との協議 ② 団内協議 ③ Popua 発電所調査	① TERM 及び TPL との協議 ② TPL との協議 ③ 団内協議 ④ Popua 発電所調査	ﾇｸｱﾛﾌｧ
6.	19 Dec.(Wed)	① TERM 及び TPL との Minutes of Discussions(M/M)（案）に関する協議 ② M/M 修正 ③ Vaini サイト及び風力発電候補地調査		ﾇｸｱﾛﾌｧ
7.	20 Dec.(Thu)	① TERM、TPL 及び Ministry of Finance & National Planning との M/M への署名 ② 大使館及び JICA(事)報告		ﾇｸｱﾛﾌｧ
8.	21 Dec.(Fri)	移動｛ﾇｸｱﾛﾌｧ (11:00) – ｵｰｸﾗﾝﾄﾞ (14:00) by NZ-973｝		ﾇｸｱﾛﾌｧ
9.	22 Dec.(Sat)	移動｛ｵｰｸﾗﾝﾄﾞ (09:45) – 東京 (16:55) by NZ-099｝		帰国

A-3　関係者（面談者）リスト

3. 関係者(面談者)リスト

トンガエナジーロードマップ **Tonga Energy Road Map (TERM)**

Mr. 'Inoke Finau Vala	Director
Mr. 'Akau' Ola	Term-C Advisor
Mr. Ofa Sefana	Acting Energy Planning Specialist
Mr. Slua Aatu	Environmental Information Officer
Mr. Moleni Tuuholoaki	Acting Director of Meteorology
Ms. Katherine Bakes	Operations Officer (World Bank)
Mr. Shreejan Pandey	M.E. Research Scholar (EPE Entre)
Mr. Feleti ka Wolfgramm	Statistician

財務・国家計画省 **Ministry of Finance and National Planning**

援助管理局 **Aid Management Division**

Ms. Natalia Palu Latu	Principal Economist

国土・環境・気候変動・天然資源省 **Ministry of Land, Environment, Climate Change and Natural Resources**

電力局 **Resources Department of Energy Section**

*[1]Mr. Ofa Sefana	Acting Energy Planning Specialist

環境・気候変動局 **Department of Environment and Climate Change**

Ms. Mafile'o Masi	Acting Deputy Director
Ms. Kate Mcpherson	Environment Legislation Policy Officer
Ms. Lesieli Tuivai	Ecologist, Environmentalist

計画・都市管理局 **Planning & Urban Management Agency**

Mr. 'Atunaisa. M. Fetokai	Deputy Physical Planner
Mr. Tevita L. Fotu	Urban Planner

測量局 **LGIS Unit**

Mr. Richard Atelea Kautoke	Sen. GIS Specialist

社会経済基盤省 **Ministry of Infrastructure**

試験局 **Laboratory, Civil Engineering Department**

Mr. Ringo K Fa'oliu	CEO for Infrastructure
Mr. 'Isileli. V. Tu'itupou	Director for Building Services & Control Division
Mr. Ken Robinson	Material Engineer

トンガ気象局 **Tonga Meteorological Service**

*[1]Mr. Moleni Tuuholoaki	Acting Director of Meteorology

トンガ電力公社 **Tonga Power Limited**

Mr. John Van Brink	Chief Executive
Mr. Lano Fonua	Strategic Initiatives Manager
Mr.Michael Lani 'Ahokava	Power Generation Manager

Mr. Murray Sheerin	Power Station Superintendent
Mr. Ian Skelton	Planning and Design Manager
Mr. Nikolasi Fonua	Business Development Engineer

トンガ科学技術専門学校 Tonga Institute of Science and Technology

Mr. Samuela Matakaiongo	Deputy Principal

工学・建築学部 School of Engineering and Construction

Mr. Nonga Soakai	Principal of School
Mr. Tevita Tali Vakalahi	Acting Deputy Principal

在トンガ日本大使館 Embassy of Japan

高 瀬 靖 夫氏	特命全権大使
川 田 義光 氏	参事官
益 原 花子 氏	専門調査員

JICA トンガ支所 JICA Tonga Office

辻本 誠 氏	所長
石垣 滋樹 氏	企画調査員
石黒 要 氏	企画調査員

ジオリサイクリング Geo Recycling

Mr. Fillimone Tu'ikolovato	Auto Mechanic Specialist & Owner
Ms. 'Ofa Tu'ikolovatu	Managing Director

シーエムエーコーポレーション CMA Corporation Limited, New Zealand

Mr. Mr. Brett Howlett	General Manager

メリジアンエナジー Meridian Energy Limited

Mr. Murray Hill	Solar Project Development Manager

エーアンドエス A & S Limited

Mr. Tukio Afeaki	Contracts Manager

A-4　協議議事録(M/M)

THE MINUTES OF MEETINGS

ON

THE MISSION FOR THE PREPARATORY SURVEY

ON

THE PROJECT FOR INTRODUCTION OF A MICRO-GRID SYSTEM WITH RENEWABLE ENERGY FOR THE TONGA ENERGY ROAD MAP

IN

THE KINGDOM OF TONGA

AGREED UPON BETWEEN

THE GOVENMENT OF THE KINGDOM OF TONGA

AND

THE JAPAN INTERNATIONAL COOPERATION AGENCY

Nuku'alofa, 30th August, 2012

Mr. 'Inoke Finau Vala
TERM-IU Director
Tonga Energy Road Map Agency
the Kingdom of Tonga

Mr. Hiroshi SUMIYOSHI
Leader
Preparatory Survey Team
Japan International Cooperation Agency

Witness

Ms. Lesieli Tufui Faletau
Acting Secretary
Ministry of Finance and National Planning

Witness

Mr. John Van Brink
Chief Executive
Tonga Power Limited

The government of The Kingdom of Tonga (hereinafter referred to as "GoT") and the Japan International Cooperation Agency (hereinafter referred to as "JICA") have made several preliminary discussions in order to identify priority projects in the field of power sector, and agreed to make preparation for the Project for Introduction of a Micro-Grid System with Renewable Energy (hereinafter referred to as "the Project"). Accordingly, JICA dispatched a mission on the Project (hereinafter referred to as "the JICA Mission") to The Kingdom of Tonga from 14th August, 2012 to 1st September, 2012 in order to develop scope and implementing arrangements of a further survey which will study outline design of the Project (hereinafter referred to as "the Preparatory Survey"). The scope and implementing arrangements of the Preparatory Survey are described in the Appendix 1. The main points discussed during its visit are described in the Appendix 2.

It should be noted that implementation of the Preparatory Survey does not imply any decision or commitment by JICA to extend its grant for the project at this stage.

Appendix 1: Scope and Implementing Arrangements of the Preparatory Survey
Appendix 2: Main Points Discussed
Appendix 3: List of Attendants

Appendix 1

SCOPE AND IMPLEMENTING ARRANGEMENTS OF THE PREPARATORY SURVEY

I. BACKGROUND AND OBJECTIVES OF THE PREPARATORY SURVERY

In April of 2012, GoT made a request for Grant Aid for the Project to the Government of Japan (GoJ). GoJ decided to conduct the Preparatory Survey and entrusted JICA to examine the viability of the Project and sent the Survey team, headed by Mr. Hiroshi SUMIYOSHI, Director, Energy and Mining Division, Natural Resources and Energy Group, Industrial Development and Public Policy Department, JICA.

II. OBJECTIVES OF THE PROJECT

The project aims to develop and introduce a Micro-Grid System with large scale of renewable energy in order to reduce consumption of fossil fuel for generating electricity, and to stabilize electricity.

The project will be conducted under the Japanese Grant Aid Program aiming at promoting "Green Growth", which the GoJ puts stress on, by introducing Japanese Technology.

The project will also contribute to achievement of Tonga Energy Road Map (TERM)-objective.

III. ITEMS REQUESTED BY GoT

1. Project Site
   Vaini, and Popua Power Station, Popua, in Tongatapu Island
   (shown in Annex 1 and 2)

2. Responsible Organization
   Tonga Energy Road Map Agency (TERM-A)

3. Executing Agency
   Tonga Power Limited (The organization chart is shown in Annex 3.) as owner of the affected and new assets.
   *TERM Implementation Unit (TERM-IU) will have oversight of the Project.

4. Materials and services
   GoT finally requested to GoJ the following components to achieve TERM.

Outline of the final Request

Item	Components
Micro grid controller	• Generation and network control system integrated into TPL's SCADA at Popua power station • IP broadband and/or mesh type communications network that overlies TPL's Tongatapu network, connecting remote generation to the Popua SCADA system and micro grid controllers. • Integration of battery or capacitive storage and load flow "smoothing" algorithms to monitor and control field assets and enable future demand side management
Storage System (Batteries)	• Batteries and controller located at either Popua or at Vaini PV Site, controlling energy flows and quality, and optimizing efficiency of the diesel generators • Conversion of the TPL 2.88 MW MAK diesel generator governor to load following capability (requires manufacturer's involvement to modify governors, TPL has discussed requirements and scope with the manufacturer)
Solar PV system (1MWp)	• A single solar PV array at Vaini, in central Tongatapu, injecting into the TPL 11kV network, including spares • Network voltage management (regulator or other dynamic support)
Operation & Maintenance of the equipment	• Training TERM-IU staff and TPL staff • Operating and maintenance manuals and process documentation • O & M support

IV. SURVEY AREA

Tongatapu Island, the Kingdom of Tonga

V. SCOPE OF THE PREPARATORY SURVEY

1. Terms of Reference

The Team will formulate the Project so as to contribute to achievement of TERM.

The Team will examine carefully potential of wind power and photovoltaic generation in Tongatapu, and control method of the micro-grid system and capacity of power storage system introduced under the Project.

Based on the results of the Survey and discussion with the Tongan side, the Team will design the micro-grid system to reduce consumption of fossil fuel in power generation effectively.

The Preparatory Survey shall cover the following items:

(1) Implementation framework

(2) Requested components of the Project and their Priority

(3) Securement of lands for the Project

(4) Environmental and social considerations

(5) Positive impact of the Project and objectively verifiable indicators of the Project

(6) Technical Conditions for the Project

(7) General Information of Electric Power Sector

(8) Major Undertaking, including Tax and levy system

(9) Local conditions and capability for procurement, construction, installation and transportation

(10) Activities of other donors

(11)Soft Component

(12)Maintenance Contract

2. Desirable specialists for the Preparatory Survey

JICA will select and dispatch a survey team to carry out the Preparatory Survey. The team will include the specialists of the following field;.

(1) Distribution System Design
(2) Operation of Diesel Engine Generator
(3) Micro-Grid System (Grid Control, and Grid Stability Analysis)
(4) Renewable Energy
(5) Battery Equipment Plan
(6) Natural Condition Survey
(7) Social and Environmental Considerations
(8) Procurement Plan and Cost Estimation
(9) Economic and Financial Analysis

VI. SCHEDULE OF THE PREPARATORY SURVEY

The Preparatory Survey will be carried out in accordance with the tentative schedule attached in the Annex 4. The schedule may be subject to change during the preparation and the course of the survey.

VII. REPORTS

JICA will prepare and submit following reports in English to GoT.

1. Inception Report:

3 copies will be submitted at the commencement of the first work period in the Kingdom of Tonga.

2. Draft Final Report:

3 hard copies and soft copy (1copy is for TERM, another copy is for TPL and the other copy is for GoT) will be submitted 4 months after the commencement of the Preparatory Survey.

This report will cover:

(1) Outline of the Project,
(2) Basic Design of the Project,
(3) Outline of the undertakings of Tongan side,
(4) Operation and maintenance plan for the Project, and
(5) Cost estimation.

GoT shall submit its comments within one month after the receipt of the Draft Final Report.

3. Final Report:

3 hard copies and soft copy (1copy is for TERM, another copy is for TPL and the other copy is for GoT) will be submitted within one month after the receipt of the comments on the Draft Final Report.

VIII. JAPAN'S GRANT AID SCHEME

GoT understands the Japan's Grant Aid Scheme explained by the JICA Mission as described in Annex 5,6 and 7.

IX. UNDERTAKINGS OF THE GOVERNMENT OF THE KINGDOM OF TONGA

GoT shall act as a counterpart agency to the survey team and also as a coordinating body with other organizations concerned for the smooth implementation of the Preparatory Survey.

GoT shall, at its own expense, provide the survey team with the following items in cooperation with other organizations concerned:

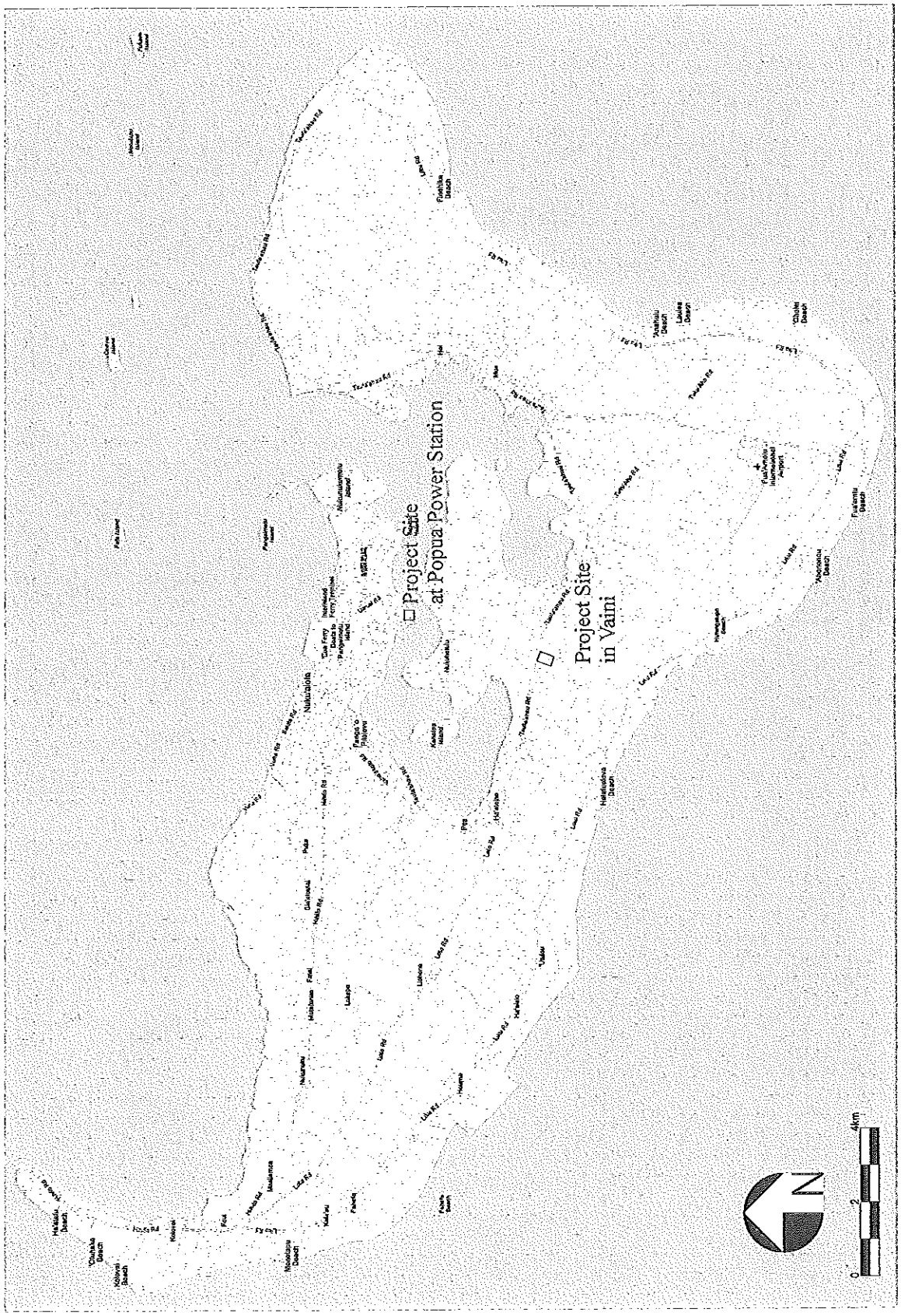
(1) security-related information as well as measures to ensure the safety of the survey team;
(2) information as well as support in obtaining medical service;
(3) data and information related to the Preparatory Survey;
(4) counterpart personnel;
(5) suitable office space with necessary equipment and secretarial service;
(6) credentials or identification cards;
(7) entry permits necessary for the survey team members to conduct field surveys;
(8) support in making transportation arrangements;
(9) support in obtaining other privileges and benefits if necessary;
(10)assist the team in custom clearance, exempt from any duties with respect to equipment, instruments, tools and other articles to be brought into and out of Tonga in connection with the implementation of the survey; and
(11) GoT shall bear claims, if any arises, against the members of the survey team resulting from, occurring in the course of, or otherwise connected with the discharge of their duties in implementation of the Preparatory Survey, except when such claim arise from gross negligence or willful misconduct on the part of the member of the survey team.

X. CONSULTATION

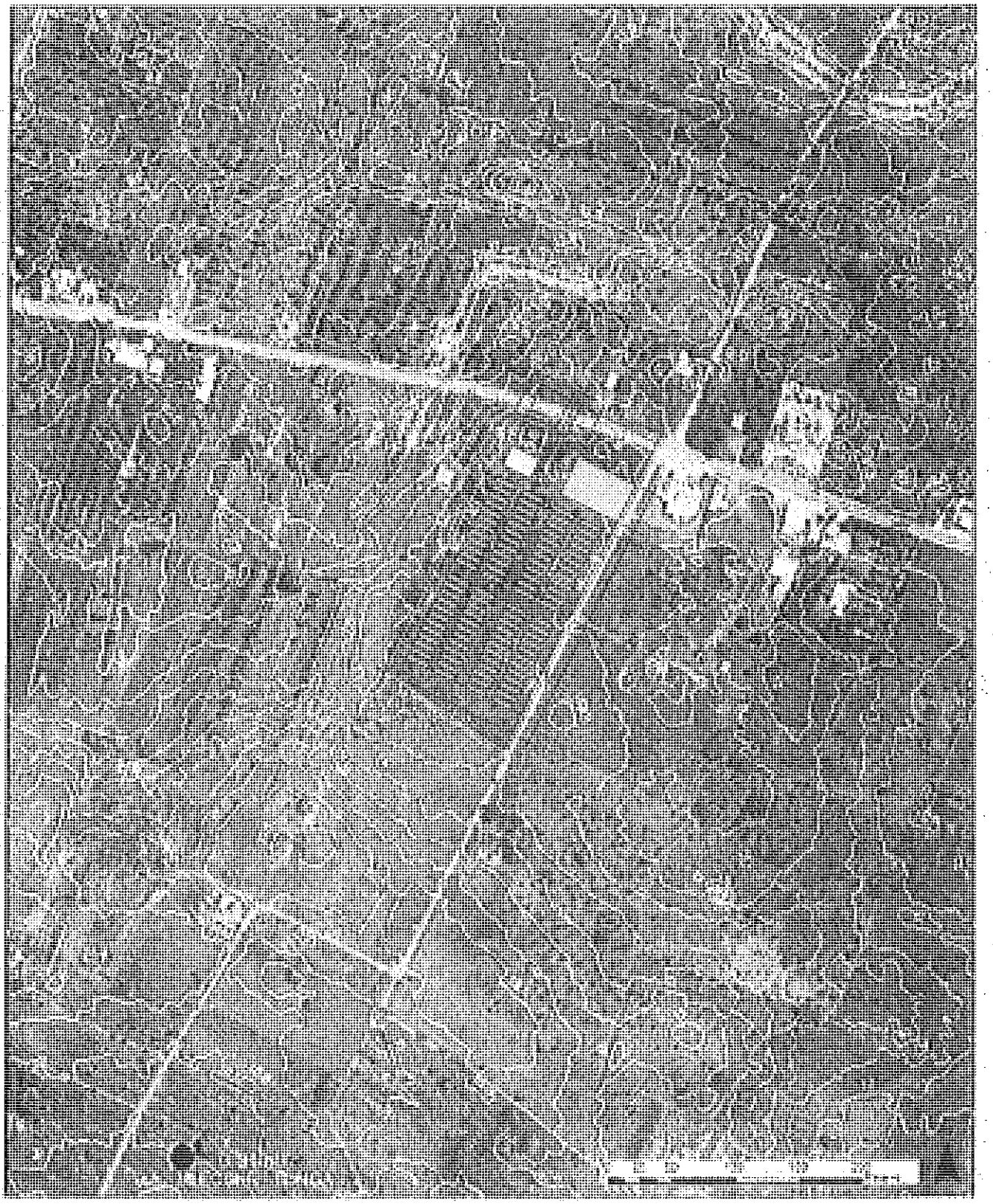
JICA and the GoT shall consult with each other in respect of any matter that may arise from or in connection with the Preparatory Survey.

END

Annex 1: Project Site
Annex 2: Vaini PV Site
Annex 3: Organization Chart of TPL
Annex 4: Schedule of the Preparatory Survey
Annex 5 Japan's Grant AID Scheme
Annex 6: Flow Chart of Japan's Grant AID Procedures
Annex 7: Major undertakings to be taken by each Government



Project Site



CANDIDATE PHOTOVOLTAIC SITE

Senior Management – Chart 1

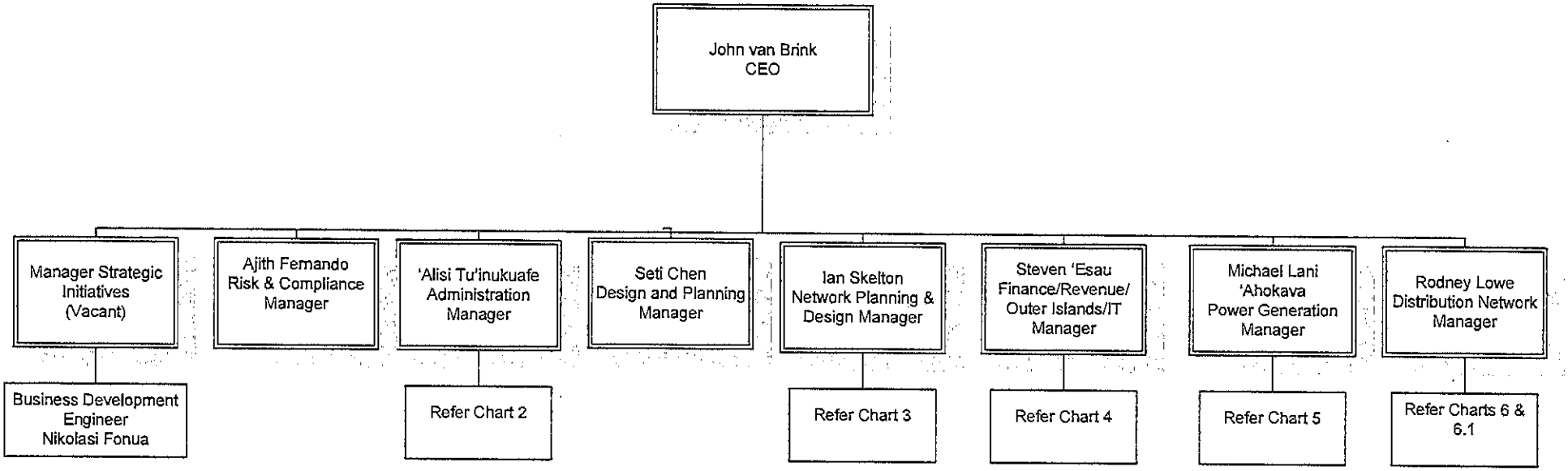
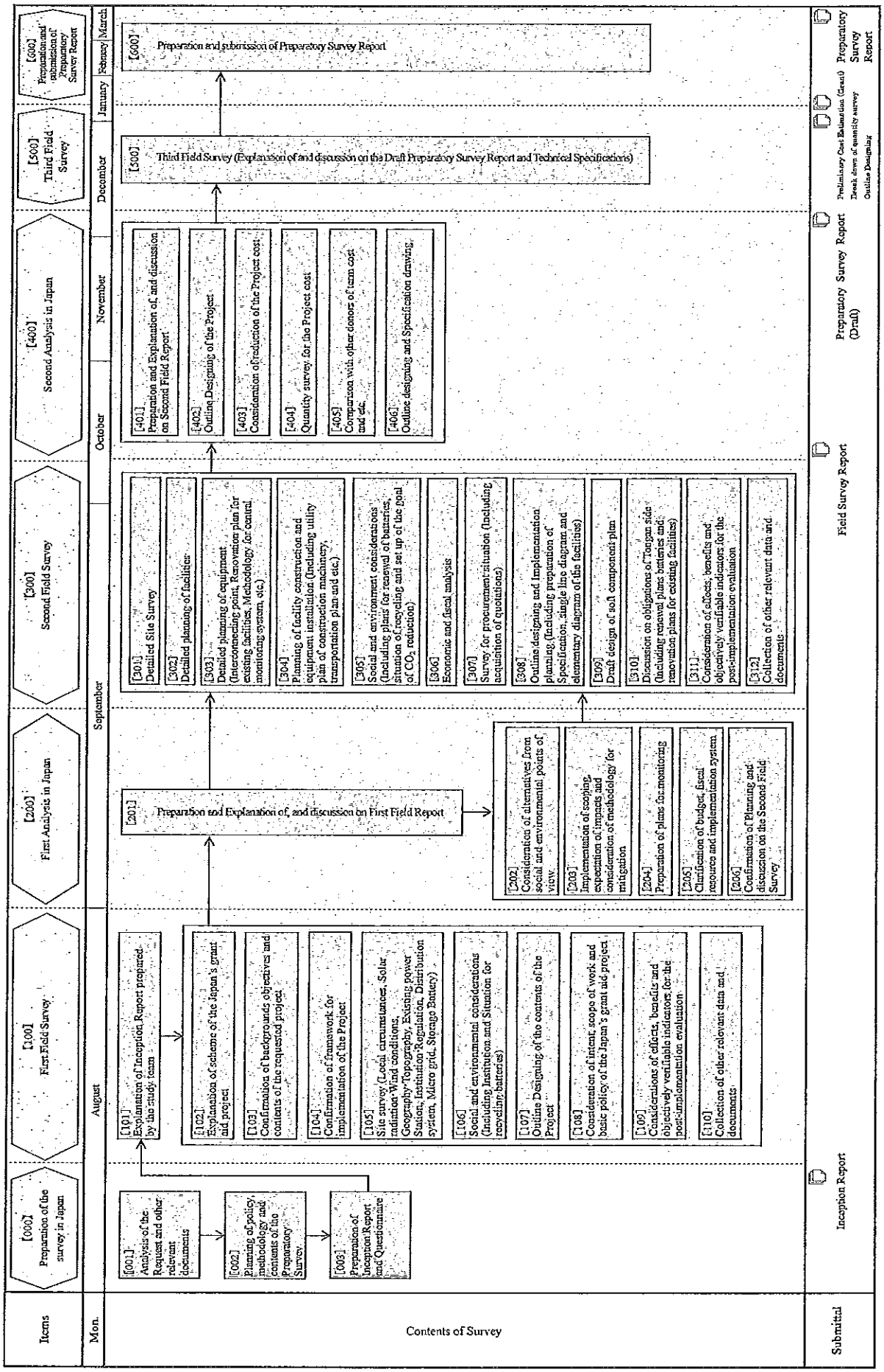


	Chart 1	Chart 2	Chart 3	Chart 4	Chart 5	Chart 6	Chart 6.1	Total
Established	9	6	13	40	20	48	11	147
Occupied	9	6	13	40	20	48	11	147
Vacancy	1	0	0	1	0	0	0	2
Trainees	0	0	2	0	1	0	4	7
Casuals	0	0	1	0	0	8	0	9



Schedule of the Preparatory Survey

JAPAN'S GRANT AID

The Government of Japan (hereinafter referred to as "the GOJ") is implementing the organizational reforms to improve the quality of ODA operations, and as a part of this realignment, a new JICA law was entered into effect on October 1, 2008. Based on this law and the decision of the GOJ, JICA has become the executing agency of the Grant Aid for General Projects, for Fisheries and for Cultural Cooperation, etc.

