

**GROSS NATIONAL HAPPINESS COMMISSION
BHUTAN**

**Data Collection Survey
for Electric Vehicles Promotion
in Bhutan**

FINAL REPORT

**MAY 2016
JAPAN INTERNATIONAL COOPERATION
AGENCY
INGEROSEC CORPORATION**

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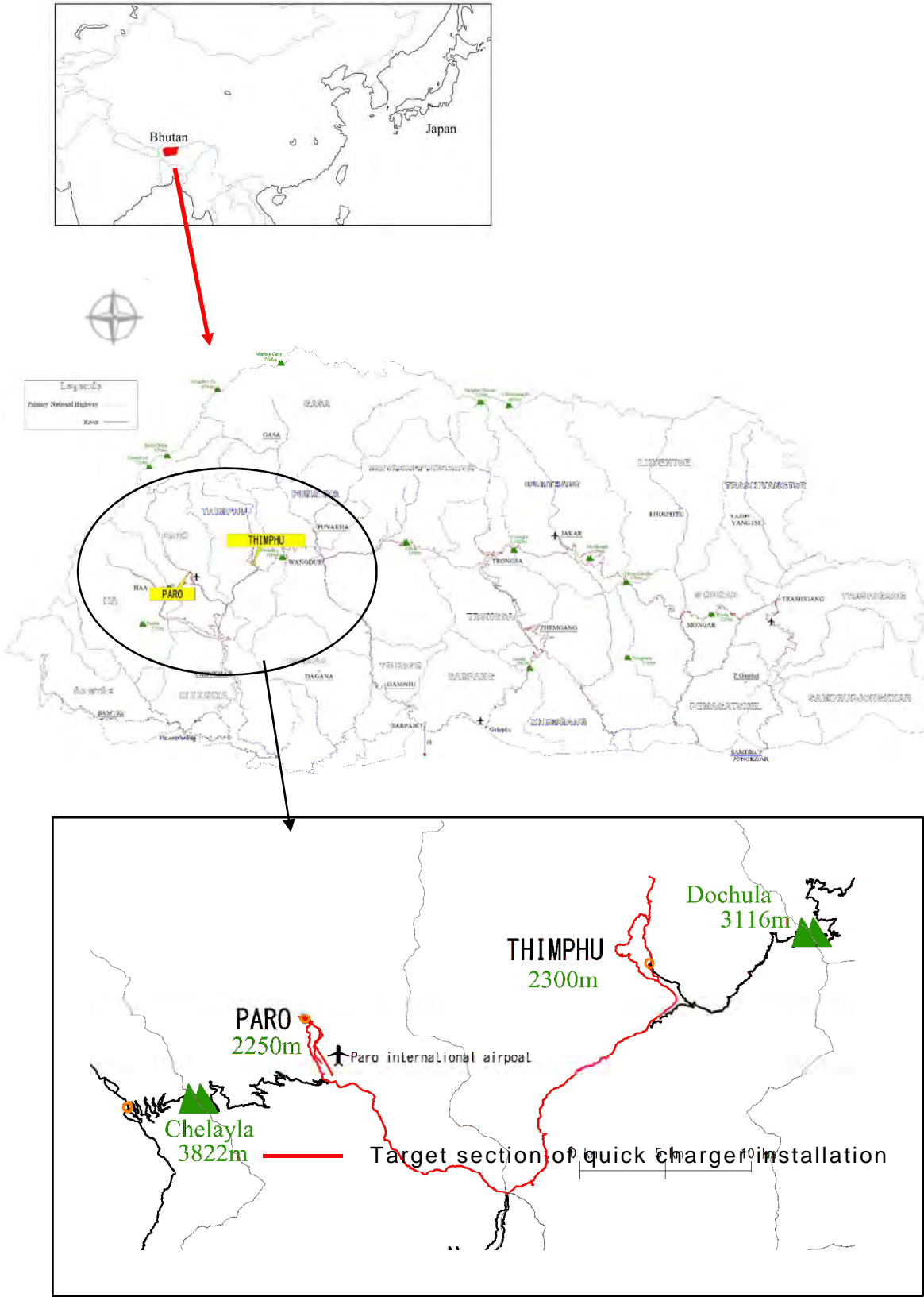
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Location Map



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Photo

	
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Chapter1 Overview of study

Chapter 1 Overview of the study

1-1. Background and purpose of the study

1-1-1 Background of the study

Vehicle roads were first built in the 1960s in Bhutan and vehicles were also introduced concurrently. Since that time, developing the road network has become a priority national issue in infrastructure development and a network totaling 8,000 kilometers has been built to date. The number of vehicles also rose steadily in line with the road network development, achieving a record increase of 10 to 12% a year during the period 1997 to 2012.

Meanwhile, this also triggered an increase in fossil fuel imports, which became a major cause of trade deficits. The fossil fuel import settlement value increased by 152% during the period 2008 to 2012 and accounted for 15% of all import value in 2012. The Royal Government of Bhutan (RGoB) raised the vehicle tax rate in 2011 to curb vehicle imports and prohibited all vehicle imports in May 2012 (which was lifted after the tax rate rose further in July 2014). However, there is a need to study intervention measures involving additional monetary policies and sustainable transportation modes as vehicle totals and fossil fuel imports continue to increase in line with active economic activities.

Given the above, Bhutan, with its abundant hydroelectric capacity, has noted the introduction and widespread use of electric vehicles (EV) as an option to curb fossil fuel imports and the RGoB has started to study various ways to promote this measure. It has already begun collaborating with automakers and introduced vehicle tax incentives. As of the end of March 2015, more than 50 EVs were registered. Conversely, the RGoB faces a number of challenges, which include the fact that EVs are far costlier than conventional gasoline vehicles and installation of quick chargers to guarantee stable long hours of driving and is requesting financial and technical support on EV promotion from international agencies and foreign governments. The Japanese government also received a request for such support at a summit meeting held in June 2014 and a proposal for the spread of EV in November 2014.

1-1-2. Purpose of the study

The purpose of this study is to identify issues to be addressed in introducing quick chargers required to help EV penetrate in Bhutan and study and propose solutions to such issues by collecting and analyzing existing information on quick chargers and trials for installing, operating and maintaining the equipment.

1-2. Approach to the study

This study was carried out according to the procedure shown in Figure 1-1.