The Grant Aid is non-reimbursable fund provided to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures

The Japanese Grant Aid is supplied through following procedures:

- Preparatory Survey
  - The Survey conducted by JICA
- Appraisal &Approval
  - Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet
- Authority for Determining Implementation
  - The Notes exchanged between the GOJ and a recipient country
- Grant Agreement (hereinafter referred to as "the G/A")
  - Agreement concluded between JICA and a recipient country
- Implementation
  - Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the preparatory Survey is to provide a basic document necessary for the appraisal of the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the recipient country necessary for the implementation of the Project.

- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of an outline design of the Project.
- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Outline Design of the Project is confirmed based on the guidelines of the Japan's Grant Aid scheme.

JICA requests the Government of the recipient country to take whatever measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA employs (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

JICA reviews the Report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the appropriateness of the Project.

3. Japan's Grant Aid Scheme

(1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes(hereinafter referred to as "the E/N") will be singed between the GOJ and the Government of the recipient country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the recipient country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country

Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When JICA and the Government of the recipient country or its designated authority deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals".

(4) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by JICA. This "Verification" is deemed necessary to fulfill accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as Annex.

(6) "Proper Use"

The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant Aid, to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant Aid.

(7) "Export and Re-export"

The products purchased under the Grant Aid should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). JICA will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

The Government of the recipient country should bear an advising commission of an Authorization to Pay

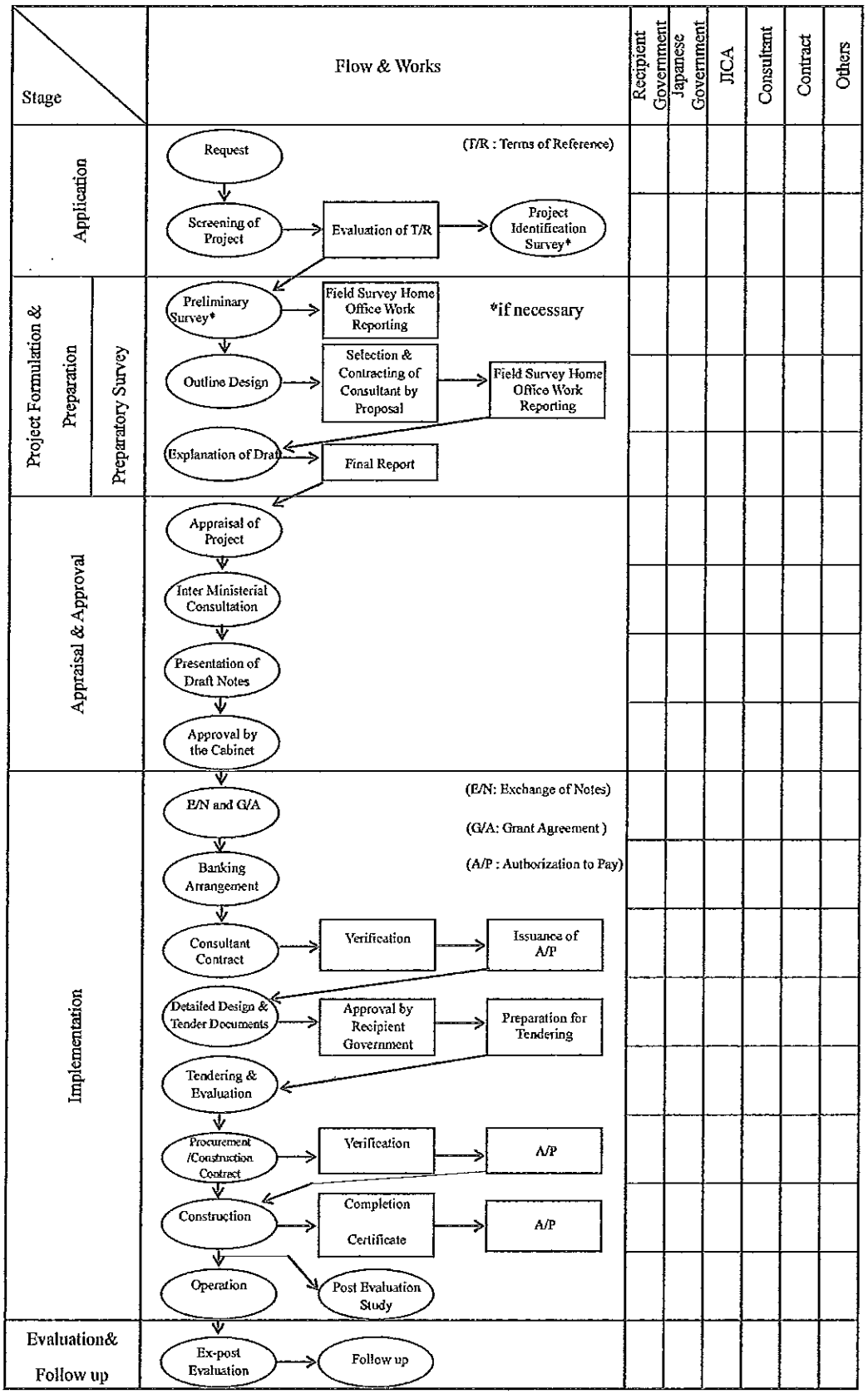
and payment commissions paid to the Bank.

(10) Social and Environmental Considerations

A recipient country must carefully consider social and environmental impacts by the Project and must comply with the environmeutal regulations of the recipient country and JICA socio-environmental guidelines.

(End)

Flow Chart of Japan's Grant Aid Procedures



Major undertakings to be taken by each Government

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	to secure [a lot] /[lots] of land necessary for the implementation of the Project and to clear the [site]/[sites];		●
2	To construct the following facilities		
	1) The building	●	
	2) The gates and fences in and around the site		●
	3) The parking lot	●	
	4) The road within the site	●	
	5) The road outside the site		●
3	To provide facilities for distribution of electricity, water supply and drainage and other incidental facilities necessary for the implementation of the Project outside the [site]/[sites]		
	1)Electricity		
	a. The distributing power line to the site		●
	b. The drop wiring and internal wiring within the site	●	
	c. The main circuit breaker and transformer	●	
	2) Water Supply		
	a. The city water distribution main to the site		●
	b. The supply system within the site (receiving and elevated tanks)	●	
	3) Drainage		
	a. The city drainage main (for storm sewer and others to the site)		●
	b. The drainage system (for toilet sewer, common waste, storm drainage and others) within the site	●	
	4) Gas Supply		
	a. The city gas main to the site		●
	b. The gas supply system within the site	●	
	5) Telephone System		
	a. The telephone trunk line to the main distribution frame/panel (MDF) of the building		●
	b. The MDF and the extension after the frame/panel	●	
	6) Furniture and Equipment		
	a. General furniture		●
	b. Project equipment	●	
4	To ensure prompt unloading and customs clearance of the products at ports of disembarkation in the recipient country and to assist internal transportation of the products		
	1) Marine (Air) transportation of the Products from Japan to the recipient country	●	
	2) Tax exemption and custom clearance of the Products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	●	
5	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the products and the services [be exempted] / [be borne by the Authority without using the Grant]		●
6	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
7	To ensure that [the Facilities and the products]/[the Facilities]/ [the products] be maintained and used properly and effectively for the implementation of the Project		●
8	To bear the following commissions paid to the Japanese bank for banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
9	To give due environmental and social consideration in the implementation of the Project.		●
10	To bear all the above expenses, other than those covered by the Grant, necessary for the implementation of the Project		●

*1 B/A : Banking Arrangement, A/P : Authorization to pay) *2 If the environmental screening category is C, No. 10 is unnecessary

Appendix 2

THE MAIN POINTS DISCUSSED

(1) Wind Turbine Generation System

GoT originally requested the introduction of Wind Turbine Generation system (500kW) and Solar PV system (500kWp). According to the request, the Team surveyed the candidate sites of the Wind turbine generation system, selected by TPL and Ministry of Land, Environment ,Climate Change and Natural Resources (MLECCNR), and had series of discussions with their representatives about wind synopsis data, land owner ship, access roads, distribution lines to be connected, environmental constraint, etc. Survey of existing conditions on the environmental constraint takes one (1) year at minimum. Accordingly, it takes one and half (1.5) year approximately to obtain permission from Japanese authorities, taking into account the required time for data analysis, assessment of the environmental impact, information disclosure, stakeholder meetings, review of EIA and so on. The time required for the EIA procedure does not meet the project schedule.

As the results of discussions, both sides agreed that the Wind turbine generation system would not be adopted in the project component. However, the team agreed on the analysis of the potential of Wind Turbine Generation system at the candidate site from the data acquired through the survey.

(2) Solar PV system

Since the Wind turbine generation system is excluded from the project component, both sides agreed that the capacity of the Solar PV system at Vaini shall be approximately 1.0 MWp to aid the achievement of the TERM's target and to ensure the introduction of renewable energy as much as possible.

(3) The Tongan side agreed to obtain approval from Mamma Mai, existing solar PV system (1.3MWp) to connect signal cables to the photovoltaic system and send its generating conditions to a micro-grid controller of the Project at Popua Power Station controlling energy flows and quality, and optimizing efficiency of the diesel engine generators.

(4) It would be necessary to integrate load sharing system between Caterpillar and Mak generators in Popua Power Station to effectively compensate load fluctuation from solar PV system. The Preparatory Survey team requested the Tongan side to provide necessary information by Sep. 10th 2012 to analyze the behavior of integrated load sharing system and to study necessary equipment and specifications for the system. The Tongan side agreed to do so.

(5) In addition to the Annex 7, both sides agreed that the following matters are included in the Undertakings of the GoT side

1) Renewal of Battery system
2) Treatment of Used batteries
3) Concluding the maintenance contract for Micro-Grid system
4) Ensuring the installation site(s) for Solar PV generation system including Micro-grid controller(s), Batteries, Power conditioners, etc.
5) Implementation of EIA and acquisition of the Environmental permission

(6) Project Title

The Project Title in Application Form submitted by the GoT was "The TERM Development and Implementation of a Micro-Grid System to the TPL Grid of Tongatapu".

JICA and the GoT agreed to change the Project Title to "The Project for Introduction of a Micro-Grid System with Renewable Energy for the Tonga Energy Road Map".

Appendix 3

List of Attendants

Tonga Energy Road Map

Mr. 'Inoke Finau Vala	TERM-IU Director
Mr. 'Akau' Ola	Term-C Advisor
Mr. Ofa Sefana	Acting Energy Planning Specialist
Mr. Slua Aatu	Environmental Information Officer
Mr. Moleni Tuuholoaki	Acting Director of Meteorology
Ms. Katherine Bakes	Operations Officer (World Bank)

Tonga Power Limited

Mr. John Van Brink	Chief Executive
Mr. Lano Fonua	Strategic Initiatives Manager
Mr.Michael Lani 'Ahokava	Power Generation Manager
Mr. Murray Sheerin	Power Station Superintendent
Mr. Ian Skelton	Planning and Design Manager
Mr. Nikolasi Fonua	Business Development Engineer

Ministry of Land, Environment, Climate Change and Natural Resources

Department of Environment and Climate Change

Ms. Mafile'o Masi	Acting Deputy Director
Ms. Kate Mcpherson	Environment Legislation Policy Officer
Ms. Lesieli Tuivai	Ecologist, Environmentalist

Planning & Urban Management Agency

Mr. 'Atunaisa. M. Fetokai	Deputy Physical Planner
Mr. Tevita L. Fotu	Urban Planner

LGIS Unit

Mr. Richard Atelea Kautoke	Sen. GIS Specialist

Ministry of Infrastructure

Laboratory, Civil Engineering Department

Mr. Ken Robinson	Material Engineer

Japan International Cooperation Agency

Mr. Hiroshi SUMIYOSHI	Team Leader
Mr. Yoshimasa SAKAMOTO	Planning Management

Consultants

Mr. Mitsuhisa NISHIKAWA	Yachiyo Engineering Co., Ltd.
Mr. Kyoji FUJII	Yachiyo Engineering Co., Ltd.
Mr. Hidekazu SATO	Yachiyo Engineering Co., Ltd.
Mr. Shinya KONDO	West Japan Engineering Consultants, Inc.
Mr. Kazunari NOGAMI	Yachiyo Engineering Co., Ltd.
Mr. Kenji OHARA	Yachiyo Engineering Co., Ltd.
Mr. Shigeki TAKASHIMA	Yachiyo Engineering Co., Ltd.
Mr. Masao YAMAKAWA	Yachiyo Engineering Co., Ltd.

THE MINUTES OF MEETINGS

ON

THE MISSION FOR THE PREPARATORY SURVEY

ON

THE PROJECT FOR INTRODUCTION OF A MICRO-GRID SYSTEM WITH RENEWABLE ENERGY FOR THE TONGA ENERGY ROAD MAP

IN

THE KINGDOM OF TONGA

AGREED UPON BETWEEN

THE GOVENMENT OF THE KINGDOM OF TONGA

AND

THE JAPAN INTERNATIONAL COOPERATION AGENCY

(EXPLANATION ON DRAFT FINAL REPORT)

Nuku'alofa, 20th December, 2012

Mr. 'Inoke Finau Vala
TERM-IU Director
Tonga Energy Road Map Agency
the Kingdom of Tonga

Mr. Hiroo TANAKA
Leader
Preparatory Survey Team
Japan International Cooperation Agency

Mr. Winston Halapua
Acting Deputy Secretary
Aid Management Division
Ministry of Finance and National Planning

Mr. John Van Brink for
Chief Executive
Tonga Power Limited

The government of The Kingdom of Tonga (hereinafter referred to as "GoT") and the Japan International Cooperation Agency (hereinafter referred to as "JICA") have made several preliminary discussions in order to identify priority projects in the field of power sector, and agreed to make preparation for the Project for Introduction of a Micro-Grid System with Renewable Energy for the Tonga Energy Road Map (hereinafter referred to as "the Project").

From August to October 2012, JICA dispatched the Survey Team to The Kingdom of Tonga; and through discussions, field surveys and the result of technical examination in Japan, JICA prepared the Draft Final Report of the Survey which included the outline design of the Project.

Accordingly, JICA dispatched a mission on the Project (hereinafter referred to as "the JICA Mission") to The Kingdom of Tonga from 15th December, 2012 to 21st December, 2012 in order to explain the Draft Final Report and to consult with the officials of concerned authorities in The Kingdom of Tonga (hereinafter referred to as "the Preparatory Survey") , which was headed by Mr. Hiroo TANAKA, Deputy Director General and Group Director for Energy and Mining, Industrial Development and Public Policy Department, JICA.

GoT and the JICA Mission have confirmed the main points discussed during its visit described in Appendix 1.

It should be noted that implementation of the Preparatory Survey does not imply any decision or commitment by JICA to extend its grant for the project at this stage.

Appendix 1: Main Points Discussed
Appendix 2: List of Attendants

Appendix 1

THE MAIN POINTS DISCUSSED

I. CONTENTS OF THE DRAFT FINAL REPORT

GoT agreed and accepted in principle the contents of the Draft Final Report and the Draft Technical Specifications of the Survey explained by the Team.

II. RESPONSIBLE AND IMPLEMENTING ORGANIZATIONS

1. Responsible Organization

Tonga Energy Road Map Agency (TERM-A)

2. Executing Agency

Tonga Power Limited (The organization chart is shown in Annex 3. as owner of the affected and new assets.

*TERM Implementation Unit (TERM-IU) will have oversight of the Project.

III. COMPONENTS OF THE PROJECT

The components of this project are as follows;

	Components	Quantity
Procurement and Installation	1.Micro-grid system at Popua Power Station	
	1.1 Micro-grid control system	1 lot
	1.2 Power storage system	Enough capacity supply 500 kW for 30 sec. from SOC 50 %
	1.3 Station service panel	1 set
	2. Micro-grid system at Vaini Project Site	
	2.1 Micro-grid control system	1 lot
	2.2 Power storage system	Enough capacity supply 500 kW for 30 sec. from SOC 50 %
	2.3 Photovoltaic system (PV system)	1,000 kWp
	2.4 11 kV interconnection switchgear	1 lot
	2.5 Station service panel	1 set
	3. Optical fiber communication system	Approx. 15 km
Procurement	4. 11 kV interconnection switchgear at Popua Power Station	1 lot
	5. Spare parts	1 set
Construction	a. Building for electrical equipment at Popua Power Station	Gross floor area: Approx. 100 m^2
	b. Foundation of Photovoltaic Arrays	1 lot
	c. Building for electrical equipment at Vaini Project Site	Gross floor area: Approx. 190 m^2

IV. JAPAN'S GRANT AID SCHEME

GoT reconfirmed the Japan's Grant Aid Scheme and the necessary measures to be taken by the Tongan side explained by the JICA Mission as described in Annex 4, 5 and 6. GoT will take the necessary measures, as described in Annex 6, for smooth implementation of the Project as prerequisites for the Japan's Grant Aid to be implemented.

V. PROJECT COST

GoT agreed that the cost for the Project should not exceed the amount agreed on Exchange of Notes (E/N). GoT also agreed that the cost for the Project contains procurement cost of equipment, transportation cost up to the Project site, installation cost and the Consultant fees.

VI. CONFIDENTIALITY OF THE PROJECT

1. Detailed specifications of the Facilities and Equipment

GoT and the JICA Mission agreed that all the information related to the Project including detailed drawings and specifications of the facilities and equipment and other technical information shall not be disclosed to any outside parties (i.e. outside of JICA and the Tongan side) before the conclusion of all contract(s) for the Project.

2. Confidentiality of the Cost Estimation

The JICA Mission explained the estimated cost of the Project as described in Annex 7. GoT and the JICA Mission agreed that the estimated cost for the Project should never be duplicated or disclosed to any outside parties (i.e. outside of JICA and the Tongan side) before tender for the Project. GoT understood that the estimated cost for the Project attached as Annex 7 is not the final and is subject to change as a result of examination through revision of the Outline Design Study.

VII. POSSIBILITY OF CHANGE IN SCOPE, SCHEDULE AND COST OF THE PROJECT

The JICA Mission stressed that the scope, the schedule, and the cost for the Project are tentative and subject to change due to the domestic circumstances in Japan and in Tonga. GoT understood it.

VIII. OTHER RELEVANT ISSUES

1. Customs and Tax Exemption

Based on the previous Minutes of Meetings signed on 30th August 2012, the Tongan side agreed that the Tongan side shall be responsible for the exemption of all customs, tax, levies and duties incurred in Tonga for implementation of the project.

2. Undertakings of the GoT side

Based on the previous Minutes of Meetings signed on 30th August 2012, both sides reconfirmed that the following matters are included in the Undertakings of the GoT side in addition to the Annex 6.

1) Replacement and proper disposal measure of the Power Storage systems
2) Concluding the maintenance contract for Micro-Grid system with the Japanese manufacturer of the Project equipment
3) Ensuring the installation site(s) for the Solar PV generation system including Micro-grid controller(s), Storage Systems, and Power conditioners, etc.
4) Implementation of EIA and acquisition of the Environmental permission by the end of March, 2013.

3. Connecting signal cables from the existing solar PV system

Based on the previous Minutes of Meetings signed on 30th August 2012, the Tongan side reconfirmed to obtain approval from Maama Mai, existing solar PV system (1.3MWp) to connect signal cables to the photovoltaic system, in order to send its generating conditions to a micro-grid controller of the Project at Popua Power Station.

4. Analysis of the potential of Wind Turbine Generation system

The Draft Final Report includes an analysis of the potential of Wind Turbine Generation systems at the candidate sites from the data acquired through the survey. The JICA Mission explained the contents to the Tongan side.

5. Consistency to the Tongan Policy for Renewable Energy

The Cabinet of Tonga dissolved in 2009 a policy goal of "increasing the proportion of renewable energy to 50% of the entire electricity supply by 2020". GoT also formulated a Tonga Energy Road Map 2010-2020 (TERM) as an implementation policy to achieve the policy goal. Both sides agreed that the Project is one of effective measure to realize the policy.

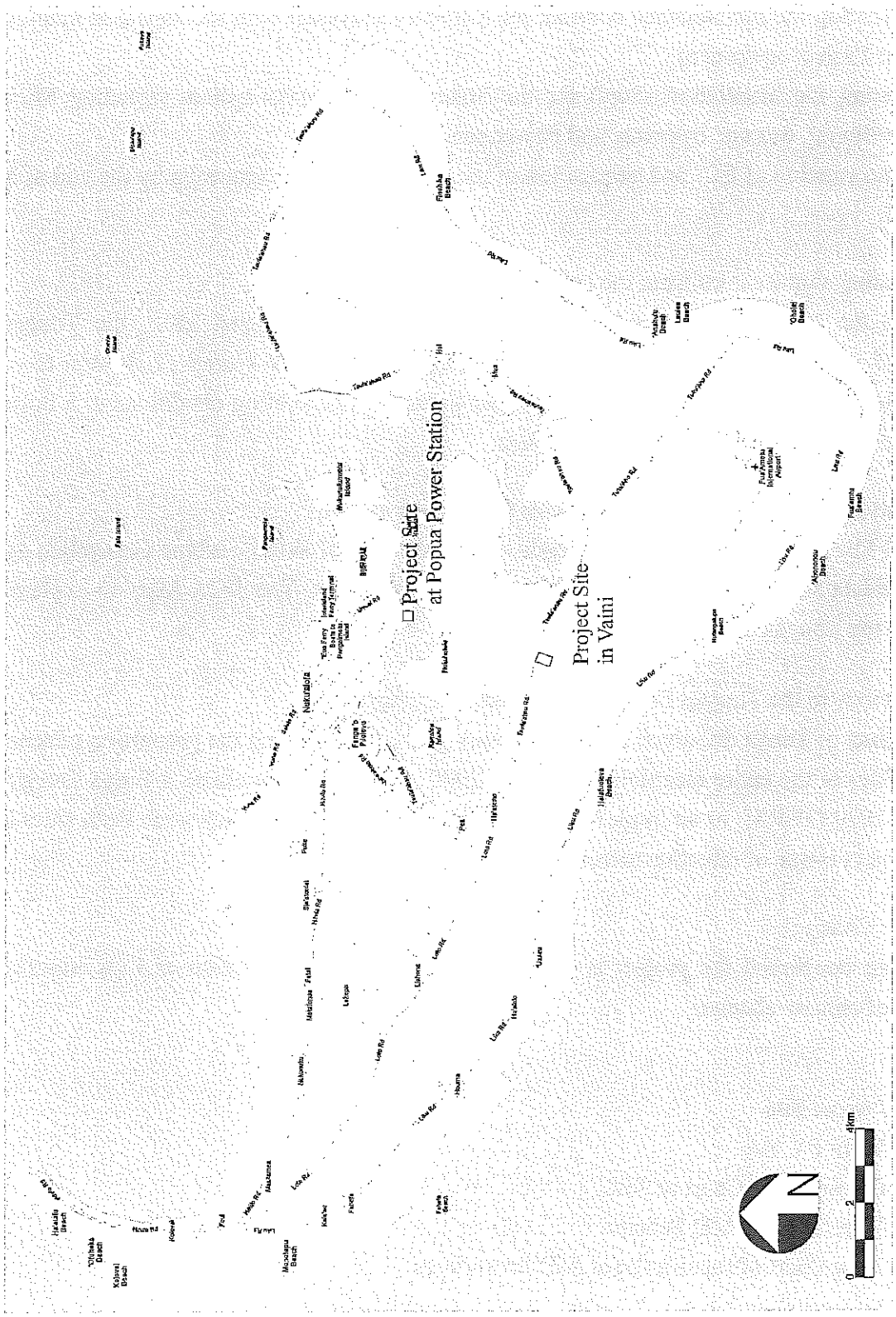
6. Climate Change

Both sides confirmed the project is expected to contribute to reduction of CO_2 emission and mitigation of climate change.