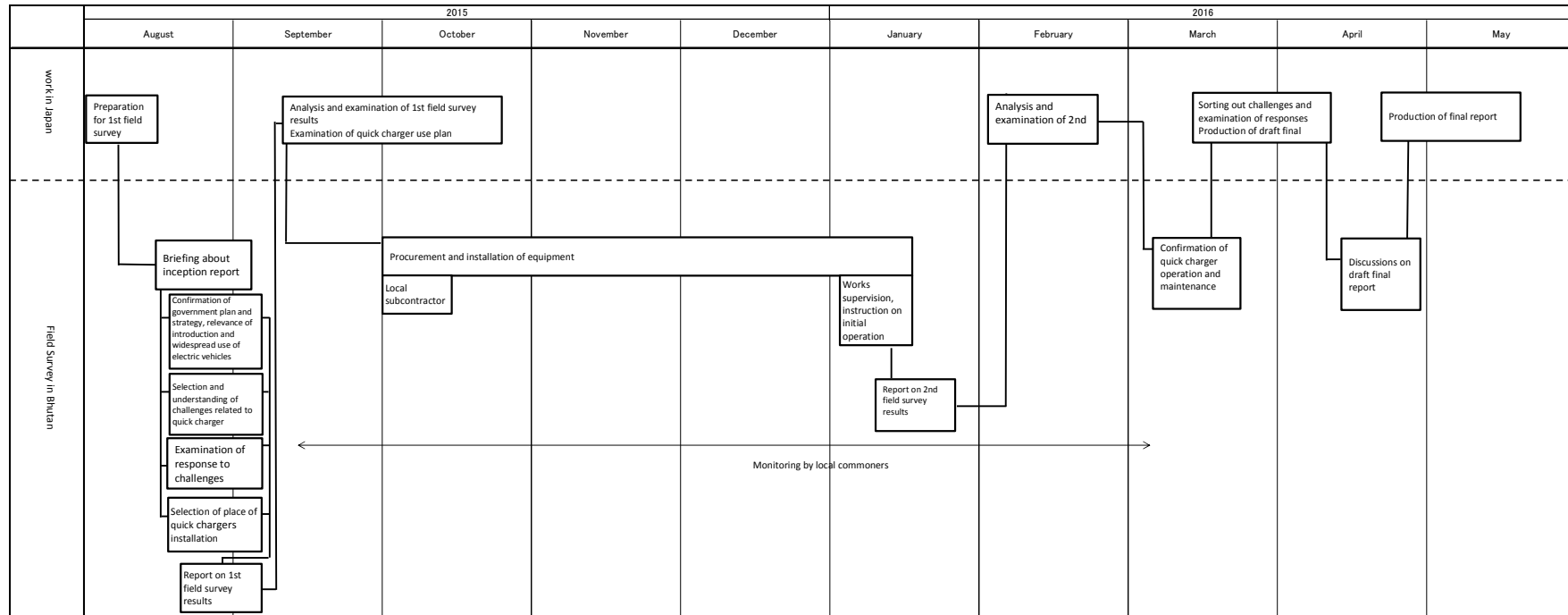


Figure 1-1 Flowchart of the study

1-3. Composition of the study team

This study was conducted by the team members shown in Table 1-1.

Table 1-1 Composition of the study team

Assignment	Name	Corporation
Management / Clean development policy	Tadanori KUMANO	Ingerosec Corp.
Equipment development plan / Procurement plan / Organization	Mitsuhide SAITO	Ingerosec Corp.
Electric installations / Operation and maintenance	Tomohiro ISOBE	Toenec Corp.
	Masaya UEDA	Toenec Corp.

1-4. List of Major Contact Persons of Related Agencies

- 1) GNHC: Gross National Happiness Commission)
 - Mr. Thinley Namgyel : Director
 - Mr. Lhaba Tshering : Chief Planning Officer
 - Mr. Nyingtob Pema Norbu : Senior Planning Officer
 - Ms. Kuenzang K Sangey : Deputy Chief Program Coordinator
- 2) MoIC: Ministry of Information and Communication)
 - Mr. Sonam Dhendup : Deputy Chief Program Coordinator
- 3) RSTA: Road Safety and Transport Authority
 - Mr. Boning : Senior motor vehicle inspector
 - Mr. Tashi Penjor : Senior motor vehicle inspector
- 4) Thimphu City Corporation
 - Mr. Kinlay Dorjee : Thrompon (Mayor)
- 5) NLC: National Land Commission
 - Mr. Rinebeu Jamtsho : Assistant Land Registrar
- 6) BPC: Bhutan Power Corporation
 - Mr. Ujjwal Deep Dahal : Sr. Manager, System Operator
 - Mr. Ugyen Dorji : Regional Manager Thimphu
 - Mr. Tshewang Rinzin : Officiating Regional Manager Thimphu
- 7) Bhutan Post Office
 - Mr. Karma Wangdi : CEO/MD

- Mr. Jigme Tenzin : Manager, Postal Operation
- Mr. Tashi Phuntsho : Manager, Finance Division
- Mr. Yasuda Chhebi : Manager, Finance Division
- 8) UNDP: United Nations Development Programme
 - Mr. Nawaraj Chhetri : Portfolio Manager
- 9) Thunder Motors (Nissan Motors Dealer)
 - Mr. Tashi Wangchuk : Chief Executive Officer
 - Ms. Kelzang Lhaden : Chief Operations Officer
- 10) Dah Chzen Motors (Mitsubishi Motors Dealer)
 - Mr. Namdrul Gyamtsho : General Manager
- 11) Neo Engineering (Installation Work Contractor of Quick Chargers)
 - Mr. Yeshey Dorji : CEO
- 12) Thimphu Home Care (Operation and Maintenance Contractor of Quick Chargers)
 - Mr. Tandin Nidup : CEO
- 13) JICA Bhutan Office
 - Yumiko Asakuma : Chief Representative
 - Shyo Takano : Representative
 - Tomoko Miyata : Project Formulation Adviser

Chapter2 Efforts to spread EV

Chapter 2 Efforts to spread EV

2-1 Sorting out priority plans

The EV promotion is dealt with in a priority plan under the Bhutan development plan shown below.

2-1-1 11th Five-Year Plan (2013-2018)

Under the basic philosophy of Gross National Happiness (GNH), Bhutan pursues its development plans based on the four pillars of “equitable and sustainable socio-economic development,” “the conservation and promotion of cultural heritage,” “the preservation and sustainable use of the environment,” and “good governance.” Currently, under the Eleventh Five-Year Plan (2013-2018), the country is targeting “an autonomous, comprehensive, and green socio-economic development.” In the transport sector, the plan targets the promotion of EV as an alternative mode of transport to address environmental issues and reduce dependency on fossil fuels and mentions how it is striving for the introduction of electric taxis.

2-1-2 National communication to the UNFCCC

Bhutan’s second national communication, which was submitted in 2011 to the Secretariat of the United Nations’ Framework Convention on Climate Change (UNFCCC), also featured the introduction of EV as a measure to mitigate transport sector problems. It states that the introduction of EV that utilizes the country’s abundant and cheap hydropower is a viable medium-term option. It also states that, with EV developing worldwide, introducing tax incentives on purchases would help effectively promote EV in Bhutan and that implementing additional policies and measures would help further promote these vehicles. It further underlines that, as EV prevail nationwide, demand for a domestic maintenance system, measures for disposal or recycling of batteries, etc. will also grow.

2-2 Planning and strategy of the EV promotion of the RGoB

At the Regional Environmentally Sustainable Transport (EST) Forum in Asia, the Bhutanese government presented a pilot project to introduce EV and demonstrated its efforts towards zero emissions to the international community. As the pilot project goals, the presentation set out achieving zero emissions in the transport sector, making Thimphu a clean electrified capital and reducing the import of fossil fuels. In addition, as a means of promoting EV, the government seeks to define affordable pricing, provide financial incentives, develop an environment enabling penetration, develop capacities and promote the assembly and production of EV in Bhutan.

Further, while studying and implementing measures to encourage the use of EV with tax incentives for purchases, discourage the use of conventional gasoline vehicles with high tax rates and relax regulations on EV imports, etc., Bhutan requests Japan and other donor countries

to help it promote EV.

In addition to these measures, promoting EV will also require Bhutan to develop an environment favorable to spreading them, such as charging facilities enabling long-distance and stable running.

According to the Bhutanese government, official policies/plans for specific subjects remain under development. Despite tax exemption in place, however, subsidies for EV, including QCs remain under examination. As for used EV imports, despite various discussion in the media and in parliament, the government decided in 2014 to authorize the import of used Nissan Leafs in good condition and not exceeding 30,000 km mileage on the clock¹.

Table 2-1 Vehicle tax rate and reference price

Type of vehicle	Nissan LEAF (EV)	Mitsubishi OUTLANDER (PHEV)	MARUTI Alto (ICEV)
Tax rate	0%	55%	120%
Reference price (Nu)	1,500,000	4,030,000	500,000

Source: Interviews with local automobile dealers

Note 1: PHEV (Plug-in Hybrid Electric Vehicle), ICEV (Internal Combustion Engine Vehicle)

Note 2: 1Nu≐0.015USD (as of April 2016)

2-3 Status of spread

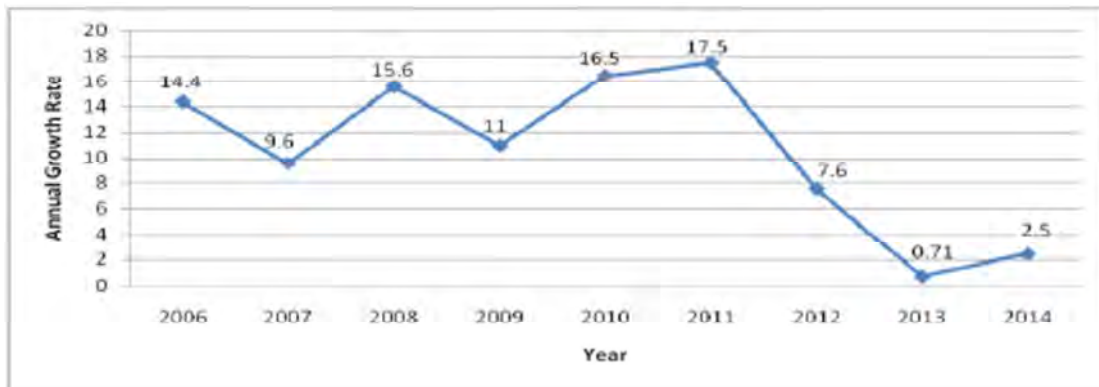
2-3-1 Status of EV

As of March 2016, 52 Nissan Leaf vehicles had been introduced in Bhutan, including 13 for government officials and 39 for general users, most of which in Thimphu. Among the vehicles for general users, four were used cars and are now used as taxis. Indian EVs (Mahindra 19 units) have also been introduced into Thimphu City Corporation, etc. Nissan and Mahindra entered into MoU with Bhutanese government, targeting market penetration.