END

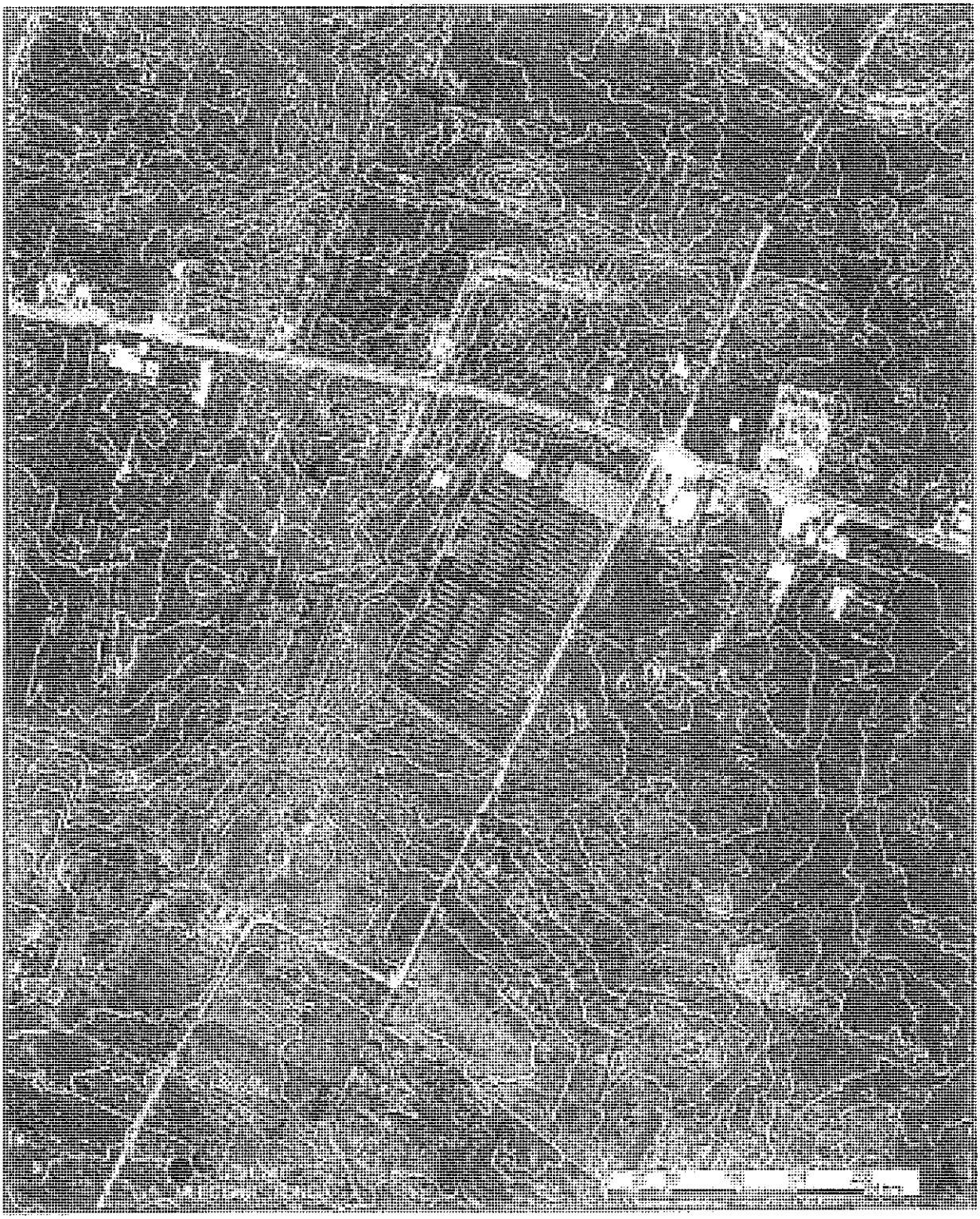
Annex 1: Project Site
Annex 2: Vaini PV Site
Annex 3: Organization Chart of TPL
Annex 4: Japan's Grant AID Scheme
Annex 5: Flow Chart of Japan's Grant AID Procedures
Annex 6: Major undertakings to be taken by each Government
Annex 7: Estimated Project Cost

Annex 1



Project Site

Annex 2



CANDIDATE PHOTOVOLTAIC SITE

Senior Management – Chart 1

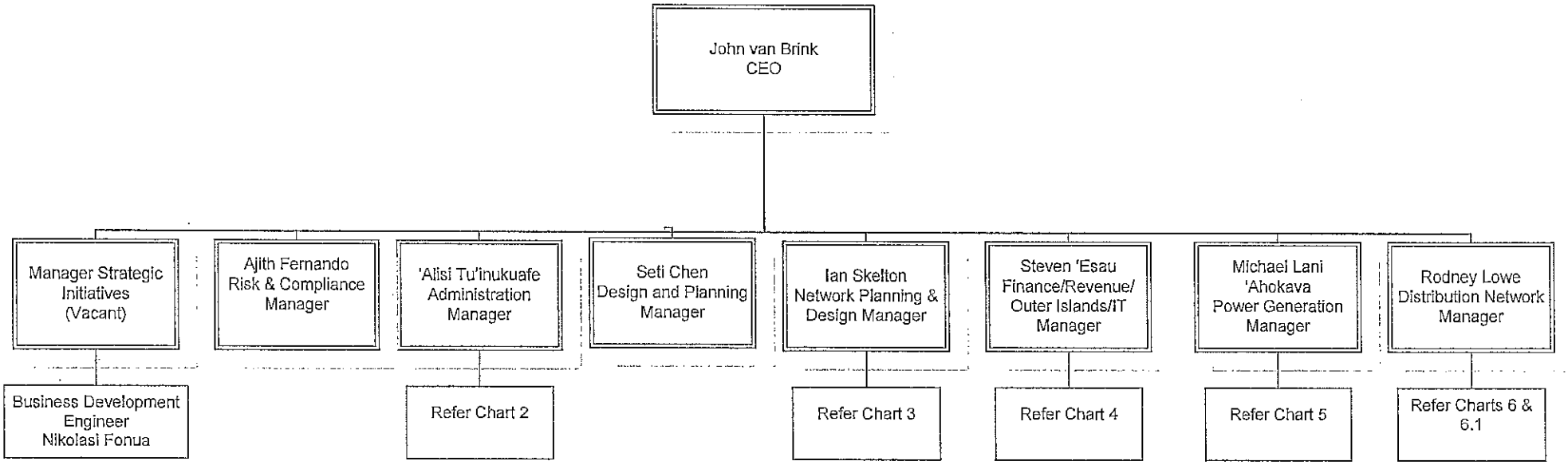


	Chart 1	Chart 2	Chart 3	Chart 4	Chart 5	Chart 6	Chart 6.1	Total
Established	9	6	13	40	20	48	11	147
Occupied	9	6	13	40	20	48	11	147
Vacancy	1	0	0	1	0	0	0	2
Trainees	0	0	2	0	1	0	4	7
Casuals	0	0	1	0	0	8	0	9

Annex 4

JAPAN'S GRANT AID

The Government of Japan (hereinafter referred to as "the GOJ") is implementing the organizational reforms to improve the quality of ODA operations, and as a part of this realignment, a new JICA law was entered into effect on October 1, 2008. Based on this law and the decision of the GOJ, JICA has become the executing agency of the Grant Aid for General Projects, for Fisheries and for Cultural Cooperation, etc.

The Grant Aid is non-reimbursable fund provided to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures

The Japanese Grant Aid is supplied through following procedures:

- Preparatory Survey
  - The Survey conducted by JICA
- Appraisal &Approval
  - Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet
- Authority for Determining Implementation
  - The Notes exchanged between the GOJ and a recipient country
- Grant Agreement (hereinafter referred to as "the G/A")
  - Agreement concluded between JICA and a recipient country
- Implementation
  - Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the preparatory Survey is to provide a basic document necessary for the appraisal of the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the recipient country necessary for the implementation of the Project.

- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of an outline design of the Project.
- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Outline Design of the Project is confirmed based on the guidelines of the Japan's Grant Aid scheme.

JICA requests the Government of the recipient country to take whatever measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA employs (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

JICA reviews the Report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the appropriateness of the Project.

3. Japan's Grant Aid Scheme

(1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes(hereinafter referred to as "the E/N") will be singed between the GOJ and the Government of the recipient country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the recipient country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country

Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When JICA and the Government of the recipient country or its designated authority deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals".

(4) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by JICA. This "Verification" is deemed necessary to fulfill accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as Annex.

(6) "Proper Use"

The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant Aid, to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant Aid.

(7) "Export and Re-export"

The products purchased under the Grant Aid should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). JICA will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

The Government of the recipient country should bear an advising commission of an Authorization to Pay

and payment commissions paid to the Bank.

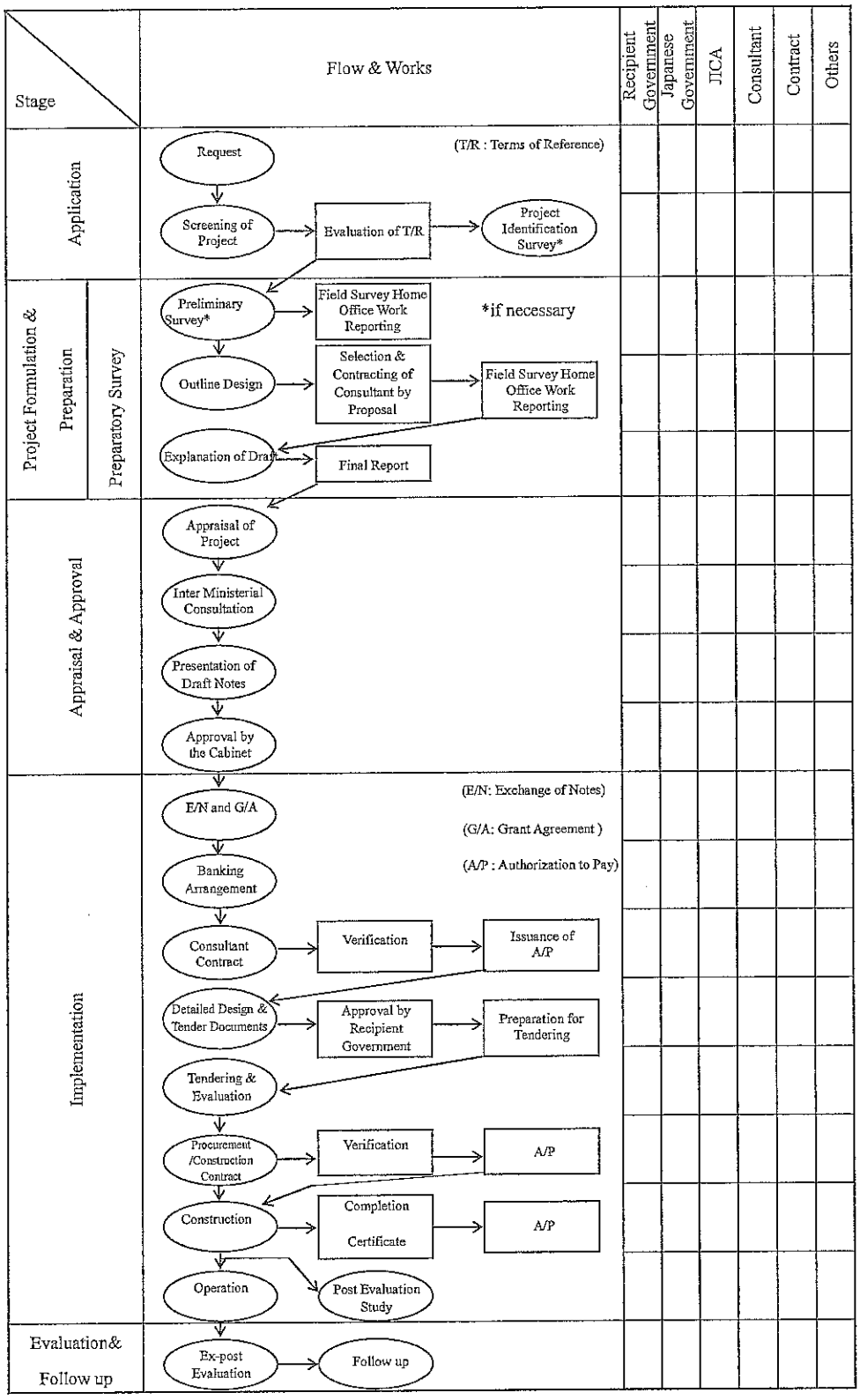
(10) Social and Environmental Considerations

A recipient country must carefully consider social and environmental impacts by the Project and must comply with the environmental regulations of the recipient country and JICA socio-environmental guidelines.

(End)

Annex 5

Flow Chart of Japan's Grant Aid Procedures



Annex 6

Major undertakings to be taken by each Government

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	to secure [a lot] /[lots] of land necessary for the implementation of the Project and to clear the [site]/[sites];		●
2	To construct the following facilities		
	1) The building	●	
	2) The gates and fences in and around the site		●
	3) The parking lot	●	
	4) The road within the site	●	
	5) The road outside the site		●
3	To provide facilities for distribution of electricity, water supply and drainage and other incidental facilities necessary for the implementation of the Project outside the [site]/[sites]		
	1)Electricity		
	a. The distributing power line to the site		●
	b. The drop wiring and internal wiring within the site	●	
	c. The main circuit breaker and transformer	●	
	2) Water Supply		
	a. The city water distribution main to the site		●
	b. The supply system within the site (receiving and elevated tanks)	●	
	3) Drainage		
	a. The city drainage main (for storm sewer and others to the site)		●
	b. The drainage system (for toilet sewer, common waste, storm drainage and others) within the site	●	
	4) Gas Supply		
	a. The city gas main to the site		●
	b. The gas supply system within the site	●	
	5) Telephone System		
	a. The telephone trunk line to the main distribution frame/panel (MDF) of the building		●
	b. The MDF and the extension after the frame/panel	●	
	6) Furniture and Equipment		
	a. General furniture		●
	b. Project equipment	●	
4	To ensure prompt unloading and customs clearance of the products at ports of disembarkation in the recipient country and to assist internal transportation of the products		
	1) Marine (Air) transportation of the Products from Japan to the recipient country	●	
	2) Tax exemption and custom clearance of the Products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	●	
5	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the products and the services [be exempted] / [be borne by the Authority without using the Grant]		●
6	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
7	To ensure that [the Facilities and the products]/[the Facilities]/ [the products] be maintained and used properly and effectively for the implementation of the Project		●
8	To bear the following commissions paid to the Japanese bank for banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
9	To give due environmental and social consideration in the implementation of the Project.		●
10	To bear all the above expenses, other than those covered by the Grant, necessary for the implementation of the Project		●

*1 B/A : Banking Arrangement, A/P : Authorization to pay) *2 If the environmental screening category is C, No. 10 is unnecessary

(Confidential)
Estimated Project Cost

The cost of the Project will be approximately JP¥ 1,642.4million in total. The content of the project cost are shown separately for the Japanese borne portion and the Tongan side borne portion in accordance with the conditions in item 3. (3) below.

This cost estimate is provisional and subject to change as a result of examination by the Government of Japan for the approval of the Grant.

1. Cost to be borne by the Japanese side:

Approximate Total cost for Japanese Portion

Cost Items	Approximate Cost (million JPY)
Equipment Procurement, Installation and Trainings	JP¥ 1,515.5million
Construction(include in the above)	(JP¥192,2million)
Detailed Design & Consultant's Supervision	JP¥ 70.2million
Total	JP¥ 1,585.7million

2. Cost to be borne by the Tongan side: US$ 696,000 (=approximately JP¥ 56.7 million)

Cost Items	US$	(≒JP¥)
① Payment of bank commission based on banking ・Commission of an Authorization to Pay (A/P) ・Payment commission	US$20,000-	JP¥1,600,000-
② Clearance of trees, and exterior wall and gate work for the PV system site in Vaini area	US$46,000-	JP¥4,000,000-
③ Work to increase the size of the distribution wire of 11kV and connection work in Vaini area	US$40,000-	JP¥3,500,000-
④ Expansion work for 11kV switch board room at the Popua Power Station:	US$52,000-	JP¥4,500,000-
⑤ Installation work for Grid-connected switch gear for 11kV system:	US$100,000-	JP¥8,000,000-
⑥ Remodeling work for the existing power generating facilities at the Popua Power Station (Including Load Sharing of Generator 7 with other generators for maintaining fuel efficiency: UD$70,000)	US$90,000-	JP¥7,200,000-
⑦ Land lease/rental at Vaini site for First year (=TOP600,000+TOP10,000/year)	US$348,000-	JP¥27,900,000-
Approximate Total cost	US$696,000-	JP¥56,700,000-

3. Conditions for estimation
   (1) Time of estimation: December, 2012
   (2) Foreign exchange rates:
   1USD = JP¥80.40 (TTS mean value from April 2012 to September 2012)
   1TOP = JP¥45.80 (TTS mean value from April 2012 to September 2012)
   (3) Others:
   The above estimation was carried out in accordance with relevant rules and the guideline of the Japanese Grant Aid.

Appendix 2

List of Attendants

Tonga Energy Road Map

Mr. 'Inoke Finau Vala	TERM-IU Director
Mr. Sitiveni Finau	Communication Officer

Tonga Power Limited

Mr. John Van Brink	Chief Executive
Mr. Michael Lani 'Ahokava	Power Generation Manager
Mr. Nikolasi Fonua	Business Development Engineer

Japan International Cooperation Agency

Mr. Hiroo TANAKA	Team Leader
Mr. Yoshimasa SAKAMOTO	Planning Management

Consultants

Mr. Mitsuhisa NISHIKAWA	Yachiyo Engineering Co., Ltd.
Mr. Kazunari NOGAMI	Yachiyo Engineering Co., Ltd.
Mr. Shozo KURASHIMA	Yachiyo Engineering Co., Ltd.

A-5　技術協議録(Field Report)
（環境チェックリストを含む）

PREPARATORY SURVEY
ON
THE PROJECT FOR
DEVELOPMENT AND INTRODUCTION OF MICRO-GRID SYSTEM
FOR THE TONGA ENERGY ROAD MAP
IN THE KINGDOM OF TONGA

THE FIRST FIELD SURVEY

FIELD REPORT

August 30th, 2012

Mr. John Van Brink
Chief Exective
Tonga Power Limited

Mr. Mitsuhisa Nishikawa
Chief Consultant,
JICA Study Team

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ANNEX

1. Members of the Team
2. Minutes of Meetings
3. Approval Letter of Land Use for the Project Site in Vaini
4. Outline of installation of 11 kV switchgears of the Project at Popua Power Station

Drawings

E-01 Single Line Diagram
E-02 Control System Diagram
E-03 Connection of Communication Cable to the Existing Photovoltaic System
A-01 Floor and Section Plan of Buildings
A-02 PCS and Batteries Building in Vaini
A-03 PCS and Batteries Building at Popua Power Station

1. Introduction

Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched a survey team to the Kingdom of Tonga to appraise the Project for Introduction of A Micro-Grid System with Renewable Energy for the Tonga Energy Road Map in the Kingdom of Tonga (hereinafter referred to as "the Project") which was requested by the government of Tonga as Japan's Grant Aid. The Project is aimed at introducing a micro-grid system with renewable energy to control energy flows and quality, and optimize efficiency of the diesel engine generators.

Tonga Power Limited (hereinafter referred to as "TPL") and JICA Preparatory Survey Team for the Project (hereinafter referred to as "the Team") had series of technical discussion to form a mutual understanding of the contents and the scope and preconditions for outline design of the Project at the stage of 1st preparatory survey and both parties agreed to record the following points as a conclusion of the discussions.

This Field Report contains the findings and results of 1st field survey. Components of the Project will be further examined and may be modified through the consultation with the Ministry of Foreign Affairs and JICA headquarters. It is important for both sides to understand that the Preparatory Survey is not a commitment for the future implementation of the Project.

2. Project Site Location

The project sites are located in Tongatapu Island in the Kingdom of Tonga.

Source: JICA Study Team

Figure 1 Project Site Location

The Project is composed of procurement and installation of approximately 1 MWp of photovoltaic system, power storage system and a micro grid controller to control energy flows and quality, and optimize efficiency of the diesel engine generators.

The Project site for the Photovoltaic (PV) system, and building for power conditioner system (PCS) and power storage system (Batteries) are shown in Figure 2 (areas: approximately 24,000 m^2). In the first field survey, the availability of the land is confirmed by TPL and the approval letter in Annex 3 to use the land for the Project was issued by the Minister of Land, Environment, Climate Change and Natural Resources who is responsible for administration of the area.

In addition, building for power conditioner system (PCS) and power storage system (Batteries) for the existing PV system of Mamma Mai, whose capacity is of 1.3 MWp, will be constructed at Popua Power Station beside the existing powerhouse for the Mak generator under the Project. It is agreed by TPL (areas: approximately 300 m^2) to use the area for the Project. However, the area is dependent on capacity of the power storage system of the Project. More definite size will be discussed in the Second Field Survey by the Tongan side and Preparatory Survey Team.

Source: JICA Study Team using GIS map by the Ministry of Land, Environment, Climate Change and Natural Resources

Figure 2 Project Site for PV system

3. Components for the Project

3.1 Components identified in the Minutes of Meetings

The Tongan and Japanese sides were signed on the Minutes of Meetings on 30th August, 2012 and the following components were finally requested by the Tongan side on it.

Table 1 Components identified in the Minutes of Discussions

	Components
Micro grid controller	• Generation and network control system integrated into TPL's SCADA at Popua power station • IP broadband and/or mesh type communications network that overlies TPL's Tongatapu network, connecting remote generation to the Popua SCADA system and micro grid controllers. • Integration of battery and load flow "smoothing" algorithms to monitor and control field assets and enable future demand side management
Storage System (Batteries)	• Batteries and controller located at either Popua or at Vaini PV Site, controlling energy flows and quality, and optimising efficiency of the diesel generators • Conversion of the TPL 2.88 MW MAK diesel generator governor to load following capability (requires manufacturer's involvement to modify governors, TPL has discussed requirements and scope with the manufacturer)
Solar PV system (1MWp)	• A single solar PV array at Vaini, in central Tongatapu, injecting into the TPL 11kV network, including spares • Network voltage management (regulator or other dynamic support)
Operation & Maintenance of the equipment	• Training TERM-IU staff and TPL staff • Operating and maintenance manuals and process documentation • O & M support

Source: Minutes of Meetings signed with JICA on the 30th August, 2012

3.2 Drawing Lists

The following drawings are attached in the end of this field report.

E-01 Single Line Diagram
E-02 Control System Diagram
E-03 Connection of Communication Cable to the Existing Photovoltaic System
A-01 Floor and Section Plan of Buildings
A-02 PCS and Batteries Building in Vaini
A-03 PCS and Batteries Building at Popua Power Station

3.3 Technical issues to be discussed

Based on agreement on the Minutes of Meetings signed on 30th August, 2012, the following technical issues were confirmed between the Tongan side and the Preparatory Survey Team.

(1) Acquisition of approval from Mamma Mai to connect signal cables to the existing PV system

The Tongan side agreed to obtain approval from Mamma Mai to connect signal cables to the existing photovoltaic system and send its generating conditions to the micro-grid controller of

the Project at Popua Power Station before the Second Field Survey. The Second Field Survey will be conducted in the middle of September.

(2) Submission of information from the Tongan side to the Preparatory Survey Team for improvement of load sharing system of the existing diesel engine generators

It would be necessary to integrate load sharing system between Caterpillar and Mak generators in Popua Power Station to effectively compensate load fluctuation from solar PV system. The Preparatory Survey Team requested the Tongan side to provide the following information by 10th September, 2012 to analyze the behavior of integrated load sharing system and to study necessary equipment and specifications for the system.

- Control system diagrams after integration for load sharing
- Required devices including communication cables for integration
- Specifications of the required devices for integration
- Installed locations of the devices at Popua Power Station

(3) Connection of the equipment of the Project to the existing SCADA system

To manage data from the equipment of the Project in the existing SCADA system, they should be connected to the hub ports of the SCADA system. The Tongan side agreed to secure the existing hub ports not in use currently for the Project. And The Tongan side also agreed to resister information of the equipment of the Project to the SCADA system by themselves after installation work and before commissioning of the Project so that the data may be inputted properly.

(4) Undertakings for procurement and installation of 11 kV switchgears for interconnection of the power storage system of the Project at the Popua Power Station

The power storage system of the Project at Popua Power Station cannot be connected to the PV system of Mamma Mai in low voltage because the existing equipment in low voltage belongs to Mamma Mai not to the Tongan side. Therefore, the power storage system shall be connected to the high voltage side.

The Tongan side plans to separate the generator bus and distribution bus currently mixed in a bus. The Tongan side requested the Preparatory Survey Team to locate 11 kV switchgears of the Project in the existing powerhouse at Popua Power Station to enable the extension work of switchgears by himself in the future. The Preparatory Survey Team agreed to do so. The outline drawing is attached in Annex 4 of this field report.

The Tongan side shall undertake modification work of the existing building such as preparation of cable trench, cable trays, walls, doors, windows and air conditioner. The modification work shall be completed prior to commencement of the work by the Japanese side, and installation

work of 11 kV switchgears procured by the Japanese side.

(5) Upgrading the conductor size of the branch line to the Project site in Vaini

The Tongan side and Preparatory Survey Team conducted the route survey to evaluate feasibility of a dedicated 11 kV line for the PV system of the Project from the Project site in Vaini to Popua Power Station. The following three alternatives were confirmed in the survey.

- Route parallel with the existing Nuk 1 Feeder
- Route parallel with the existing Nuk 2 Feeder
- Submarine cables across the lagoon

In case of overhead lines parallel with the existing feeders, some areas, especially the part through downtown, do not have enough space for installation of an additional 11 kV line. In case of submarine cable, there is possibility to affect mangrove growing along the lagoon. As the results of the survey, it was confirmed that installation of the dedicated line is not feasible.

The both parties agreed to connect the PV system of the Project to the existing Vaini Feeder. However, the conductor of the branch line from the trunk line of Vaini Feeder to the Project site in Vaini is of AAAC 25 mm^2 (refer Figure 2). The Tongan side also agreed to upgrade the conductor size of the branch line (approximately 200 m) to the Project site from 25 mm^2 to 160 mm^2 to secure the enough capacity for the PV system of the Project.

(6) Capacity of the Power Storage system

The Preparatory Survey Team will analyze the collected data in the First Field Survey and consider appropriate capacity of the power storage system of the Project to control quality of supplied power and optimize efficiency of the diesel engine generators. The capacity will be discussed in the Second Field Survey based on the analysis. Therefore, the size of the buildings of the Project may be changed in accordance with the capacity of the power storage system.

(7) Topographic and geological survey in the Second Field Survey

Topographic and geological survey shall be conducted in the Second Field Survey for basic design of the Project. The Tongan side shall obtain relevant approvals to clear the Project site in Vaini from concerned parties, and finish clearing work of bush and trees enough for the survey prior to the Second Field Survey. The Second Field Survey will be conducted in the middle of September.

3.4 Wind Power Generation

Based on discussion with the Tongan side in the First Field Survey, the wind power generation was excluded from the components of the Project due to procedural grounds for Environmental Impact Assessment as mentioned in Item 4 of this field report.

However, based on the data observed in Lapaha Village by the Minister of Land, Environment, Climate Change and Natural Resources through 18 months, potential evaluation for wind power generation will be conducted from the technical viewpoint and the results will be included in the Preparatory Survey Report. At the same time, the potential in Niutoua will also be analyzed with wind condition characteristics and energy characteristics such as average wind velocity and energy density of wind power simulated based on the data observed in Lapaha Village and the surrounding topographic information.

4. Environmental and Social Consideration

4.1 Environmental Legal Framework

Existing environmental legislation relevant to the Project is shown below.

Table 2 Existing Environmental Legislation relevant to the Project

Legislation	Year Passed	Last Amended	Objective
Environmental Impact Assessment Act 2003	2003	-	To provide for the application of environmental impact assessment to the planning of development in Tonga
Environmental Impact Assessment Regulations 2010	2010	-	To regulate major development projects and the applications of notification consistent with the EIA Act 2003)
Waste Management Act 2005	2005		To manage and oversee the function of the Waste Management Board
Parks and Reserves Act 1976	1976	1979, 1988	To provide for the establishment of Parks and Reserves Authority and for the establishment, preservation and administration of Parks and Reserves
Hazardous Wastes and Chemicals Act 2010	2010		To provide for the regulation and proper management of hazardous wastes and chemicals in accordance with accepted international practices and the International Conventions applying to the use, transboundary movement and disposal of hazardous substances and for related purposes.
Renewal Energy Act 2008	2008	2010	To regulate the use of renewable energy in the Kingdom and related matters
Environmental Management Act 2010	2010		To establish the Ministry of Environment & Climate Change* to ensure the protection and proper management of the environment and the promotion of sustainable development

*The Ministry of Environment & Climate Change was incorporated into the MLECCNR as the Department of Environment & Climate Change due to the reorganization of government ministries in July 2012.
Source: Department of Environment & Climate Change

The Environmental Impact Assessment Act 2003 (EIA Act 2003) provided the power of the Ministry, the establishment and functions of the Environmental Assessment Committee, penalty, definition of major projects and so on. The major project is defined as a development activity which is likely to result in or increase pollution, or to have adverse impact on natural environment. A development activity which is classified as the major project is subject to conduct an appropriate environmental impact assessment. Development of electric generation station is defined as the major project even though renewal energy is used for the power generation. Therefore, the Project is subject to conduct an EIA.

4.2 Environmental Policies in TERM

The objective of TERM is to reduce vulnerability to high and variable petroleum price with introduction of renewable energy. In order to achieve the objective, a set of key principles have been set out in TERM. Social and environmental sustainability is one of the key principles, and it is explained as follows. "Environmental and Social sustainability encompasses both minimizing local negative social and physical environmental impacts of the energy sector, as well as aligning with global goals with respect to minimizing impact on climate change where possible. New energy investments under the TERM would be subject to *Environmental and Social Impact Assessment and Mitigation Plans* as necessary, as per international practice. Special consideration will be given to those groups with specific needs including youth, women, religious groups and those with special needs. Investments that have major negative environmental or social impacts or constraints that cannot be mitigated or solved will be avoided."

As mentioned above, TERM requires environmental and social impact assessment and mitigation plans as per international practice in order for development of electric generation station. In this regard, the JICA Guidelines for Environmental and Social Considerations shall be observed as well as the World Bank's Safeguard Policies and other standards of international financial organizations related to the environmental and social considerations of the Project.

4.3 Environmental Management Administration and EIA Procedures

The Environmental Management Act 2010, which created the former Ministry of Environment and Climate Change (MECC), empowered the Minister and the Director for Environment and Climate Change as well as Environmental Officers on environmental management. In relation to the EIA procedure, the Minister determines whether the proposed development is a minor or major project, and receives an assessment report and issues the approval with or without conditions, a request for further information, or a rejection. Meanwhile, the Director, who is the head of the Secretariat of the Environmental Assessment Committee (EAC) and chairs the Committee, inspects or investigates any facility or activity deemed to be causing potential impact on the environment. The Secretariat which is staffed with Environmental Officers receives application documents related to environmental impact assessment of the proposed project and gives advice on implementation of environmental study under the Director's instructions. It is deemed that the power and authority of those key actors are the same as before, although the former MECC was incorporated into the MLECCNR in July 2012.

The EIA Act 2003 has been enforced under the Environmental Impact Assessment Regulations 2010 (EIA Regulations 2010). The EIA Regulations provides the procedures of EIA for major projects classified under the EIA Act 2003. The EIA procedures, as shown in the Attachment 4.1, are divided into four steps; namely, notification, environmental impact assessment, review and final decision with or without conditions.

All development activities must be notified to the Minister who determines whether the proposed development is a major project or not. However, according to the Department of Environment and Climate Change (DECC), this Project can skip the notification because it is obviously the major project, and the proponent can step into the study of EIA, complete the EIA report and submit it to the Secretariat with an application. The Secretariat compiles a report based on the application and the EIA report, and then submits those documents to the EAC for the review. The EAC reviews the submitted documents and prepares/submits a recommendation to the Minister for final decision. According to the TPL, in case of the project of Popua 1MW Solar Firm, it took less than 3 months from the notification to the final decision by the Minister.

4.4 Available Renewal Energy in the Project

The GoT requested to the GoJ to introduce both solar PV system and wind turbine generator system as the renewal energy source of the Project. However, the wind turbine system is hardly adopted in the Project from the viewpoint of environmental constraint.

It is unlikely that the construction, existence and operation of solar PV system have serious impacts on social and natural environment. Meanwhile as for wind turbine generator system, the following environmental items should be appropriately evaluated prior to the construction because problems of those items might be caused by wind turbine due to its mechanism.

- Noise
- Low-frequency noise
- Radio disturbance
- Shadow flicker
- Disturbance of birds' migration routes
- Spoiling of landscape

As to disturbance of birds' migration routes especially, survey of existing conditions on the migration routes generally takes one year at minimum. Accordingly, it takes one and a half year approximately to obtain environmental permit, taking into account the required time for data analysis, assessment of the environmental impacts, information disclosure, stakeholder meetings, review of the EIA and so on. The time required for the EIA procedures does not meet the time schedule of the Project.

4.5 Land System

The prime feature of land system in the Kingdom of Tonga is that "all the land of the Kingdom is the property of the Crown", as declared in the Land Act. The Minister of the MLECCNR is responsible for the land administration of the Kingdom's land as the representative of the Crown. There are two types of landownership; one is the Crown Land and the other, estate so-called "Tofia". The Crown Lands include Royal Estates, Royal Family Estates, lands for public purposes

such as road and cemetery, and so on, while the Tofias, which are entitled to privilege of hereditary transfer, have been given to only so many people such as nobles provided in the Land Act. People (or Commoner) can only lease the Crown Lands or Tofias with conditionality of less than 99 years' lease period because the Land Act places a ban on sale of the Kingdom's land.

4.6 Landownership of the Project Site

The project site for the solar PV system in Vaini is owned by Lord Ma'afu who is the Minister for the MLECCNR. Lord Ma'afu has accepted TPL's request for the lease of the land, and sent the confirmation letter to TPL (Refer to the Annex 3). Soon after the implementation of the Project is assured, TPL will make a contract of the lease with Load Ma'afu.

The documents of the lease contract shall be submitted to the MLECCNR for approval and registration. The submitted lease contract will be deliberated in the Cabinet and, if it is acceptable, the Minister of the MLECCNR will approve the lease contract with the Cabinet's consent. And then, the project site will be surveyed and registered by the MLECCNR. According to the Planning & Urban Management Agency of the MLECCNR, it generally takes one month from submission of the lease contract to the registration.

ANNEX

1. Members of the Team
2. Minutes of Meetings
3. Approval Letter of Land Use for the Project Site in Vaini
4. Outline of installation of 11 kV switchgears of the Project at Popua Power Station

ANNEX 1

Members of the Team

Members of the Team

Name	Assignment	Organization
Hiroshi SUMIYOSHI	Team Leader	Japan International Corporation Agency
Yoshimasa SAKAMOTO	Planning Management	Japan International Corporation Agency
Mitsuhisa NISHIKAWA	Chief Consultant / Distribution System Design	Yachiyo Engineering Co., Ltd.
Kyoji FUJII	Deputy Chief Consultant/ Operation of Diesel Engine Generator	Yachiyo Engineering Co., Ltd.
Hidekazu SATO	Micro-Grid System 1(Grid Control) / Battery Equipment Plan	Yachiyo Engineering Co., Ltd.
*1)Masahiko TAKEMURA	Micro-Grid System 2 (Grid Stability Analysis)	Yachiyo Engineering Co., Ltd.
*2)Shozo KURASHIMA	Renewable Energy 1	Yachiyo Engineering Co., Ltd.
Shinya KONDO	Renewable Energy 2	West Japan Engineering Consultants, Inc.
Kazunari NOGAMI	Procurement Plan/ Cost Estimation 1	Yachiyo Engineering Co., Ltd.
Kenji OHARA	Natural Condition Survey/ Cost Estimation 2	Yachiyo Engineering Co., Ltd.
Shigeki TAKASHIMA	Social and Environmental Considerations	Yachiyo Engineering Co., Ltd.
*2)Masuo WADA	Economic and Financial Analysis	Yachiyo Engineering Co., Ltd.
Masao YAMAKAWA	Coordinator/ Assistance for Micro-Grid Design	Yachiyo Engineering Co., Ltd.

Remarks: *1) He will attend Analysis in Japan.
*2) They will attend Second Field Survey.

ANNEX 2

Minutes of Meetings

THE MINUTES OF MEETINGS

ON

THE MISSION FOR THE PREPARATORY SURVEY

ON

THE PROJECT FOR INTRODUCTION OF A MICRO-GRID SYSTEM WITH RENEWABLE ENERGY FOR THE TONGA ENERGY ROAD MAP

IN

THE KINGDOM OF TONGA

AGREED UPON BETWEEN

THE GOVENMENT OF THE KINGDOM OF TONGA

AND

THE JAPAN INTERNATIONAL COOPERATION AGENCY

Nuku'alofa, 30th August, 2012

Mr. 'Inoke Finau Vala
TERM-IU Director
Tonga Energy Road Map Agency
the Kingdom of Tonga

Mr. Hiroshi SUMIYOSHI
Leader
Preparatory Survey Team
Japan International Cooperation Agency

Witness

Ms. Lesieli Tufui Faletau
Acting Secretary
Ministry of Finance and National Planning

Witness

Mr. John Van Brink
Chief Executive
Tonga Power Limited

The government of The Kingdom of Tonga (hereinafter referred to as "GoT") and the Japan International Cooperation Agency (hereinafter referred to as "JICA") have made several preliminary discussions in order to identify priority projects in the field of power sector, and agreed to make preparation for the Project for Introduction of a Micro-Grid System with Renewable Energy (hereinafter referred to as "the Project"). Accordingly, JICA dispatched a mission on the Project (hereinafter referred to as "the JICA Mission") to The Kingdom of Tonga from 14th August, 2012 to 1st September, 2012 in order to develop scope and implementing arrangements of a further survey which will study outline design of the Project (hereinafter referred to as "the Preparatory Survey"). The scope and implementing arrangements of the Preparatory Survey are described in the Appendix 1. The main points discussed during its visit are described in the Appendix 2.

It should be noted that implementation of the Preparatory Survey does not imply any decision or commitment by JICA to extend its grant for the project at this stage.

Appendix 1: Scope and Implementing Arrangements of the Preparatory Survey
Appendix 2: Main Points Discussed
Appendix 3: List of Attendants

SCOPE AND IMPLEMENTING ARRANGEMENTS OF THE PREPARATORY SURVEY

I. BACKGROUND AND OBJECTIVES OF THE PREPARATORY SURVERY

In April of 2012, GoT made a request for Grant Aid for the Project to the Government of Japan (GoJ). GoJ decided to conduct the Preparatory Survey and entrusted JICA to examine the viability of the Project and sent the Survey team, headed by Mr. Hiroshi SUMIYOSHI, Director, Energy and Mining Division, Natural Resources and Energy Group, Industrial Development and Public Policy Department, JICA.

II. OBJECTIVES OF THE PROJECT

The project aims to develop and introduce a Micro-Grid System with large scale of renewable energy in order to reduce consumption of fossil fuel for generating electricity, and to stabilize electricity.

The project will be conducted under the Japanese Grant Aid Program aiming at promoting "Green Growth", which the GoJ puts stress on, by introducing Japanese Technology.

The project will also contribute to achievement of Tonga Energy Road Map (TERM)-objective.

III. ITEMS REQUESTED BY GoT

1. Project Site
Vaini, and Popua Power Station, Popua, in Tongatapu Island
(shown in Annex 1 and 2)

2. Responsible Organization
Tonga Energy Road Map Agency (TERM-A)

3. Executing Agency
Tonga Power Limited (The organization chart is shown in Annex 3.) as owner of the affected and new assets.
*TERM Implementation Unit (TERM-IU) will have oversight of the Project.

4. Materials and services
GoT finally requested to GoJ the following components to achieve TERM.

Outline of the final Request

Item	Components
Micro grid controller	• Generation and network control system integrated into TPL's SCADA at Popua power station • IP broadband and/or mesh type communications network that overlies TPL's Tongatapu network, connecting remote generation to the Popua SCADA system and micro grid controllers. • Integration of battery or capacitive storage and load flow "smoothing" algorithms to monitor and control field assets and enable future demand side management
Storage System (Batteries)	• Batteries and controller located at either Popua or at Vaini PV Site, controlling energy flows and quality, and optimizing efficiency of the diesel generators • Conversion of the TPL 2.88 MW MAK diesel generator governor to load following capability (requires manufacturer's involvement to modify governors, TPL has discussed requirements and scope with the manufacturer)
Solar PV system (1MWp)	• A single solar PV array at Vaini, in central Tongatapu, injecting into the TPL 11kV network, including spares • Network voltage management (regulator or other dynamic support)
Operation & Maintenance of the equipment	• Training TERM-IU staff and TPL staff • Operating and maintenance manuals and process documentation • O & M support

IV. SURVEY AREA

Tongatapu Island, the Kingdom of Tonga

V. SCOPE OF THE PREPARATORY SURVEY

1. Terms of Reference

The Team will formulate the Project so as to contribute to achievement of TERM.

The Team will examine carefully potential of wind power and photovoltaic generation in Tongatapu, and control method of the micro-grid system and capacity of power storage system introduced under the Project.

Based on the results of the Survey and discussion with the Tongan side, the Team will design the micro-grid system to reduce consumption of fossil fuel in power generation effectively.

The Preparatory Survey shall cover the following items:

(1) Implementation framework
(2) Requested components of the Project and their Priority
(3) Securement of lands for the Project
(4) Environmental and social considerations
(5) Positive impact of the Project and objectively verifiable indicators of the Project
(6) Technical Conditions for the Project
(7) General Information of Electric Power Sector
(8) Major Undertaking, including Tax and levy system
(9) Local conditions and capability for procurement, construction, installation and transportation
(10) Activities of other donors
(11) Soft Component
(12) Maintenance Contract

2. Desirable specialists for the Preparatory Survey

JICA will select and dispatch a survey team to carry out the Preparatory Survey. The team will include the specialists of the following field;.

(1) Distribution System Design
(2) Operation of Diesel Engine Generator
(3) Micro-Grid System (Grid Control, and Grid Stability Analysis)
(4) Renewable Energy
(5) Battery Equipment Plan
(6) Natural Condition Survey
(7) Social and Environmental Considerations
(8) Procurement Plan and Cost Estimation
(9) Economic and Financial Analysis

VI. SCHEDULE OF THE PREPARATORY SURVEY

The Preparatory Survey will be carried out in accordance with the tentative schedule attached in the Annex 4. The schedule may be subject to change during the preparation and the course of the survey.

VII. REPORTS

JICA will prepare and submit following reports in English to GoT.

1. Inception Report:

3 copies will be submitted at the commencement of the first work period in the Kingdom of Tonga.

2. Draft Final Report:

3 hard copies and soft copy (1copy is for TERM, another copy is for TPL and the other copy is for GoT) will be submitted 4 months after the commencement of the Preparatory Survey.

This report will cover:

(1) Outline of the Project,
(2) Basic Design of the Project,
(3) Outline of the undertakings of Tongan side,
(4) Operation and maintenance plan for the Project, and
(5) Cost estimation.

GoT shall submit its comments within one month after the receipt of the Draft Final Report.

3. Final Report:

3 hard copies and soft copy (1copy is for TERM, another copy is for TPL and the other copy is for GoT) will be submitted within one month after the receipt of the comments on the Draft Final Report.

VIII. JAPAN'S GRANT AID SCHEME

GoT understands the Japan's Grant Aid Scheme explained by the JICA Mission as described in Annex 5,6 and 7.

IX. UNDERTAKINGS OF THE GOVERNMENT OF THE KINGDOM OF TONGA

GoT shall act as a counterpart agency to the survey team and also as a coordinating body with other organizations concerned for the smooth implementation of the Preparatory Survey.

GoT shall, at its own expense, provide the survey team with the following items in cooperation with other organizations concerned:

(1) security-related information as well as measures to ensure the safety of the survey team;
(2) information as well as support in obtaining medical service;
(3) data and information related to the Preparatory Survey;
(4) counterpart personnel;
(5) suitable office space with necessary equipment and secretarial service;
(6) credentials or identification cards;
(7) entry permits necessary for the survey team members to conduct field surveys;
(8) support in making transportation arrangements;
(9) support in obtaining other privileges and benefits if necessary;
(10)assist the team in custom clearance, exempt from any duties with respect to equipment, instruments, tools and other articles to be brought into and out of Tonga in connection with the implementation of the survey; and
(11) GoT shall bear claims, if any arises, against the members of the survey team resulting from, occurring in the course of, or otherwise connected with the discharge of their duties in implementation of the Preparatory Survey, except when such claim arise from gross negligence or willful misconduct on the part of the member of the survey team.

X. CONSULTATION

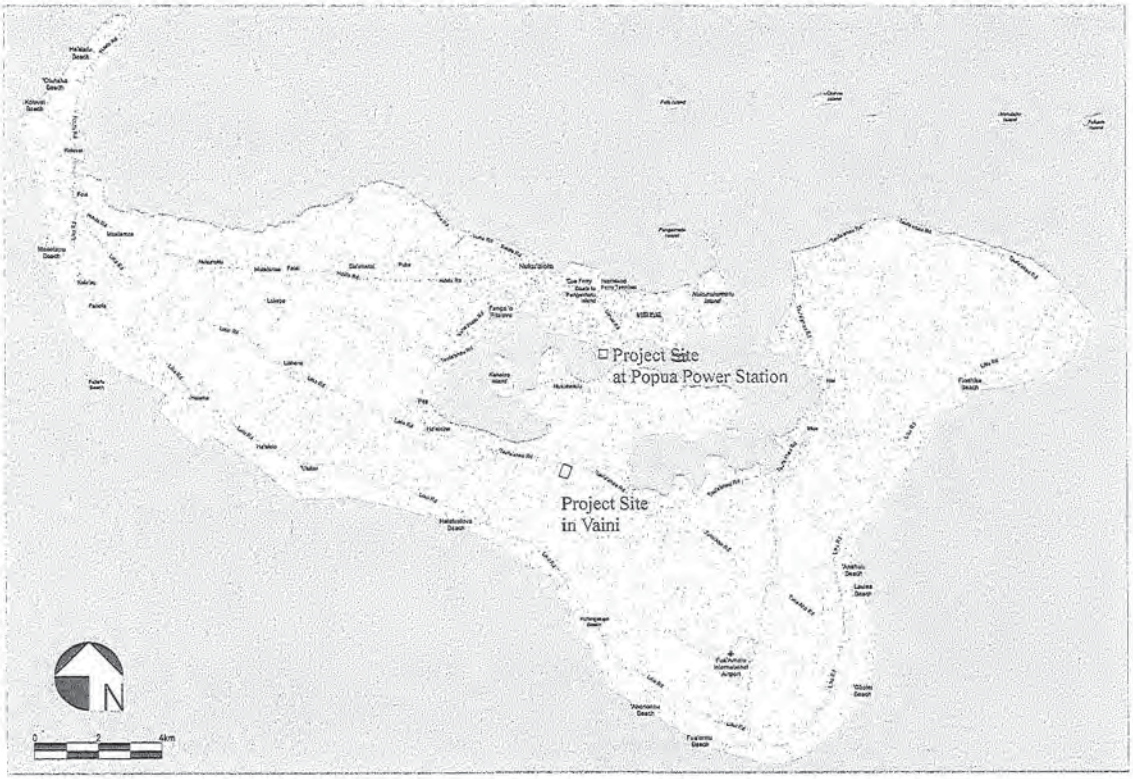
JICA and the GoT shall consult with each other in respect of any matter that may arise from or in connection with the Preparatory Survey.

END

Annex 1: Project Site
Annex 2: Vaini PV Site
Annex 3: Organization Chart of TPL
Annex 4: Schedule of the Preparatory Survey
Annex 5 Japan's Grant AID Scheme
Annex 6: Flow Chart of Japan's Grant AID Procedures
Annex 7: Major undertakings to be taken by each Government

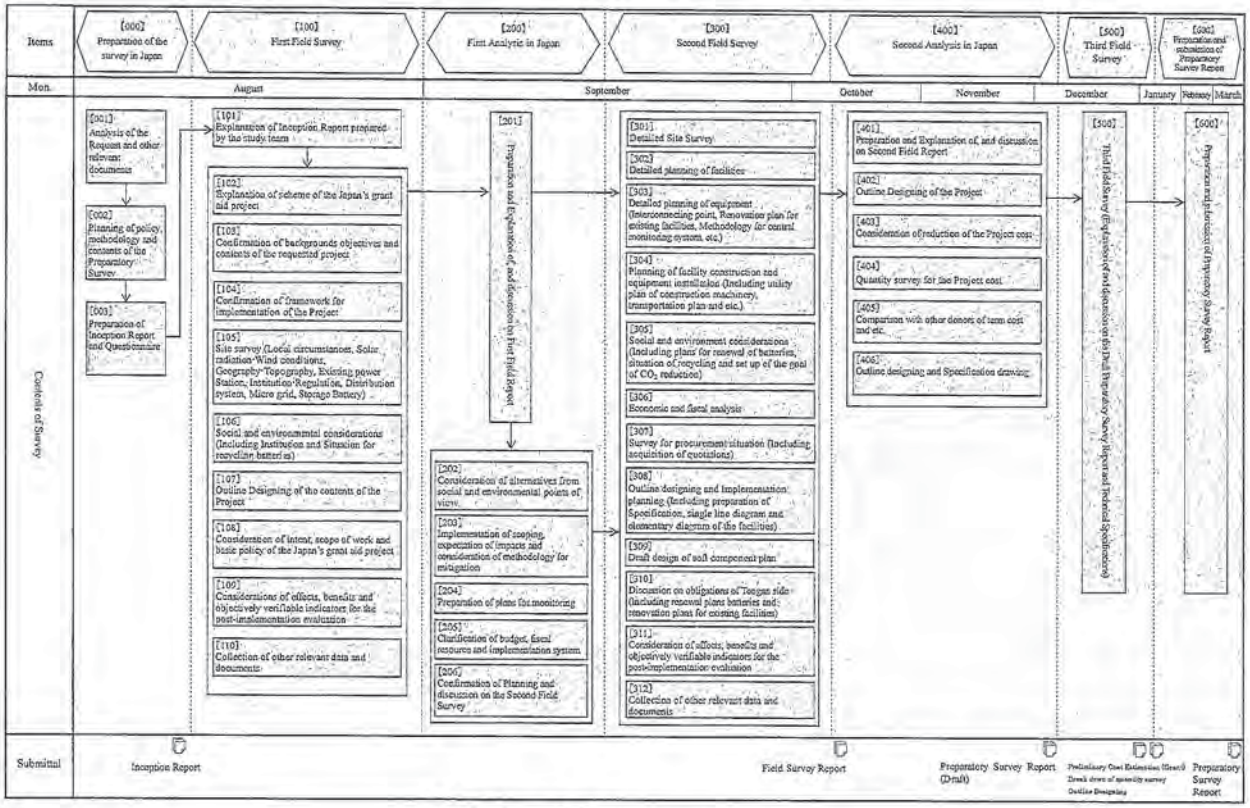
Annex 2

CANDIDATE PHOTOVOLTAIC SITE



Project Site

Annex 1



Schedule of the Preparatory Survey

Annex 4

Senior Management – Chart 1

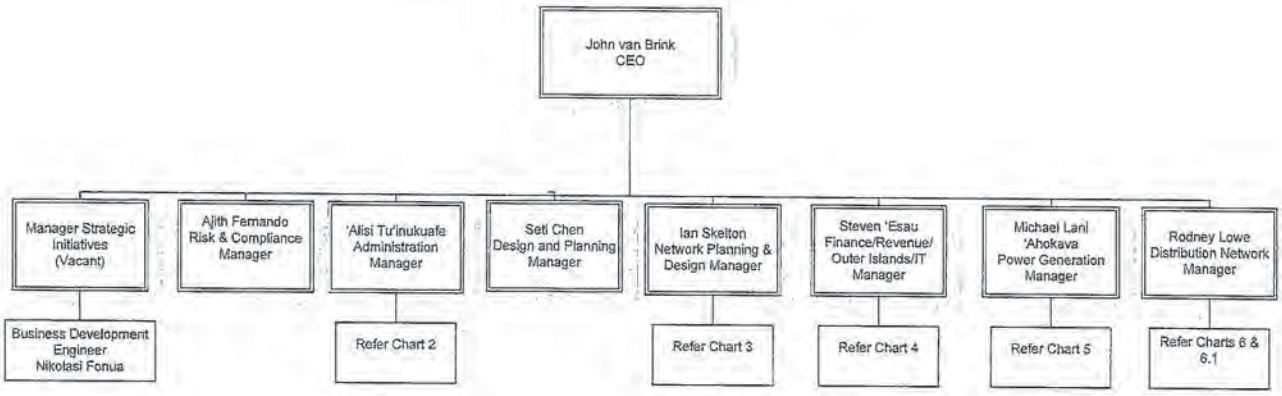


	Chart 1	Chart 2	Chart 3	Chart 4	Chart 5	Chart 6	Chart 6.1	Total
Established	9	6	13	40	20	48	11	147
Occupied	9	6	13	40	20	48	11	147
Vacancy	1	0	0	1	0	0	0	2
Trainees	0	0	2	0	1	0	4	7
Casuals	0	0	1	0	0	8	0	9

Annex 3

JAPAN'S GRANT AID

The Government of Japan (hereinafter referred to as "the GOJ") is implementing the organizational reforms to improve the quality of ODA operations, and as a part of this realignment, a new JICA law was entered into effect on October 1, 2008. Based on this law and the decision of the GOJ, JICA has become the executing agency of the Grant Aid for General Projects, for Fisheries and for Cultural Cooperation, etc.

The Grant Aid is non-reimbursable fund provided to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures

The Japanese Grant Aid is supplied through following procedures:

- Preparatory Survey
  - The Survey conducted by JICA
- Appraisal &Approval
  - Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet
- Authority for Determining Implementation
  - The Notes exchanged between the GOJ and a recipient country
- Grant Agreement (hereinafter referred to as "the G/A")
  - Agreement concluded between JICA and a recipient country
- Implementation
  - Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the preparatory Survey is to provide a basic document necessary for the appraisal of the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the recipient country necessary for the implementation of the Project.

- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of an outline design of the Project.
- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Outline Design of the Project is confirmed based on the guidelines of the Japan's Grant Aid scheme.

JICA requests the Government of the recipient country to take whatever measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA employs (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

JICA reviews the Report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the appropriateness of the Project.

3. Japan's Grant Aid Scheme

(1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes(hereinafter referred to as "the E/N") will be singed between the GOJ and the Government of the recipient country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the recipient country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country

Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When JICA and the Government of the recipient country or its designated authority deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals".

(4) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by JICA. This "Verification" is deemed necessary to fulfill accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as Annex.

(6) "Proper Use"

The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant Aid, to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant Aid.

(7) "Export and Re-export"

The products purchased under the Grant Aid should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). JICA will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

The Government of the recipient country should bear an advising commission of an Authorization to Pay

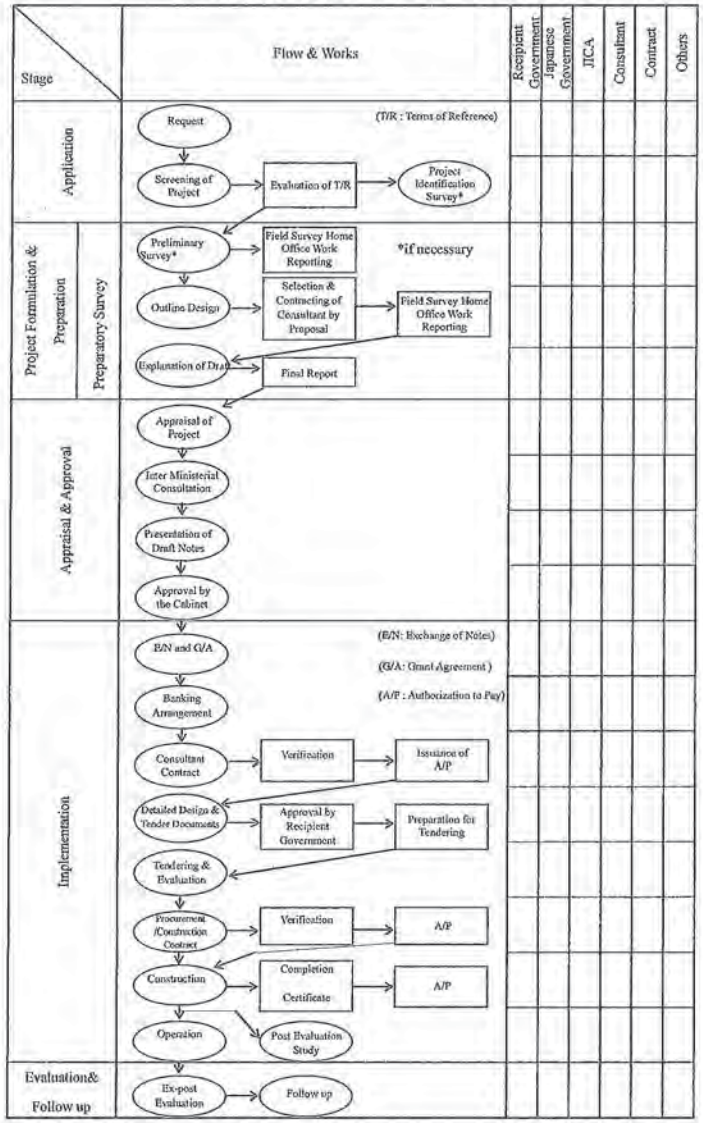
and payment commissions paid to the Bank.

(10) Social and Environmental Considerations

A recipient country must carefully consider social and environmental impacts by the Project and must comply with the environmental regulations of the recipient country and JICA socio-environmental guidelines.

(End)

Flow Chart of Japan's Grant Aid Procedures



Major undertakings to be taken by each Government

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	to secure [a lot] /[lots] of land necessary for the implementation of the Project and to clear the [site]/[sites];		●
2	To construct the following facilities		
	1) The building	●	
	2) The gates and fences in and around the site		●
	3) The parking lot	●	
	4) The road within the site	●	
	5) The road outside the site		●
3	To provide facilities for distribution of electricity, water supply and drainage and other incidental facilities necessary for the implementation of the Project outside the [site]/[sites]		
	1)Electricity		
	a. The distributing power line to the site		●
	b. The drop wiring and internal wiring within the site	●	
	c. The main circuit breaker and transformer	●	
	2) Water Supply		
	a. The city water distribution main to the site		●
	b. The supply system within the site (receiving and elevated tanks)	●	
	3) Drainage		
	a. The city drainage main (for storm sewer and others to the site)		●
	b. The drainage system (for toilet sewer, common waste, storm drainage and others) within the site	●	
	4) Gas Supply		
	a. The city gas main to the site		●
	b. The gas supply system within the site	●	
	5) Telephone System		
	a. The telephone trunk line to the main distribution frame/panel (MDF) of the building		●
	b. The MDF and the extension after the frame/panel	●	
	6) Furniture and Equipment		
	a. General furniture		●
	b. Project equipment	●	
4	To ensure prompt unloading and customs clearance of the products at ports of disembarkation in the recipient country and to assist internal transportation of the products		
	1) Marine (Air) transportation of the Products from Japan to the recipient country	●	
	2) Tax exemption and custom clearance of the Products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	●	
5	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the products and the services [be exempted] / [be borne by the Authority without using the Grant]		●
6	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
7	To ensure that [the Facilities and the products]/[the Facilities]/ [the products] be maintained and used properly and effectively for the implementation of the Project		●
8	To bear the following commissions paid to the Japanese bank for banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
9	To give due environmental and social consideration in the implementation of the Project.		●
10	To bear all the above expenses, other than those covered by the Grant, necessary for the implementation of the Project		●

*1 B/A : Banking Arrangement, A/P : Authorization to pay) *2 If the environmental screening category is C, No. 10 is unnecessary

Appendix 2

THE MAIN POINTS DISCUSSED

(1) Wind Turbine Generation System

GoT originally requested the introduction of Wind Turbine Generation system (500kW) and Solar PV system (500kWp). According to the request, the Team surveyed the candidate sites of the Wind turbine generation system, selected by TPL and Ministry of Land, Environment ,Climate Change and Natural Resources (MLECCNR), and had series of discussions with their representatives about wind synopsis data, land owner ship, access roads, distribution lines to be connected, environmental constraint, etc. Survey of existing conditions on the environmental constraint takes one (1) year at minimum. Accordingly, it takes one and half (1.5) year approximately to obtain permission from Japanese authorities, taking into account the required time for data analysis, assessment of the environmental impact, information disclosure, stakeholder meetings, review of EIA and so on. The time required for the EIA procedure does not meet the project schedule.

As the results of discussions, both sides agreed that the Wind turbine generation system would not be adopted in the project component. However, the team agreed on the analysis of the potential of Wind Turbine Generation system at the candidate site from the data acquired through the survey.

(2) Solar PV system

Since the Wind turbine generation system is excluded from the project component, both sides agreed that the capacity of the Solar PV system at Vaini shall be approximately 1.0 MWp to aid the achievement of the TERM's target and to ensure the introduction of renewable energy as much as possible.

(3) The Tongan side agreed to obtain approval from Mamma Mai, existing solar PV system (1.3MWp) to connect signal cables to the photovoltaic system and send its generating conditions to a micro-grid controller of the Project at Popua Power Station controlling energy flows and quality, and optimizing efficiency of the diesel engine generators.

(4) It would be necessary to integrate load sharing system between Caterpillar and Mak generators in Popua Power Station to effectively compensate load fluctuation from solar PV system. The Preparatory Survey team requested the Tongan side to provide necessary information by Sep. 10th 2012 to analyze the behavior of integrated load sharing system and to study necessary equipment and specifications for the system. The Tongan side agreed to do so.

(5) In addition to the Annex 7, both sides agreed that the following matters are included in the Undertakings of the GoT side

1) Renewal of Battery system
2) Treatment of Used batteries
3) Concluding the maintenance contract for Micro-Grid system
4) Ensuring the installation site(s) for Solar PV generation system including Micro-grid controller(s), Batteries, Power conditioners, etc.
5) Implementation of EIA and acquisition of the Environmental permission

(6) Project Title

The Project Title in Application Form submitted by the GoT was "The TERM Development and Implementation of a Micro-Grid System to the TPL Grid of Tongatapu".

JICA and the GoT agreed to change the Project Title to "The Project for Introduction of a Micro-Grid System with Renewable Energy for the Tonga Energy Road Map".

Appendix 3

List of Attendants

Tonga Energy Road Map

Mr. 'Inoke Finau Vala	TERM-IU Director
Mr. 'Akau' Ola	Term-C Advisor
Mr. Ofa Sefana	Acting Energy Planning Specialist
Mr. Slua Aatu	Environmental Information Officer
Mr. Moleni Tuuholoaki	Acting Director of Meteorology
Ms. Katherine Bakes	Operations Officer (World Bank)

Tonga Power Limited

Mr. John Van Brink	Chief Executive
Mr. Lano Fonua	Strategic Initiatives Manager
Mr.Michael Lani 'Ahokava	Power Generation Manager
Mr. Murray Sheerin	Power Station Superintendent
Mr. Ian Skelton	Planning and Design Manager
Mr. Nikolasi Fonua	Business Development Engineer

Ministry of Land, Environment, Climate Change and Natural Resources

Department of Environment and Climate Change

Ms. Mafile'o Masi	Acting Deputy Director
Ms. Kate Mcpherson	Environment Legislation Policy Officer
Ms. Lesieli Tuivai	Ecologist, Environmentalist

Planning & Urban Management Agency

Mr. 'Atunaisa. M. Fetokai	Deputy Physical Planner
Mr. Tevita L. Fotu	Urban Planner

LGIS Unit

Mr. Richard Atelea Kautoke	Sen. GIS Specialist

Ministry of Infrastructure

Laboratory, Civil Engineering Department

Mr. Ken Robinson	Material Engineer

Japan International Cooperation Agency

Mr. Hiroshi SUMIYOSHI	Team Leader
Mr. Yoshimasa SAKAMOTO	Planning Management

Consultants

Mr. Mitsuhisa NISHIKAWA	Yachiyo Engineering Co., Ltd.
Mr. Kyoji FUJII	Yachiyo Engineering Co., Ltd.
Mr. Hidekazu SATO	Yachiyo Engineering Co., Ltd.
Mr. Shinya KONDO	West Japan Engineering Consultants, Inc.
Mr. Kazunari NOGAMI	Yachiyo Engineering Co., Ltd.
Mr. Kenji OHARA	Yachiyo Engineering Co., Ltd.
Mr. Shigeki TAKASHIMA	Yachiyo Engineering Co., Ltd.
Mr. Masao YAMAKAWA	Yachiyo Engineering Co., Ltd.

ANNEX 3

Approval Letter of Land Use for the Project Site in Vaini

JOHN VAN BRINK
Chief Executive Officer
Tonga Power Limited
Nuku'alofa

22nd August 2012

Dear John,

Request for Land at Vaini Village by Tonga Power Limited for Solar Energy Project

1. Further to your meeting yesterday with Lord Ma'afu regarding the above matter, I write to confirm the availability of land to be leased to Tonga Power Limited at Vaini.

2. The available land is comprised of 6 acres and described as Lot 54 of Block 77/93 at Vaini. A copy of the map is attached with a rough sketch of the area highlighted in green.

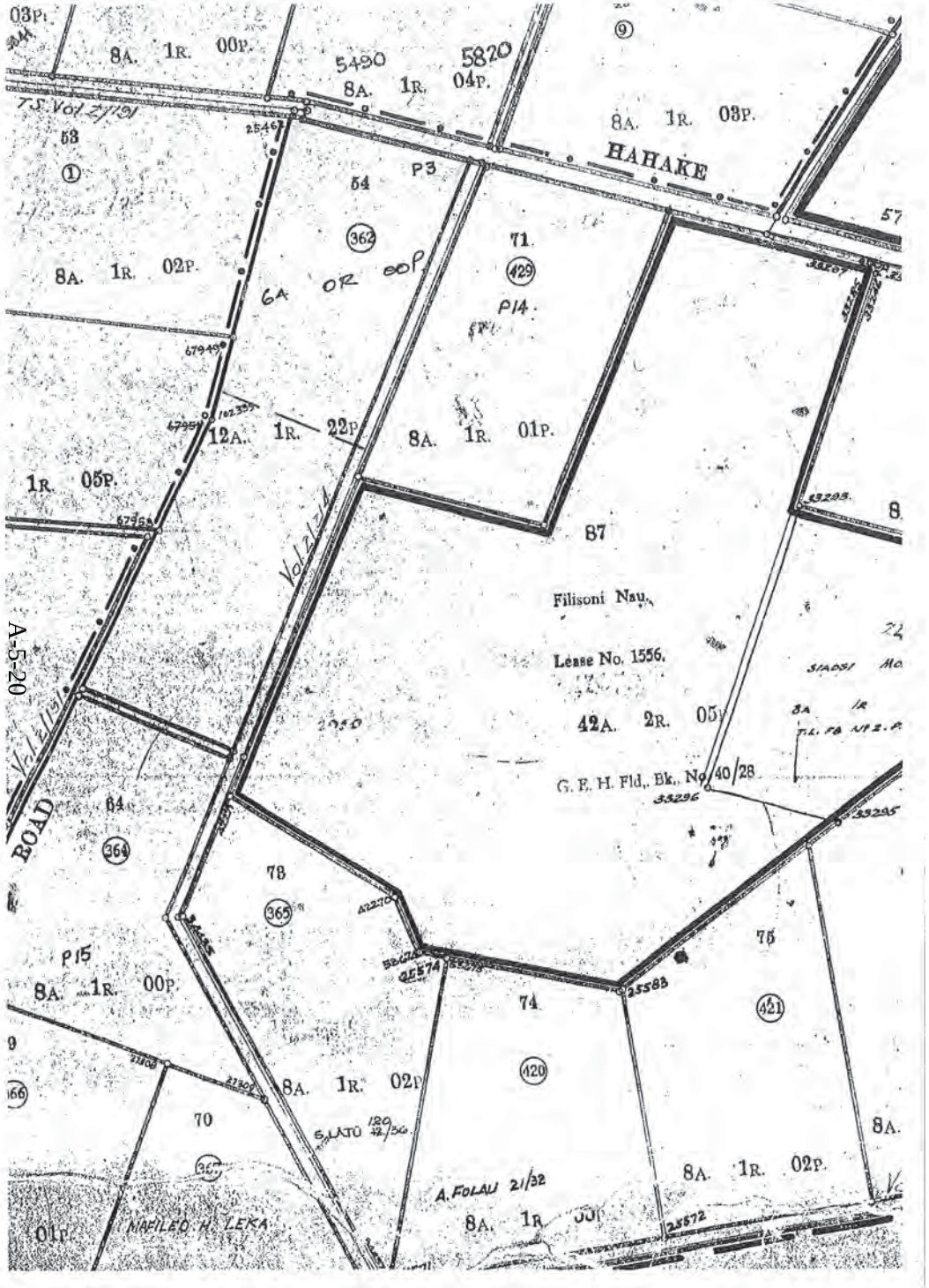
3. Should you require any further information on the matter, please do not hesitate to contact me.

Yours sincerely,

Rosamond C. Bing

rosamond.bing@gmail.com

Legal Advisor for Lord Ma'afu

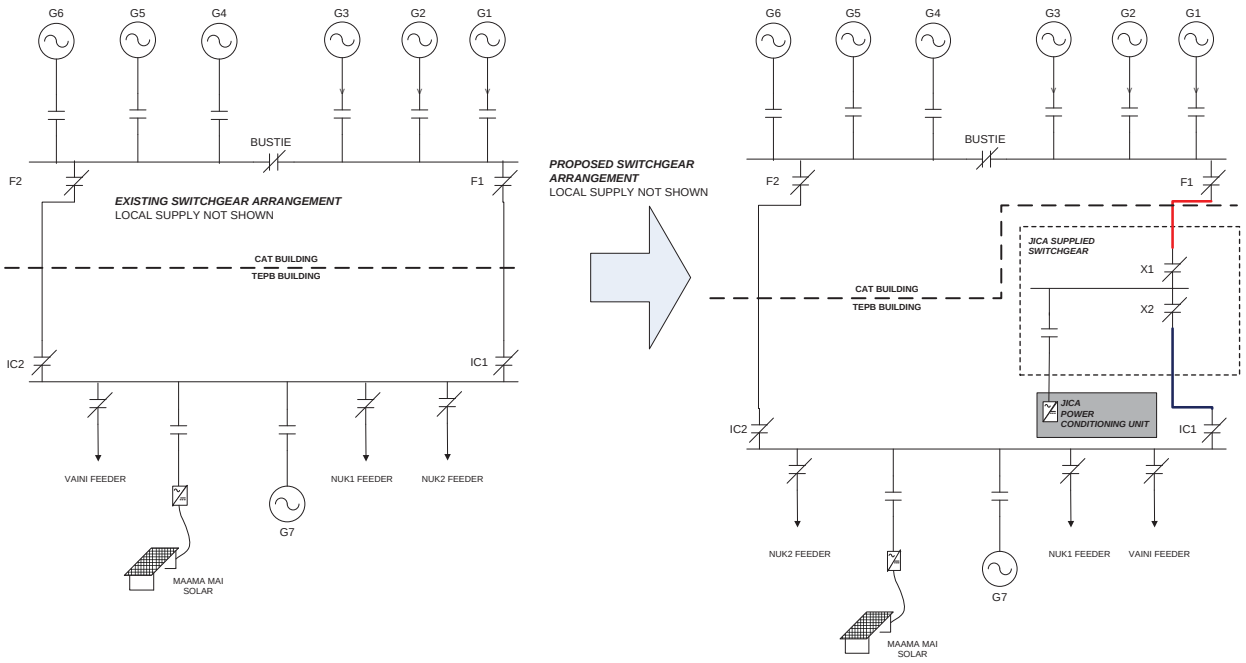


ANNEX 4

Outline of installation of 11 kV switchgears of the Project at Popua Power Station

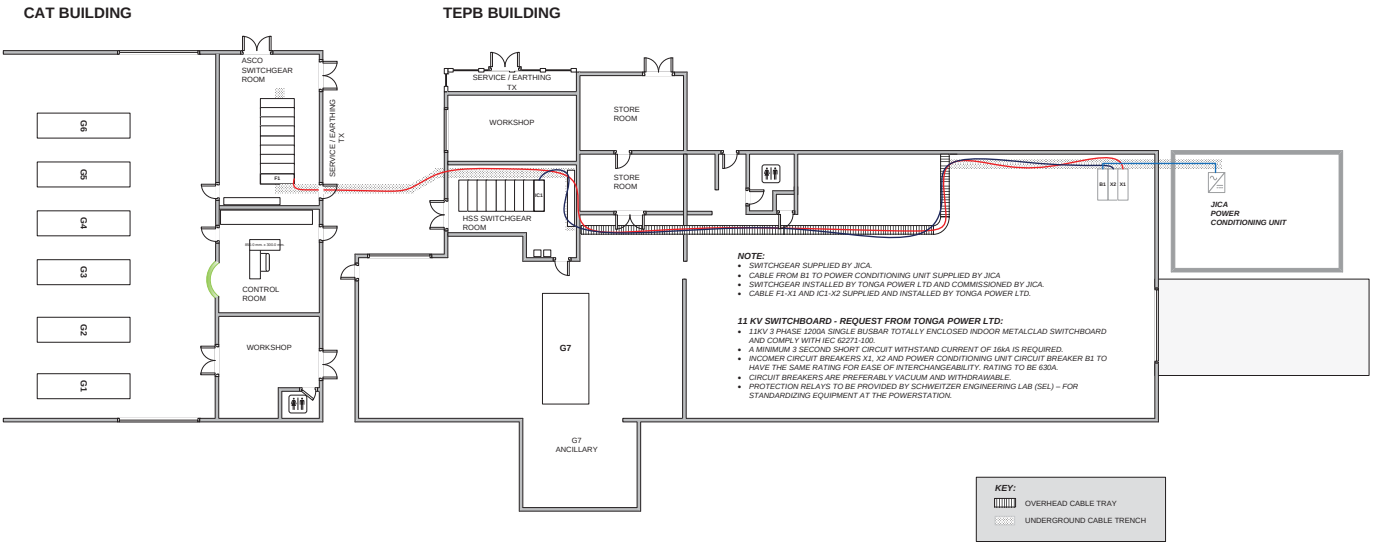
TONGA POWER LTD : POPUA POWERSTATION

SWITCHGEAR ARRANGEMENT PROPOSAL FOR JICA SOLAR PV PROJECT



TONGA POWER LTD : POPUA POWERSTATION

SWITCHGEAR ARRANGEMENT PROPOSAL FOR JICA SOLAR PV PROJECT



Drawings

E-01 Single Line Diagram

E-02 Control System Diagram

E-03 Connection of Communication Cable to the Existing Photovoltaic System

A-01 Floor and Section Plan of Buildings

A-02 PCS and Batteries Building in Vaini

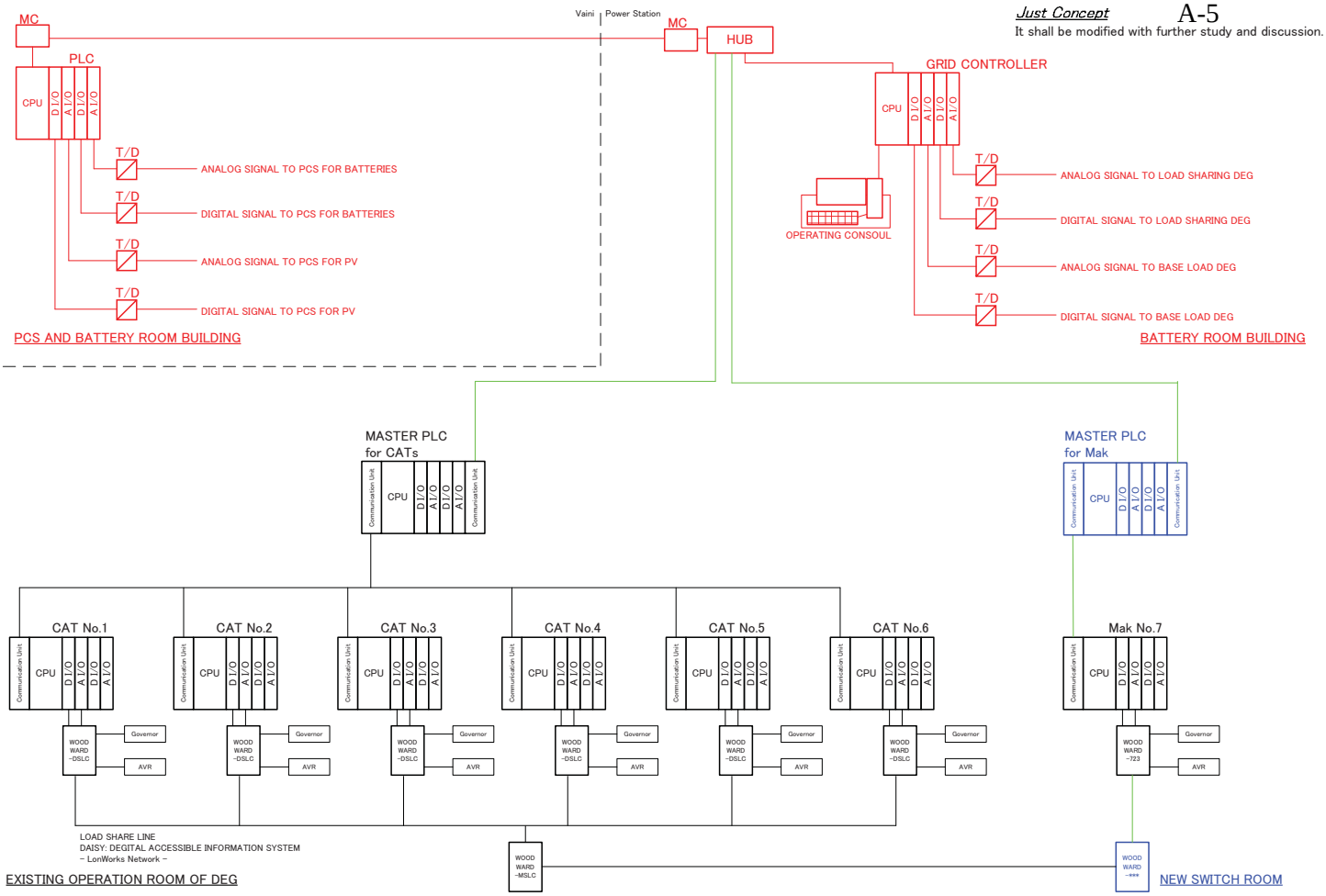
A-03 PCS and Batteries Building at Popua Power Station

PG 3 of 3

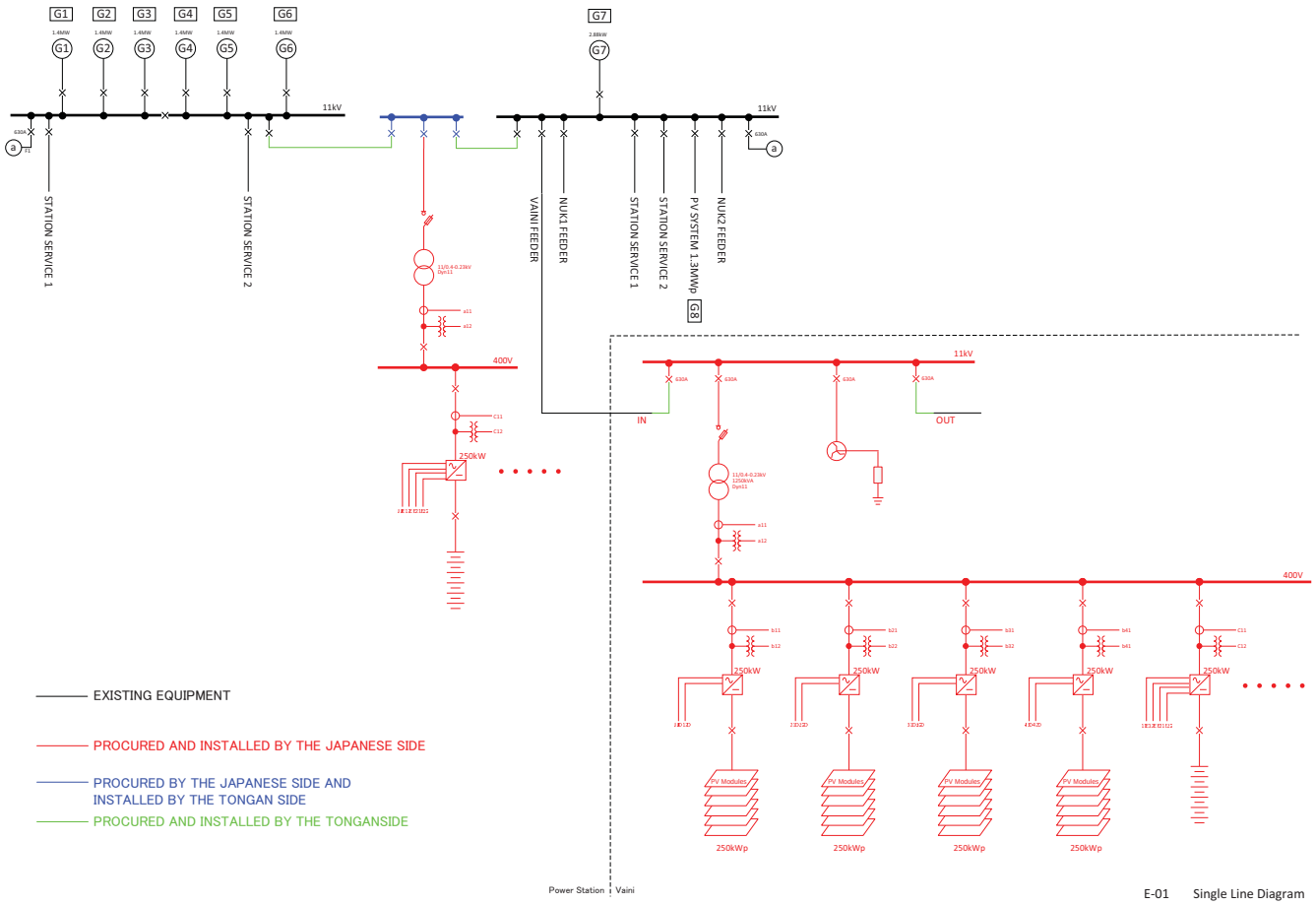
TONGA POWER LTD : POPUA POWERSTATION

SWITCHGEAR ARRANGEMENT PROPOSAL FOR JICA SOLAR PV PROJECT

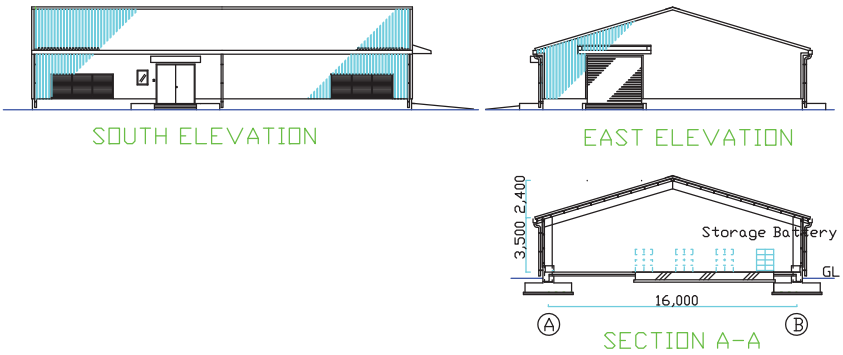
FUTURE FOR TONGA POWER LTD
TO ENSURE SECURITY OF POWER SUPPLY
LOCAL SUPPLY NOT SHOWN



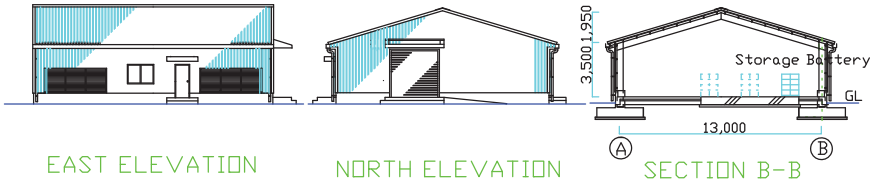
E-02 Control System Diagram



E-01 Single Line Diagram

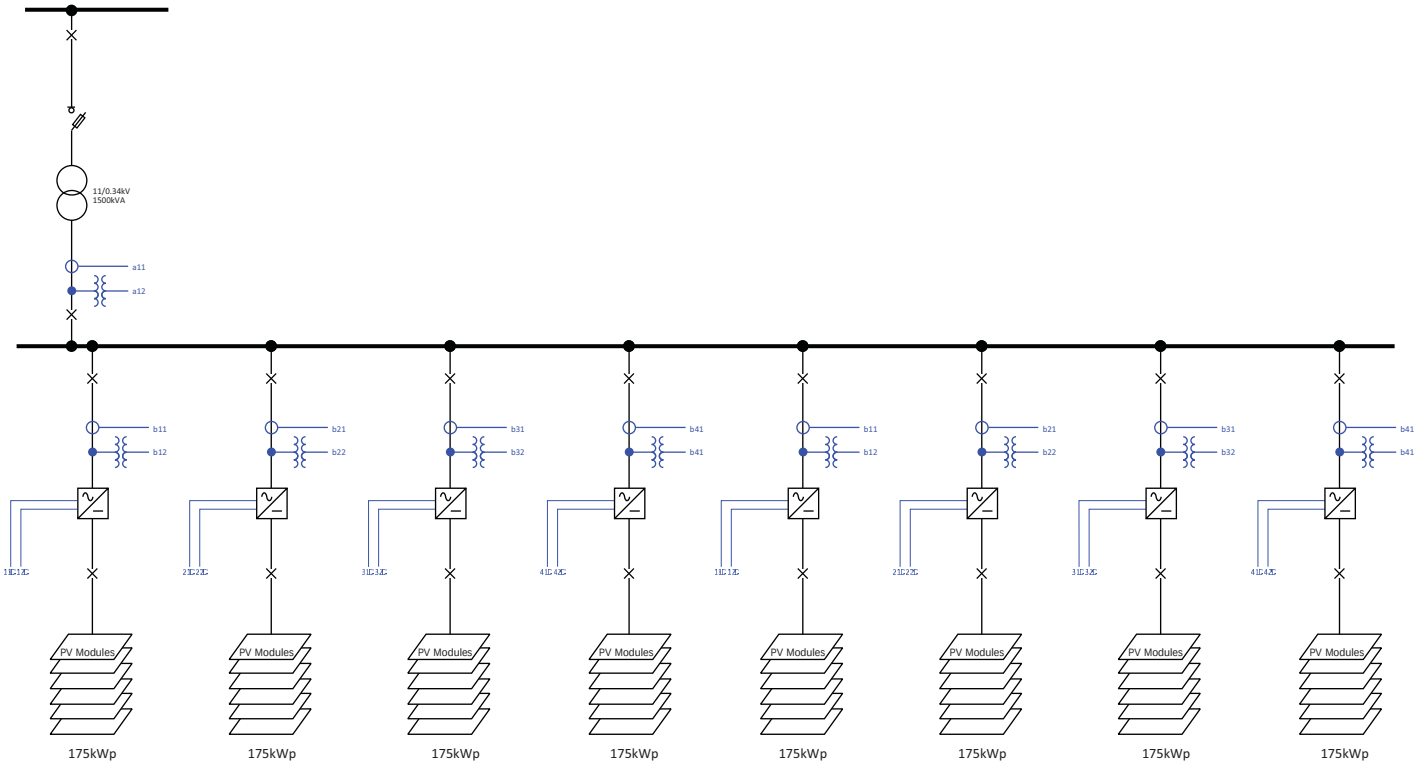


PCS & BATTERIES BUILDING at Project Site in VAINI

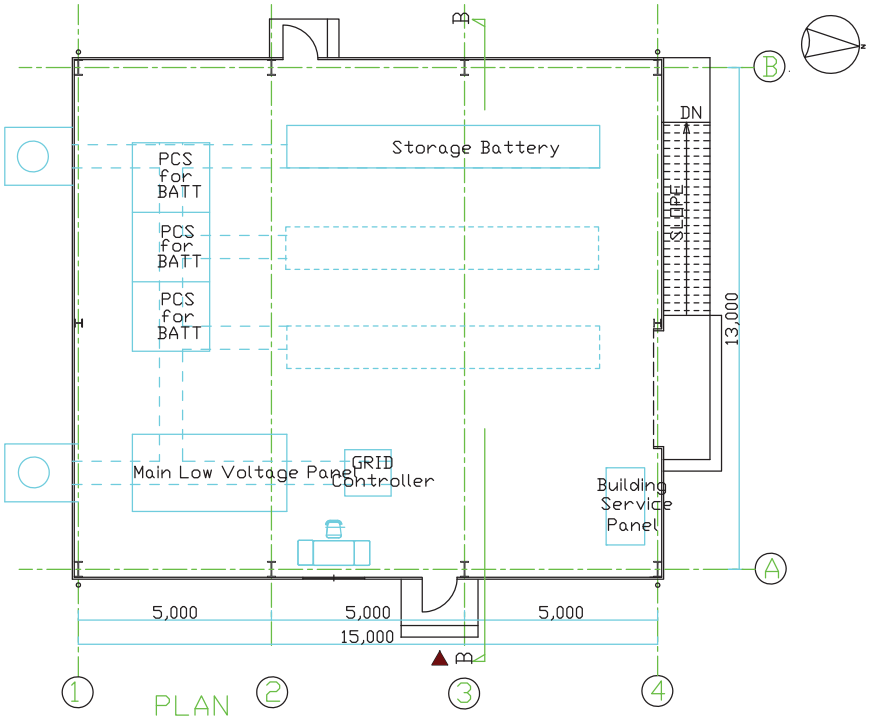


PCS & BATTERIES BUILDING at POPUA Power Station

A-01 FLOOR AND SECTION PLAN OF BUILDINGS

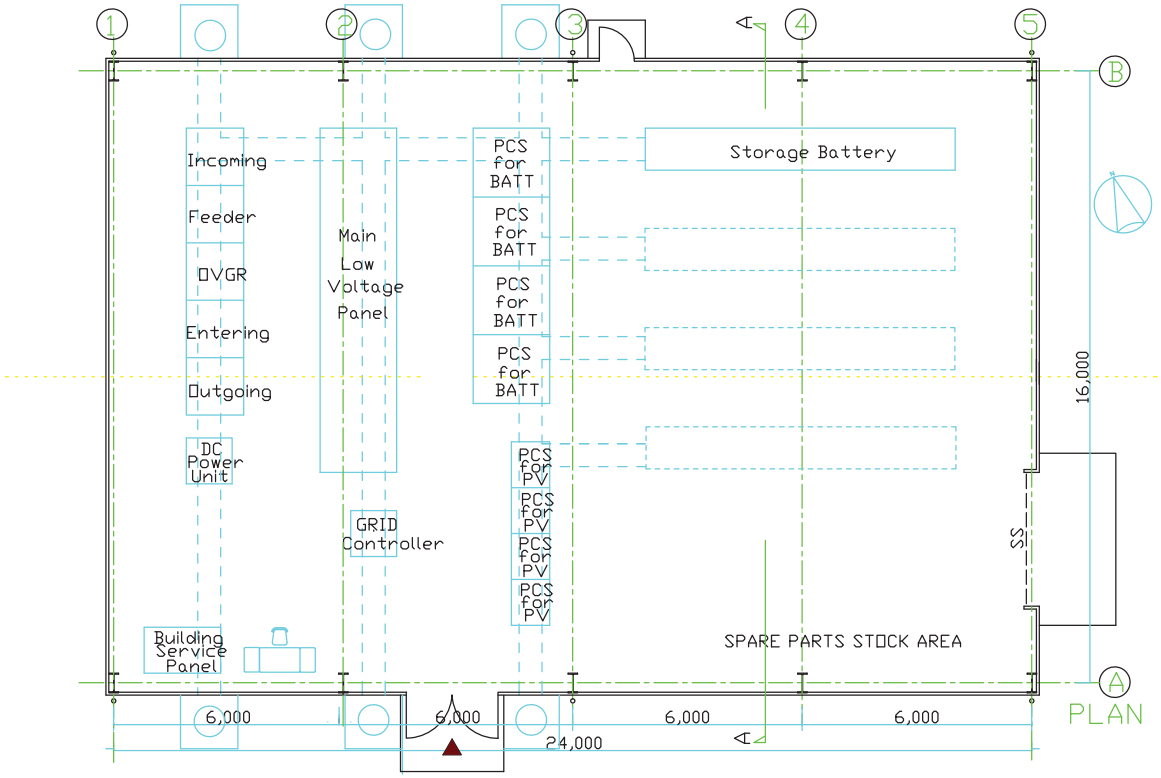


E-03 Connection of Signal Cable to the existing Photovoltaic System



PCS & BATTERIES BUIDING at POPUA Power Station

A-03 PCS & BATTERIES BUILDING AT POPUA POWER STATION



PCS & BATTERIES BUILDING at Project Site in VAINI

A-02 PCS & BATTERIES BUILDING IN VAINI

PREPARATORY SURVEY
ON
THE PROJECT FOR
DEVELOPMENT AND INTRODUCTION OF MICRO-GRID SYSTEM
FOR THE TONGA ENERGY ROAD MAP
IN THE KINGDOM OF TONGA

THE SECOND FIELD SURVEY

FIELD REPORT

October 5th, 2012

Mr. John Van Brink
Chief Executive
Tonga Power Limited

Mr. Mitsuhisa Nishikawa
Chief Consultant,
JICA Study Team

Witnesses:

Mr. 'Inoke Finau Vala
TERM-IU Director,
Tonga Energy Road Map Agency

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1. **Introduction** ·····
2. **Project Site Location** ·····
3. **Final Requested Components for the Project** ·····
4. **Environmental and Social Consideration** ·····
5. **Work Demarcations of the Tongan and Japanese Side** ·····
6. **Project Implementation Schedule** ·····
7. **Other Relevant Issues** ·····

ANNEX

1. Members of the Team
2. Schedule of the Second Field Survey
3. Presentation Documents (Findings of the Second Field Survey)
4. Environmental Check list
5. Activities and Technology Transfer Method of Soft Component

Drawings

D-01 Single Line Diagram
D-02 Control System Diagram
D-03 Arrangement of panels at Vaini Site
D-04 Floor Plan of Building at Vaini Site
D-05 Section Plan of Building at Vaini Site
D-06 Floor Plan of Building at Popua Power Station
D-07 Section Plan of Building at Popua Power Station

1. Introduction

Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched a survey team to the Kingdom of Tonga to appraise the Project for Introduction of A Micro-Grid System with Renewable Energy for the Tonga Energy Road Map in the Kingdom of Tonga (hereinafter referred to as "the Project") which was requested by the government of Tonga as Japan's Grant Aid. The Project is aimed at introducing a micro-grid system with renewable energy to control energy flows and quality, and optimize efficiency of the diesel engine generators.

Tonga Power Limited (hereinafter referred to as "TPL") and JICA Preparatory Survey Team for the Project (hereinafter referred to as "the Team") had series of technical discussion to form a mutual understanding of the contents and the scope and preconditions for outline design of the Project at the stage of 1st preparatory survey and both parties agreed to record the following points as a conclusion of the discussions.

This field report contains the findings and results of the second field survey. Components of the Project will be further examined and may be modified through the consultation with the Ministry of Foreign Affairs and JICA headquarters. It is important for both sides to understand that the Preparatory Survey is not a commitment for the future implementation of the Project.

2. Project Site Location

The Project sites are located in Tongatapu Island, the Kingdom of Tonga.

Source: JICA Study Team

Figure 1 Project Site Location

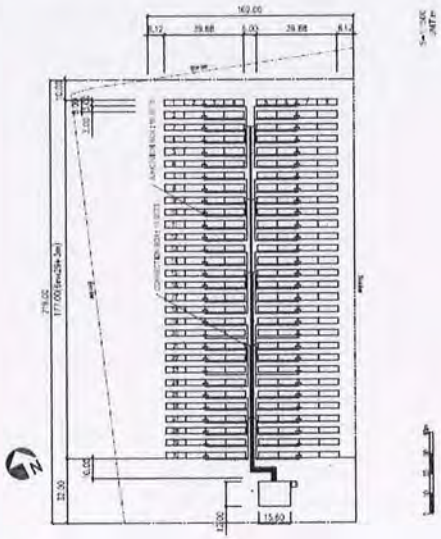
The Project is composed of procurement and installation of approximately 1 MWp of photovoltaic system, power storage system and a micro grid controller to control energy flows and quality,

and optimize efficiency of the diesel engine generators.

The Project site for the Photovoltaic (PV) system, and building for power conditioner system (PCS) and power storage system are shown in Figure 2 (areas: approximately 24,000 m^2). In the first field survey, the availability of the land is confirmed by TPL and the approval letter to use the land for the Project was issued by the Minister of Land, Environment, Climate Change and Natural Resources, who is responsible for administration of the area. The lease agreement for the Project site has been concluded between the land owner and TPL.

In addition, building for power conditioner system (PCS) and power storage system for the existing PV system of Mamma Mai, whose capacity is of 1.3 MWp, will be constructed at Popua Power Station beside the existing powerhouse for the Mak generator under the Project. It is agreed by TPL (areas: approximately 100 m^2) to use the area for the Project.

However, the area is dependent on capacity of the power storage system of the Project. More definite size will be considered by the Team based on the outline design and cost estimation in Japan, discussed between the Ministry of Foreign Affairs, JICA and the Team and explained to the Tongan side in the third field survey.



Source: JICA Study Team

Figure 2 Project Site for PV system

3. Components for the Project

3.1 Final Requested Components

The Tongan and Japanese sides were agreed on the final requested components in conformity with the Minutes of Meetings on 30th August, 2012 in the first field survey.

Table 1 Outline of the Project

	Components	Quantity or Capacity
Procurement and Installation	1.Micro-grid system at Popua Power Station	
	1.1 Micro-grid control system	
	(1) Micro-grid control panel	1 set
	(2) Control panel to stabilize output from PV system	1 set
	(3) Data management system	1 lot
	(4) Weather monitor instruments (Pyranometer, Temperature meter)	1 lot
	1.2 Power storage system	
	(1) Capacitors	Enough capacity supply 500 kW for 30 sec. from SOC 50 %
	(2) Capacitor panel	Enough capacity to include the capacitors
	(3) Capacitor connecting panel	1 lot
	(4) Power conditioner for capacitors	500 kW
	(5) Transformer for interconnection	750 kVA
	(6) High voltage transformer panel	Same as number of power conditioners for capacitors
	(7) Low voltage transformer panel	Same as number of power conditioners for capacitors
	1.3 Station service panel	1 set
	2. Micro-grid system at Vaini Project Site	
	2.1 Micro-grid control system	
	(2) Control panel to stabilize output from PV system	1 set
	(3) Data management system	1 lot
	(4) Weather monitor instruments (Pyranometer, Temperature meter)	1 lot
	2.2 Power storage system	
	(1) Capacitors	Enough capacity supply 500 kW for 30 sec. from SOC 50 %
	(2) Capacitor panel	Enough capacity to include the capacitors
	(3) Capacitor connecting panel	1 lot
	(4) Power conditioner for capacitors	500 kW
	(5) Transformer for interconnection	750 kVA
	(6) High voltage transformer panel	Same as number of power conditioners for capacitors
	(7) Low voltage transformer panel	Same as number of power conditioners for capacitors
	2.3 Photovoltaic system (PV system)	
	(1) PV module	1,000 kWp
	(2) Power conditioner	1,000 kW
	(3) Connection box	1 lot
	(4) Junction box	1 lot
	(5) Mounting structure for PV modules	1 lot
	(6) Transformer for interconnection	1,250 kVA
	(7) High voltage transformer panel	Same as number of power conditioners for capacitors
	(8) Low voltage transformer panel	Same as number of power conditioners for capacitors
	2.4 11 kV interconnection switchgear	
	(1) 11 kV switchgear	7 sets
	(2) Earthing transformer (including reactor)	1 set
	(3) DC power supply panel	1 set
	2.5 Station service panel	1 set
	3. Optical fiber communication ssystem	Approx. 10 km
Procurement	4. 11 kV interconnection switchgear at Popua Power Station	
	(1) 11 kV switchgear	4 sets
	(2) Earthing transformer (including reactor)	1 set
	(3) DC power supply panel	1 set
	5. Spare parts	1 lot
	6. Emergency spare parts	1 lot
Construction	a. Building for electrical equipment at Popua Power Station	Gross floor area: Approx. 100 m^2
	b. Building for electrical equipment at Vaini Project Site	Gross floor area: Approx. 190 m^2

Source: JICA Study Team

3.2 Drawing Lists

The following drawings are attached in the end of this field report.

- D-01 Single Line Diagram
- D-02 Control System Diagram
- D-03 Arrangement of panels at Vaini Site
- D-04 Floor and Section Plan of Building at Vaini Site
- D-05 PCS and Batteries Building at Vaini Site
- D-06 Floor and Section Plan of Building at Popua Power Station
- D-07 PCS and Batteries Building at Popua Power Station

3.3 Technical issues discussed in the first field survey and reconfirmed in the second field survey

(1) Acquisition of approval from Mamma Mai to connect signal cables to the existing PV system

The Tongan side agreed to obtain a letter showing approval from Mamma Mai that a transducer of the Project will be located in the 11 kV switchgear of the existing photovoltaic system and connected to the current and voltage transformer in parallel to the existing transducer by 19th October, 2012.

(2) Modification work to enable the existing Mak generator to share load with the CAT ones

Based on the plan discussed between the Tongan side and Team in the first field survey, the Team consulted a major manufacturer of control devices for diesel engine generators (not the same manufacturer for the existing ones) with its feasibility in the analysis in Japan.

It was advised by the manufacturer that more careful consideration for safety operation should be carried out in such case as Popua Power Station where composition of buses is complex though the plan is feasible. Every possible accident shall be considered and safety operation shall be sorted based on TPL's own policy. It was revealed that it is difficult that such third party as a consultant may carry out the basic design for the modification work or the third party as a Japanese contractor may implement the work.

The Team explained the results and the Tongan side and Team agreed to exclude the modification work to enable the existing Mak generator to share load with the CAT ones. The work will be carried out based on the basic design planned by TPL and the original contractor of the existing Mak generator, when a new Mak generator is extended in 2013.

(3) Cost estimation for the modification work of the existing power house at the Popua Power Station

The power storage system of the Project at Popua Power Station will be connected in 11 kV. The Tongan side requested the Team to locate 11 kV switchgears of the Project in the existing powerhouse at Popua Power Station to enable the extension work of switchgears by himself in the future. The Team agreed to do so in the first field survey.

The Tongan side shall undertake modification work of the existing building such as preparation of cable trench, cable trays, walls, doors, windows and air conditioner. The modification work shall be completed prior to commencement of the work by the Japanese side, and installation work of 11 kV switchgears procured by the Japanese side. It is required for the Tongan side to inform the cost to the Team by 19th October, 2012.

(4) Capacity of the Power Storage system

The Tongan side agreed to apply capacitor banks as the power storage system of the Project. Based on the results of the analysis in Japan, capacity of a capacitor banks is specified as enough capacity to supply 500 kW for 30 seconds from 50% of state of charge. The capacitor bank will be provided to Popua Power Station and Vaini Project Site respectively. The results of the analysis in Japan are shown in Annex 3 of this field report.

(5) Evaluation on Potential of Wind Power Generation in Tongatapu Island

Based on discussion with the Tongan side in the first field survey, the wind power generation was excluded from the components of the Project due to procedural grounds for Environmental Impact Assessment.

However, potential evaluation for wind power generation will be conducted from the technical viewpoint and the results will be included in the Preparatory Survey Report. The results of the analysis in Japan are shown in Annex 3 of this field report and explained to the Tongan side in the second field survey.

3.4 Technical issues discussed in the second field survey

(1) Shutdown of Mak generator during PV generation

Output from PV system is fluctuated based on weather conditions. Velocity and range of such fluctuation will be reduced by the power storage system of the Project during some seconds. However, load of the diesel engine generators shall be increased or decreased finally to meet demand after the period. Load control system in consist with demand shall be provided to every diesel engine in operation to stabilize the power system with the micro-grid system of the Project,

while PV is operating and demand stays in low level.

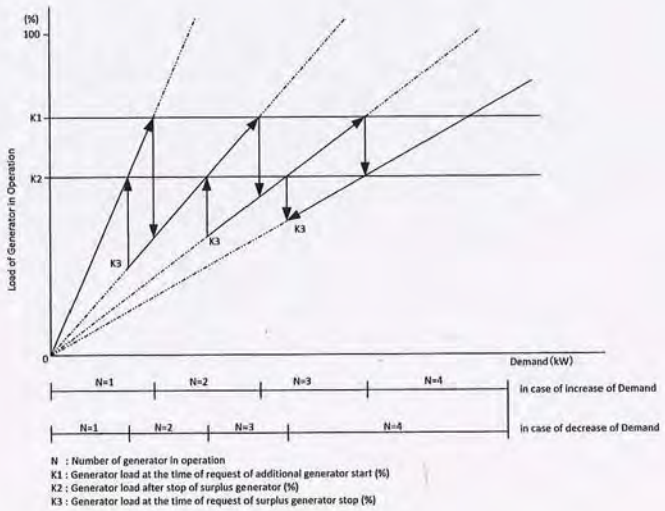
The existing Mak generator is not holding load sharing control system with the other generators. Therefore, it shall be stopped when the PV system starts operation and demand stays in low level as below 6,000 kW.

(2) Reference data for control of number of the existing CAT generators in operation

The control sequence of number of the CAT generators in operation is shown in Figure 3. The load ratios for the sequence are currently set as follows.

K1 = 85 %
K2 = 65%

The start sequence of an additional generator runs in consist with demand increase, every time load ratio increases to 85 %. And the stop sequence of a redundant generator runs in consist with demand decrease, every time load ratios decreases to 65 %.



Source: prepared by JICA Study Team based on JIS F 9800

Figure 3 Control sequence of number of generators in operation

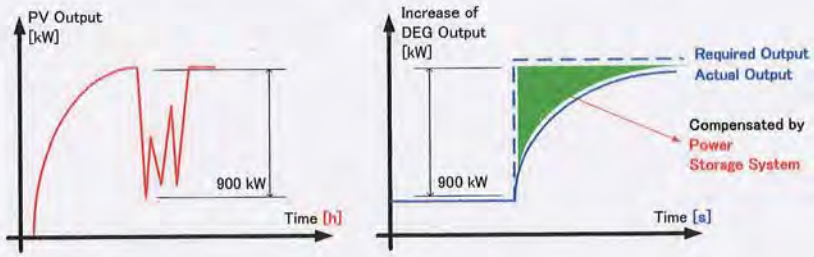
Based on the above set value, number of generator in operation is controlled in the manner shown in Table 2.

Table 2 Current conditions of operation (K1 = 85 %, K2 = 65 %)

Number in operation	K3	DEG output before a generator stops	K1	DEG output before a generator starts
N=1	0 %	0 kW	85 %	1,190 kW
N=2	33 %	910 kW	85 %	2,380 kW
N=3	43 %	1,820 kW	85 %	3,570 kW
N=4	49 %	2,730 kW	85 %	4,760 kW
N=5	52 %	3,640 kW	85 %	5,950 kW
N=6	54 %	4,550 kW	85 %	-

Source: JICA Study Team

Load of the CAT generators shall be increased or decreased finally to meet demand after the period of compensation by the power storage system and keep frequency of the power system within the management range (50 Hz ± 0.5 Hz) during PV operation as shown as Figure 4.



Source: JICA Study Team

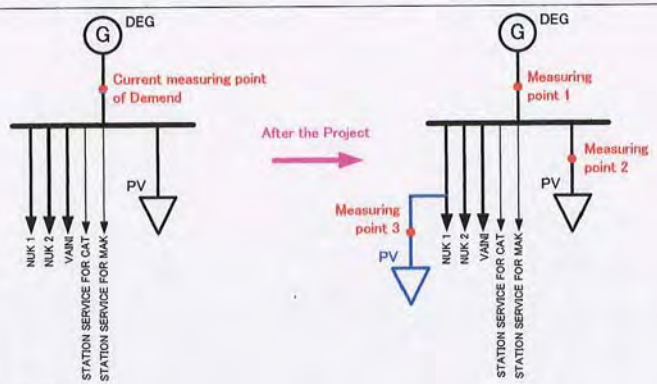
Figure 4 Compensation by the power storage system

It takes some minutes to start and synchronize a diesel engine generator, and increase load ratio up to level of load sharing. Therefore, spinning reserve shall surely be maintained against sudden decrease of PV output without additional start of a CAT generator.

Surely to keep spinning reserve, number of the CAT generator in operation shall be controlled based on demand. The current reference point of demand is shown in the left of Figure 5. Then, number of the CAT generator in operation is controlled under the condition that their required output is the actual demand minus output from PV system. Spinning reserve will be short in case of this reference method, if 1,000 kWp of the additional PV system is introduced by the Project and penetration to PV generation is increased remarkably.

In case of highly relying on PV generation, number of the CAT generator in operation shall be controlled based on the actual demand, which is obtained by totaling the power at the measuring points shown in the right of Figure 5.

The Tongan side and Team agreed to modify the reference points for the control sequence of number of the CAT generators in operation surely to keep spinning reserve.



Source: TPL

Figure 5 Reference points of demand

(3) Shutdown of a part of PV system

To prevent such condition as the CAT generators are operated below the minimum load ratio possible in the current operation, a part of PV system shall be shutdown. Such case will occur, when demand stays in the level of 4,000 kW. The minimum load ratio shown in Table 2 is 33 %. The load ratio of the CAT generators is kept over Approx. 30 % by shutting down 500 kWp of PV system of the Project, if PV starts operation and demand stays below 4,000 kW. The Tongan side and Team agreed to include such control sequence in the micro-grid system of the Project for the safety operation of the CAT generators.

3.5 Soft Components

Soft Component is also included in the Project.
Refer to ANNEX 5 for the details.

4. Environmental and Social Consideration

4.1 Environmental Legal Framework

Existing environmental legislation relevant to the Project is shown below.

Table 4.1 Existing Environmental Legislation relevant to the Project

Legislation	Year Passed	Last Amended	Objective
Environmental Impact Assessment Act 2003	2003	-	To provide for the application of environmental impact assessment to the planning of development in Tonga
Environmental Impact Assessment Regulations 2010	2010	-	To regulate major development projects and the applications of notification consistent with the EIA Act 2003)
Waste Management Act 2005	2005		To manage and oversee the function of the Waste Management Board
Parks and Reserves Act 1976	1976	1979 & 1988	To provide for the establishment of Parks and Reserves Authority and for the establishment, preservation and administration of Parks and Reserves
Hazardous Wastes and Chemicals Act 2010	2010		To provide for the regulation and proper management of hazardous wastes and chemicals in accordance with accepted international practices and the International Conventions applying to the use, transboundary movement and disposal of hazardous substances and for related purposes.
Renewal Energy Act 2008	2008	2010	To regulate the use of renewable energy in the Kingdom and related matters
Environmental Management Act 2010	2010		To establish the Ministry of Environment & Climate Change* to ensure the protection and proper management of the environment and the promotion of sustainable development

*The Ministry of Environment & Climate Change was incorporated into the MLECCNR as the Department of Environment & Climate Change due to the reorganization of government ministries in July 2012.

Source: Department of Environment & Climate Change

The Environmental Impact Assessment Act 2003 (EIA Act 2003) provides the power of the Ministry, the establishment and functions of the Environmental Assessment Committee, penalty, definition of major projects and so on. The major project is defined as a development activity which is likely to result in or increase pollution, or to have adverse impact on natural environment. A development activity which is classified as the major project is subject to conduct an appropriate environmental impact assessment. Development of electric generation station is defined as the major project even though renewal energy is used for the power generation. Therefore, the Project is subject to conduct an EIA.

4.2 Environmental Policies in TERM

The objective of TERM is to reduce vulnerability to high and variable petroleum price with introduction of renewable energy. In order to achieve the objective, a set of key principles have been set out in TERM. Social and environmental sustainability is one of the key principles, and it is explained as follows. "Environmental and Social sustainability encompasses both minimizing local negative social and physical environmental impacts of the energy sector, as well as aligning with global goals with respect to minimizing impact on climate change where possible. New energy investments under the TERM would be subject to Environmental and Social Impact Assessment and Mitigation Plans as necessary, as per international practice. Special consideration will be given to those groups with specific needs including youth, women, religious groups and those with special needs. Investments that have major negative environmental or social impacts or

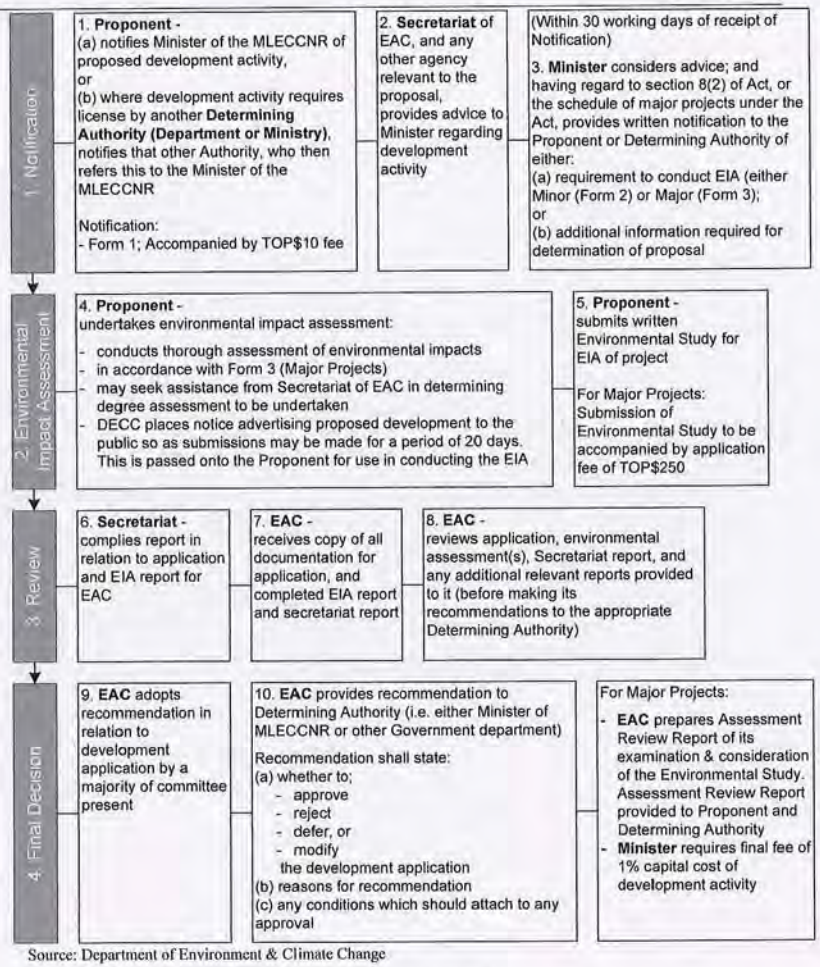
constraints that cannot be mitigated or solved will be avoided."

As mentioned above, TERM requires environmental and social impact assessment and mitigation plans as per international practice in order for development of electric generation station. In this regard, the JICA Guidelines for Environmental and Social Considerations shall be observed as well as the World Bank's Safeguard Policies and other standards of international financial organizations related to the environmental and social considerations of the Project.

4.3 Environmental Management Administration and EIA Procedures

The Environmental Management Act 2010, which created the former Ministry of Environment and Climate Change (MECC), empowered the Minister and the Director for Environment and Climate Change as well as Environmental Officers on environmental management. In relation to the EIA procedure, the Minister determines whether the proposed development is a minor or major project, and receives an assessment report and issues the approval with or without conditions, a request for further information, or a rejection. Meanwhile, the Director, who is the head of the Secretariat of the Environmental Assessment Committee (EAC) and chairs the Committee, inspects or investigates any facility or activity deemed to be causing potential impact on the environment. The Secretariat which is staffed with Environmental Officers receives application documents related to environmental impact assessment of the proposed project and gives advice on implementation of environmental study under the Director's instructions. It is deemed that the power and authority of those key actors are the same as before, although the former MECC was incorporated into the MLECCNR in July 2012.

The EIA Act 2003 has been enforced under the Environmental Impact Assessment Regulations 2010 (EIA Regulations 2010). The EIA Regulations provides the procedures of EIA for major projects classified under the EIA Act 2003. The EIA procedures, as shown in the following figure, are divided into four steps; namely, notification, environmental impact assessment, review and final decision with or without conditions.



Source: Department of Environment & Climate Change

Figure 4.1 Procedures of EIA

All development activities must be notified to the Minister who determines whether the proposed development is a major project or not. However, according to the Department of Environment and Climate Change (DECC), this Project can skip the notification because it is obviously the major project, and the proponent can step into the study of EIA, complete the EIA report and submit it to the Secretariat with an application. The Secretariat compiles a report based on the application and the EIA report, and then submits those documents to the EAC for the review. The EAC reviews the submitted documents and prepares/submits a recommendation to the Minister for final decision. According to the TPL, in case of the project of Popua 1MW Solar Firm, it took less than 3 months from the notification to the final decision by the Minister.

4.4 Outline of the Project

The components of the Project include micro grid controller, storage system, solar PV system and O&M of the equipment. Regarding the renewal energy resource, the Tongan side originally requested introduction of both 0.5MW solar PV system and 0.5MW wind turbine generator. Due to the environmental constraints, only solar PV system was adopted to the Project as the renewal energy resource.

Table 4.2 Components of the Project

Item	Components
Micro Grid Controller	• Generation and network control system integrated into TPL's SCADA at Popua power station • IP broadband and/or mesh type communications network that overlies TPL's Tongatapu network, connecting remote generation to the Popua SCADA system and micro grid controllers • Integration of battery or capacitive storage and local flow "smoothing" algorithms to monitor and control field assets and enable future demand side management
Storage System (Capacitors)	• Capacitors and controller located at either Popua or at Vaini PV Site, controlling energy flows and quality, and optimizing efficiency of the diesel generators • Conversion of the TPL 2.88 MW MAK diesel generator governor to load following capability (requires manufacturer's involvement to modify governors, TPL has discussed requirements and scope with manufacturer)
Solar PV System (1MW)	• A single solar PV array at Vaini, in central Tongatapu, injecting into the TPL 11kV network, including spares • Network voltage management (regulator or other dynamic support)
Operation & Maintenance of the Equipment	• Training TERM-IU staff and TPL staff • Operating and maintenance manuals and process documentation • O&M support

Source: JICA Study Team

4.5 Review of Alternatives

In order to optimize the environmental and social impacts by the Project, the following alternatives including zero option were reviewed.

Alternative 0: None of project implementation (zero option)
Alternative 1: Construction of 0.5MW PV plant and 0.5 wind plant, and other needed facilities
Alternative 2: Construction of 1.0MW PV plant and other needed facilities

The Alternative 1 is the original plan that was requested by the Government of Tonga, and the Alternative 2 is the agreed plan by the Tongan and Japanese sides during the First Field Survey. The results of review of those alternatives are shown in the following table.

Table 4.3 Comparison of Alternatives

Items to be reviewed	Alternative 0 (w/o Project)	Alternative 1 (0.5MW PV plant + 0.5MW wind plant)	Alternative 2 (1.0MW PV plant)
Benefit	None	• Reduction of fossil-fuel consumption and stabilization of electricity supply by development of renewal-energy-based electric generation along with introduction of micro-grid system	Same as on the left
Reduction of CO_2 Emission	None	1,268 ton/year	886 ton/year
Social Impacts	As-is (Social impacts due to the vulnerability to oil price will continue without any improvement)	• A certain decrease of agricultural product because of land use conversion from farm land to power station • Possible damage of tourism resources because of spoiling of landscape caused by existence of gigantic wind turbine	• A certain decrease of agricultural product because of land use conversion from farm land to power station
Environmental Impacts	As-is (Environmental impacts due to consumption of fossil-fuel in the existing diesel power plant will continue without any improvement)	• Minor changes of topography in the project sites are expected because of clearing and leveling of the sites • Possible soil erosion because of clearing and leveling of the sites • Possible impact of flora, fauna and biodiversity because of existence and operation of wind plant • Possible impact of landscape because of existence and operation of wind plant	• Minor changes of topography in the project sites are expected because of clearing and leveling of the sites • Possible soil erosion because of clearing and leveling of the sites
Possible Pollution	As-is	• Possible air pollution because of SPM and dust arising from operation of construction vehicles and machineries • Possible generation of construction wastes from construction activities • Possible generation of used lead-acid batteries approximately every 10 years • Possible pollution of noise arising from construction vehicles and machineries • Possible pollution of noise and low-frequency noise because of operation of wind turbine	• Possible air pollution because of SPM and dust arising from operation of construction vehicles and machineries • Possible generation of construction wastes from construction activities • Possible pollution of noise arising from construction vehicles and machineries

Source: JICA Study Team

The Alternative 0 (zero) means that the operation of existing power generating system (11.28MW diesel generating along with the newly developed Popua 1.3MW Solar Farm) continues without any changes. Therefore, it brings neither benefit nor reduction of CO_2 emission in future.

In case of the Alternative 1, it is likely to bring the most reduction of CO_2 emission compared to the other alternatives. The GOT requested to the GOJ to introduce both solar PV system and wind turbine generator system as the renewal energy source of the Project. However, the wind turbine system is hardly adopted in the Project from the viewpoint of environmental constraint.

It is unlikely that the construction, existence and operation of solar PV system have serious impacts on social and natural environment. Meanwhile as for wind turbine generator system, the following environmental items should be appropriately evaluated prior to the construction because problems of those items might be caused by wind turbine due to its mechanism.

- Noise
- Low-frequency noise
- Radio disturbance
- Shadow flicker
- Disturbance of birds' migration routes
- Spoiling of landscape

As to disturbance of birds' migration routes especially, survey of existing conditions on the migration routes generally takes one year at minimum. Accordingly, it takes one and a half year or more to obtain environmental permission from both Japanese and Tongan authorities, taking into account the required time for data analysis, assessment of the environmental impacts, information disclosure, stakeholder meetings, review of the EIA and so on. The time required for the EIA procedures does not meet the time schedule of the Project.

4.6 Scoping

(1) Specification of Factors affecting Environment

Factors (or activities) which are accompanied by the project implementation and assumed to be affecting environment in/around the project site are examined in the cases of the Alternative 1 (0.5MW PV plant + 0.5MW wind plant) and the Alternative 2 (1.0MW PV plant) as mentioned in the preceding section. The specified factors are shown below.

Table 4.4 Factors Affecting Environment

Factors affecting environment		Assumed environmental impacts
Construction Phase	Land preparation	Loss of agricultural product, topographical change, soil erosion and generation of construction wastes due to land preparation work (clearing and leveling of the sites)
	Operation of construction machineries	Air pollution, noise and vibration due to operation of construction machineries at the sites
	Transportation of equipment and materials	Air pollution, noise and vibration due to transportation of equipment and construction materials to and from the sites
	Construction of power plant	Construction wastes due to construction work of facilities
Operation Phase	Existence of PV plant	Loss of agricultural product due to existence of PV plant
	Existence of wind plant *	Loss of agricultural product, spoiling of landscape, impacts on flora, fauna and biodiversity due to existence of wind turbine
	Operation of wind plant *	Spoiling of landscape, impacts on flora, fauna and biodiversity, generation of used lead-acid batteries, noise and vibration due to operation of wind plant

Note: The marked item (*) is only applicable to the Alternative 1.

Source: JICA Study Team

(2) Review of Environmental Items

The environmental items to be examined are classified into three categories; social environment, natural environment and pollution, and 30 environmental items are specified based on the JICA Guidelines for Environmental and Social Considerations. The relationship between the environmental items and the factors affecting environment is shown in the following tables, in the both cases of the Alternative 1 and the Alternative 2.

Table 4.5 Scoping Matrix for Alternative 1 (0.5MW PV Plant + 0.5MW Wind Plant) (1/2)

Category	No.	Factor affecting environment / Category and environmental item	OVERALL RATING	Const. Phase: Land preparation	Const. Phase: Op. of const. machinery	Const. Phase: Transp. of equipment	Const. Phase: Const. of power plant	Op. Phase: Existence of PV plant	Op. Phase: Existence of wind plant	Op. Phase: Operation of wind plant	Description
Social Environment	1	Involuntary resettlement									There is no possibility of impact because no houses exist in the sites.
	2	Local economy such as employment and livelihood, etc.	B	B				B	B		Loss of agricultural product is expected because some coconut trees and other crops are cultivated in the sites of power plant.
	3	Land use and utilization of local resources									There is no possibility of impact because the construction and operation of power plants do not affect surrounding land use and utilization of local resources.
	4	Social institutions such as social infrastructure and local decision-making									There is no possibility of impact because there are not any social institutions in the sites.
	5	Existing social infrastructure and services									There is no possibility of impact because there are not any social infrastructure and services in the sites.
	6	The poor, indigenous and ethnic people									There is no possibility of impact because the sites have not any relationships with poor, indigenous and ethnic people.
	7	Misdistribution of benefit and damage									There is no possibility of impact because the construction and operation of power plants do not result in any misdistribution of benefit and damage.
	8	Cultural heritage									There are not any cultural heritages in the sites.
	9	Local conflict on interests									There is no possibility of impact because the construction and operation of power plants do not create any local conflict on interests.
	10	Water usage or water rights and rights of common									There is no possibility of impact because the construction and operation of power plants do not affect water usage and water rights.
	11	Sanitation									There is no possibility of impact because the construction and operation of power plants do not affect sanitation.
	12	Hazards (Risk) of infectious diseases such as HIV/AIDS									There is no possibility of impact because the construction and operation of power plants do not lead to any hazards of infectious diseases. During construction phase, hiring of local workers is expected and workers' lodging is not necessary.
Natural Environment	13	Topography and geographical features	B	B							Minor changes of topography are expected because of clearing and leveling of the sites.
	14	Soil erosion	B	B							There is a possibility of impact because of clearing and leveling of the sites during construction phase.
	15	Groundwater									There is no possibility of impact because the construction and operation of power plants do not affect groundwater.
	16	Hydrological situation									There is no possibility of impact because the construction and operation of power plants do not affect hydrological situation.
	17	Coastal zone									There is no possibility of impact because the construction and operation of power plants do not affect coastal zone.
	18	Flora, fauna and biodiversity	C						C	C	There is a possibility of impact because of the existence and operation of wind plant.
	19	Meteorology									There is no possibility of impact because the construction and operation of power plants do not affect meteorology.
	20	Landscape	C						C	C	There is a possibility of impact because of the existence and operation of wind plant.
	21	Global warming									There is no possibility of impact because the construction and operation of power plants do not affect global warming.

Table 4.5 Scoping Matrix for Alternative 1 (0.5MW PV Plant + 0.5MW Wind Plant) (2/2)

Category	No.	Factor affecting environment / Category and environmental item	OVERALL RATING	Const. Phase: Land preparation	Const. Phase: Op. of const. machinery	Const. Phase: Transp. of equipment	Const. Phase: Const. of power plant	Op. Phase: Existence of PV plant	Op. Phase: Existence of wind plant	Op. Phase: Operation of wind plant	Description
Pollution	22	Air pollution	B		B	B					There is a possibility of impact because of SPM and dust arising from operation of construction vehicles and machineries.
	23	Water pollution									There is no possibility of impact because the construction and operation of power plants do not lead to water pollution.
	24	Soil contamination									There is no possibility of impact because the construction and operation of power plants do not lead to soil contamination.
	25	Waste	B	B			B			B	Construction wastes arise from construction activities. Replacement of lead-acid batteries arises periodically, say every 10 years.
	26	Noise and vibration	C		B	B				C	There is a possibility of impact because of noise and vibration arising from operation of construction vehicles and machineries. Operation of wind plant generates noise and low-frequency noise.
	27	Ground subsidence									There is no possibility of impact because the construction and operation of power plants do not lead to ground subsidence.
	28	Offensive odor									There is no possibility of impact because the construction and operation of power plants do not lead to offensive odor.
	29	Bottom sediment									There is no possibility of impact because the construction and operation of power plants do not lead to bottom sediment.
	30	Accidents									There is a possibility of impact on traffic safety because of the operation of construction vehicles and machineries.

Rating
A: Serious impact is expected.
B: Some impact is expected.
C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)
No mark: No impact is expected. IEE/EIA is not necessary.

Source: JICA Study Team

In the case of the Alternative 1, eight (8) environmental items shall be examined through the study of EIA. Of these items, three (3) items are rated as C that means the extent of impact is unknown and, accordingly, those impacts have to be carefully assessed through the study of EIA. As shown in the above table, those C ratings are, incidentally, attributed to the wind turbine plant.

Table 4.6 Scoping Matrix for Alternative 2 (1.0MW PV Plant) (1/2)

Factor affecting environment / Category and environmental item			OVERALL RATING	Const. Phase				Op. Ph.	Description
				Land preparation	Op. of const. machinery	Transp. of equipment	Const. of power plant	Existence of PV plant	
Social Environment	1	Involuntary resettlement							There is no possibility of impact because no houses exist in the sites.
	2	Local economy such as employment and livelihood, etc.	B	B				B	Loss of agricultural product is expected because some coconut trees are cultivated in the site of PV plant.
	3	Land use and utilization of local resources							There is no possibility of impact because the construction and operation of power plants do not affect surrounding land use and utilization of local resources.
	4	Social institutions such as social infrastructure and local decision-making							There is no possibility of impact because there are not any social institutions in the sites.
	5	Existing social infrastructure and services							There is no possibility of impact because there are not any social infrastructure and services in the sites.
	6	The poor, indigenous and ethnic people							There is no possibility of impact because the site has not any relationships with poor, indigenous and ethnic people.
	7	Misdistribution of benefit and damage							There is no possibility of impact because the construction and operation of PV plant do not result in any misdistribution of benefit and damage.
	8	Cultural heritage							There are not any cultural heritages in the site.
	9	Local conflict on interests							There is no possibility of impact because the construction and operation of PV plant do not create any local conflict on interests.
	10	Water usage or water rights and rights of common							There is no possibility of impact because the construction and operation of PV plant do not affect water usage and water rights.
	11	Sanitation							There is no possibility of impact because the construction and operation of power plants do not affect sanitation.
	12	Hazards (Risk) of infectious diseases such as HIV/AIDS							There is no possibility of impact because the construction and operation of PV plant do not lead to any hazards of infectious diseases. During construction phase, hiring of local workers is expected and workers' lodging is not necessary.
Natural Environment	13	Topography and geographical features	B	B					Minor changes of topography are expected because of clearing and leveling of the site.
	14	Soil erosion	B	B					There is a possibility of impact because of clearing and leveling of the site during construction phase.
	15	Groundwater							There is no possibility of impact because the construction and operation of PV plant do not affect groundwater.
	16	Hydrological situation							There is no possibility of impact because the construction and operation of PV plant do not affect hydrological situation.
	17	Coastal zone							There is no possibility of impact because the construction and operation of PV plant do not affect coastal zone.
	18	Flora, fauna and biodiversity							There is no possibility of impact because the construction and operation of PV plant do not affect flora, fauna and biodiversity.
	19	Meteorology							There is no possibility of impact because the construction and operation of PV plant do not affect meteorology.
	20	Landscape							There is no possibility of impact because the construction and operation of PV plant do not affect landscape.
	21	Global warming							There is no possibility of impact because the construction and operation of PV plant do not affect global warming.

Table 4.6. Scoping Matrix for Alternative 2 (1.0MW PV Plant) (2/2)

Factor affecting environment / Category and environmental item			OVERALL RATING	Const. Phase				Op. Ph.	Description
				Land preparation	Op. of const. machinery	Transp. of equipment	Const. of power plant	Existence of PV plant	
Pollution	22	Air pollution	B		B	B			There is a possibility of impact because of SPM and dust arising from operation of construction vehicles and machineries.
	23	Water pollution							There is no possibility of impact because the construction and operation of power plants do not lead to water pollution.
	24	Soil contamination							There is no possibility of impact because the construction and operation of power plants do not lead to soil contamination.
	25	Waste	B	B			B		Construction wastes arise from construction activities.
	26	Noise and vibration	B		B	B			There is a possibility of impact because of noise and vibration arising from operation of construction vehicles and machineries.
	27	Ground subsidence							There is no possibility of impact because the construction and operation of power plants do not lead to ground subsidence.
	28	Offensive odor							There is no possibility of impact because the construction and operation of power plants do not lead to offensive odor.
	29	Bottom sediment							There is no possibility of impact because the construction and operation of power plants do not lead to bottom sediment.
	30	Accidents							There is a possibility of impact on traffic safety because of the operation of construction vehicles and machineries.

Rating
A: Serious impact is expected.
B: Some impact is expected.
C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)
No mark: No impact is expected. IEE/EIA is not necessary.

Source: JICA Study Team

In the case of the Alternative 2, six (6) environmental items shall be examined through the study of EIA. Those 6 items are all rated as B that means some impact is expected. The degrees of those impacts are deemed to be very limited and, in fact, reliable mitigation measures can be done against those impacts.

4.7 Emission Reduction

The effect of emission reduction by both cases of the Alternative 1 and Alternative 2 can be estimated from the offset of diesel fuel with the electric generation by the renewal energy resource respectively. The results of the estimation are shown below.

Table 4.7 Emission Reduction in the cases of Alternative 1 and Alternative 2 (Tentative)

	Alternative 1 (0.5MW PV plant + 0.5MW wind plant)	Alternative 2 (1.0MW PV plant)
Rated Capacity of System (MW)	1.0	1.0
Estimated Electricity Output (MWh/year)	1,874	1,308
Reduced Quantity of Diesel Oil (kl/year)	468	327
Reduction of CO_2 Emission (t-CO_2/year)	1,268	886

Source: JICA Study Team

In the case of Alternative 1, the reduction of CO_2 emission will be 1,268 tons. On the other hand, 886 tons of CO_2 reduction is expected in the case of Alternative 2. The effect of emission reduction in Alternative 2 is less than the case of Alternative 1 because solar PV plant does not generate electricity during nighttime. The detailed estimation of the emission reduction by both cases of the Alternative 1 and Alternative 2 is shown below.

Case of the Alternative 1

The estimated electricity output in the case of the Alternative 1 is as follows.

Estimated Electricity Output by 0.5MW PV Plant: 654 MWh/year

Estimated Electricity Output by 0.5MW Wind Plant: 1,220 MWh/year

Total Output: 1,874 MWh/year

The estimated electricity output can be converted to reduced quantity of diesel oil based on the actual fuel consumption of the diesel power plant in Tongatapu as follows.

Reduced Quantity of Diesel Oil = 1,874 MWh/year ÷ 4 kWh/l = 468 kl/year

The reduction of CO2 emission is calculated using the unit calorific value (39.1GJ/kl) and the emission factor (0.0693kg-CO2/l) of diesel oil as follows.

Reduction of CO2 Emission = 468 kl/year × 39.1 GJ/kl × 0.0693 kg-CO2/l = 1,268 t-CO2/year

Case of the Alternative 2

The estimated electricity output in the case of the Alternative 2 is as follows.

Estimated Electricity Output by 1.0MW PV Plant: 1,308 MWh/year

In the same way, the estimated electricity output can be converted to reduced quantity of diesel oil based on the actual fuel consumption of the diesel power plant in Tongatapu as follows.

Reduced Quantity of Diesel Oil = 1,307.8 MWh/year ÷ 4 kWh/l = 327 kl/year

The reduction of CO2 emission is calculated as follows.

Reduction of CO2 Emission = 326.9 kl/year × 39.1 GJ/kl × 0.0693 kg-CO2/l = 886 t-CO2/year

4.8 Mitigation Measures

As shown in the following table, the mitigation measures are examined in the case of the Alternative 2 that is the agreed plan between the Tongan and Japanese sides.

Table 4.8 Assumed Mitigation Measures

Items	Rating	Possible Impact	Assumed Mitigation Measures
Local economy such as employment and livelihood, etc.	B	Loss of agricultural product is expected because some coconut trees are cultivated in the site of PV plant.	The project site for PV plant is currently owned by a noble and covered by bush with some coconut trees. Those trees and bush will be cut down and cleared. TPL will lease the site from the noble and compensation for the loss of agricultural product will be included in the land lease.
Topography and geographical features	B	Minor changes of topography are expected because of clearing and leveling of the site.	The degree of the topographic change is very small because the magnitude of land preparation work is very limited and soil transportation to/from the site is not expected. Impacts such as soil erosion resulting from topographic change can be avoided or mitigated with appropriate measures such as covering over turned soil by tarpaulin.
Soil erosion	B	There is a possibility of impact because of clearing and leveling of the site during construction phase.	During construction phase, soil erosion can be avoided or mitigated with appropriate measures such as covering over turned soil by tarpaulin.
Air pollution	B	There is a possibility of impact because of SPM and dust arising from operation of construction vehicles and machineries.	During construction phase, occurrence of dust will be avoided or mitigated by watering or dustproof covering on turned soil. As for SPM and dust arising from transportation of construction materials and equipment from wharf to the site, the impact will be mitigated with careful selection of transportation route and operation hour avoiding the center of town.
Waste	B	Construction wastes arise from construction activities.	Construction waste will be treated at the nearby landfill site located at approx. 500 meters on the north of the project site, in accordance with law.
Noise and vibration	B	There is a possibility of impact because of noise and vibration arising from operation of construction vehicles and machineries.	The noise and vibration caused by vehicle operation for transportation of construction materials and equipment from wharf to the site will be mitigated with careful selection of transportation route and operation hour avoiding the center of town. In addition, operation of construction vehicles and machineries will be limited during daytime hours in order to avoid impact of noise and vibration at night.

Source: JICA Study Team

4.9 Monitoring Plan

As a whole, the impacts of the Project on the natural and social environment are not significant as mentioned in the previous section. The most of the impacts are deemed to occur during construction phase, and those impacts can be avoided or mitigated with daily construction management. Accordingly, there are not any environmental items to be monitored.

4.10 Land System

The prime feature of land system in the Kingdom of Tonga is that "all the land of the Kingdom is the property of the Crown", as declared in the Land Act. The Minister of the MLECCNR is responsible for the land administration of the Kingdom's land as the representative of the Crown. There are two types of landownership; one is the Crown Land and the other, estate so-called "Tofia". The Crown Lands include Royal Estates, Royal Family Estates, lands for public purposes such as road and cemetery, and

so on, while the Tofias, which are entitled to privilege of hereditary transfer, have been given to only so many people such as nobles provided in the Land Act. People (or Commoner) can only lease the Crown Lands or Tofias with conditionality of less than 99 years' lease period because the Land Act places a ban on sale of the Kingdom's land.

4.11 Landownership of the Project Site for Solar PV System

The project site for the solar PV system at Vaini is owned by Lord Ma'afu who is the Minister for the MLECCNR. Lord Ma'afu has accepted TPL's request for the lease of the land, and sent the confirmation letter to TPL during the First Field Survey on August 2012. At present (as of October 2nd, 2012), the document of the lease contract has been finalized through the negotiation between TPL and the legal advisor for Lord Ma'afu. According to TPL, the lease contract will be concluded within a week or so, along with a signing ceremony. The compensation for orchard trees such as mango and coconut palm is included in the lease contract.

In general, the documents of the lease contract will be submitted to the MLECCNR for approval and registration. The submitted lease contract will be deliberated in the Cabinet and, if it is acceptable, the Minister of the MLECCNR will approve the lease contract with the Cabinet's consent. And then, the project site will be surveyed and registered by the MLECCNR. According to the Planning & Urban Management Agency of the MLECCNR, it generally takes one month from submission of the lease contract to the registration.

In this case, however, the MLECCNR conducted the survey of the Project Site and identified the boundary prior to conclusion of the lease contract, because of the urgent need of topographic survey of the Project Site.

4.12 Preparation of Environmental Checklist

Through the consultation between TPL and the JICA study team, the environmental checklist for the Project (refer to ANNEX. 4) was prepared in order to confirm the situation of EIA procedures and the environmental items to be considered.

4.13 Perspective on EIA Report and Environmental Permit

In accordance with advice of the Secretariat of EAC in the Department of Environment & Climate Change, TPL will submit a series of documents based on the results of the Second Field Survey to the Secretariat, in order to obtain a pre-approval for the Project and to shorten the time period required to the EIA procedure. In relation to the preparation of the EIA report, TPL will implement an environmental and social survey including stakeholder meetings. A series of finalized drawings and specifications, which will be provided by the JICA mission to TPL during the Third Field Survey in this December, will be necessary to submit the EIA report for the formal application to the Secretariat.

5. Work Demarcations for Both of the Tongan and Japanese Side

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as shown as Table 5.1.

Table 5.1 Work Demarcations for Both of the Tongan and Japanese Side

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	to secure [a lot] /[lots] of land necessary for the implementation of the Project and to clear the [site]/[sites];		●
2	To construct the following facilities		
	1) The building	●	
	2) The gates and fences in and around the site		●
	3) The parking lot	●	
	4) The road within the site	●	
	5) The road outside the site		●
	6) The gate house if needed		●
3	To provide facilities for distribution of electricity, water supply and drainage and other incidental facilities necessary for the implementation of the Project outside the [site]/[sites]		
	1)Electricity		
	a. The distributing power line to the site		●
	b. The drop wiring and internal wiring within the site	●	
	c. The main circuit breaker and transformer	●	
	2) Water Supply		
	a. The city water distribution main to the site		●
	b. The supply system within the site (receiving and elevated tanks)	●	
	3) Drainage		
	a. The city drainage main (for storm sewer and others to the site)		●
	b. The drainage system (for toilet sewer, common waste, storm drainage and others) within the site	●	
	4) Gas Supply		
	a. The city gas main to the site		●
	b. The gas supply system within the site	●	
	5) Telephone System		
	a. The telephone trunk line to the main distribution frame/panel (MDF) of the building		●
	b. The MDF and the extension after the frame/panel	●	
	6) Furniture and Equipment		
	a. General furniture		●
	b. Project equipment	●	
4	To connect the PV system to the existing grid		
	1) Procurement of underground Cable long enough to connect to the existing pole	●	
	2) Installation of the cable to the existing grid		●
5	To ensure prompt unloading and customs clearance of the products at ports of disembarkation in the recipient country and to assist internal transportation of the products		
	1) Marine (Air) transportation of the Products from Japan to the recipient country	●	
	2) Tax exemption and custom clearance of the Products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	●	
6	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the products and the services [be exempted] / [be borne by the Authority without using the Grant]		●
7	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
8	To ensure that [the Facilities and the products]/[the Facilities]/ [the products] be maintained and used properly and effectively for the implementation of the Project		●
9	To bear the following commissions paid to the Japanese bank for banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
10	To give due environmental and social consideration in the implementation of the Project.		●
11	To bear all the above expenses, other than those covered by the Grant, necessary for the implementation of the Project		●

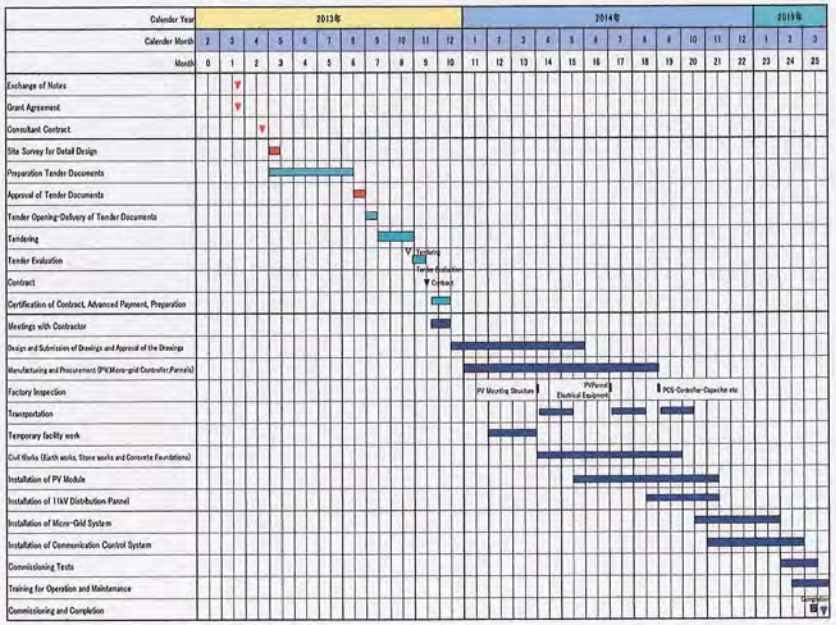
*1 B/A: Banking Arrangement, A/P: Authorization to pay) *2 If the environmental screening category is C, No.10 is unnecessary

6. Project Implementation Schedule

The tentative implementation schedule is shown as Table 6.1. In case that the Project is committed by the Japanese Government, the Project will proceed as follows in case of the earliest scenario, as shown as Table 6.1. The construction work will be commenced at the beginning of 2013.

- The Exchange of Notes and Grant Agreement between the Tongan and Japanese Government will be signed in March, 2013.
- The Tender Opening will be held in September, 2013.
- Construction work of the Project will start in May, 2014.
- Commissioning of the Project will be in March, 2015.

Table 6.1 Tentative Implementation Schedule of the Project



7. Other Relevant Issues

(1) Submission of data of possible minimum demand during PV operation to the Team with information of occurrence frequency

The Tongan side agreed to submit data of possible minimum demand during PV operation to the Team based on the analysis of data for the past one year with information of occurrence frequency during the second field survey as official opinions from TPL.

(2) Submission of data showing control characteristics of the existing MaK generators for dynamic analysis to the Team

The Tongan side request the Team to carry out the dynamic analysis under the load sharing conditions by the Mak generators for reference, based on the data showing control characteristics of the existing MaK generators. The Team agreed to do so, based on the following data submitted by the Tongan side during the second field survey.

- Control block diagram of AVR and Governor both for control device and mechanical device
- Set value of above mentioned devices such as gains, time constants, control limit and etc.
- Inertia constant of engine and generator

(3) Meeting to examine the control of the micro-grid system of the Project between the concerned parties for technical issues

Prior to the commencement of procurement and installation of the Project, the concerned parties such as TPL, the manufacturer of the Micro-grid system of the Project, manufacturer or contractor of the existing CAT generator and Consultant shall be gathered to examine the control of the grid system. The meeting shall be held in Tongatapu Island after conclusion of the Contract of the Project.

The Tongan side and Team agreed that the Japanese side shall bear the cost to dispatch engineers of the manufacturer of the Micro-grid system of the Project and Consultant, and the Tongan side shall bear the cost to dispatch engineers of the manufacturer or contractor of the existing CAT generator.

(4) Conditions for introduction of Renewable Energy after the Project

Power supply in Tongatapu Island after the Project will highly rely on renewable energy which fluctuates steeply in accordance with change of weather condition. The Team advised to the Tongan side that introduction of power storage system should condition upon further introduction of power source from renewable energy, and type, capacity and control method of the storage system should carefully be examined based on the capacity and characteristics of introduced type of renewable energy.