According to the statistics of the RSTA (Road Safety and Transport Authority), the percentage of electric cars as a proportion of the total of Light Vehicles is about 0.17%. As shown in Figure 3-1, the average growth rate for the number of registered vehicles in Bhutan over the past nine years has been about 10.6%. If the total of electric cars increases at the same rate, the increase should be no more than 7-8 units per year. In particular, an increase in EV seems unlikely based on the slowdown in recent years on the increased number of registered vehicles.

Conversely, RGoB currently is advancing the development of the main highway, which is expected to spark an increase in the number of motor vehicles as well as benefiting EV promotion.

¹ http://www.nationalcouncil.bt/assets/uploads/docs/download/2015/Final_Policy_review_on_Electric_cars.pdf



Source: Road Safety and Transport Authority report 2015

Figure 2-1 Annual Vehicle Growth Rate, 2006-2014

Local newspapers have reported complaints from electric taxi drivers that the actual mileage per charge was much shorter than they were told (175km with full charge)². We thought that this was because Bhutan was an undulating country with significant differences in altitude and the fact that shared taxis often ran loaded full to capacity. To clarify matters, the study team conducted actual driving tests in the city of Thimphu and between Thimphu and Paro. The result shows that in the city of Thimphu with many ups and downs, mileage is 1.67 times more than the actual distance while between Thimphu and Paro, with fewer undulations, mileage was 1.16 times more than the actual distance. The result is shown in 3-2.

2-3-2 Status of charging facilities

Home chargers are available at almost every EV owner's residence, the airport parking lot and some governmental agencies and corporations.

At the start of this study (August 2015), the only QC available in the country was one at a Nissan dealer. The use of the QC was restricted to once a day for taxis. It was barely used after we installed a pilot QC and offered free charging. Subsequently, the dealer installed a single QC to Paro International Airport Parking, which is currently available and free of charge (as of April 2016, the installation fee and electricity charges have been born by the Civil Aviation Bureau). The dealer owns another four QCs and is considering the locations and power supply with QC installation in mind.

As shown in Chapter 4, a total of four QCs have been installed as a pilot project of this study, operation of which started from February 2016.

² KUENSEL as of June 10, 2015

2-4 Assistance by other aid agencies

At the time of this study, there were no specific projects being carried out by other aid agencies for EV promotion, although some agencies were researching and examining the issue.

2-4-1 World Bank (WB)

The World Bank studied the introduction of EV and compiled a comprehensible report in June 2015 on the EV initiative, its economic effects, charging facilities and a comparison with countries that preceded the introduction of EV, etc. The report presents three scenarios of how to spread EV depending on the degree of promotion, the outline of which was reported by local papers.

The different scenarios for EV spread are calculated depending on the varying probabilities at which people choose EV when replacing their current vehicles, assuming that people will newly introduce about 80, 250 and 1,000 EVs every year, respectively, boosting the number of EVs in the country to 500, 1,500 and 6,000 vehicles respectively by 2020. The report further highlights the fact that, as EV spread nationwide, the need to install ordinary and QCs will grow.

2-4-2 United Nations Development Plan (UNDP)

The RGoB is preparing to apply financial assistance to the Global Environment Facility (GEF) through UNDP. The scope of the request would include subsidiary to promote EV introduction, while details of the amount of subsidy and the number of taxis are to be further examined.

2-4-3 Bilateral assistance trends in recent years

No assistance has been provided by bilateral donors for EV initiative.

2-5 Validity and significance of EV promotion

Based on the various points mentioned in Chapter 2, the validity and significance of the EV promotion policy was confirmed by the following perspectives:

2-5-1 Environment aspects

The promotion policy of EV is reasonable and consistent with the priority plan, as shown in 2-1. In addition, there is also scope to reduce fossil fuel, given abundant hydroelectric power in the background, while reducing air pollution will also reduce carbon dioxide emissions, for example.

2-5-2 Financial and economic aspects

If EV are widely introduced, the import value of automobiles would increase, yet the fuel

import volume would reduce. According to Bhutan Trade Statistics, fuel accounts for about 10% of the total import value of Bhutan where import surplus is a serious challenge. Based on the positive fiscal and economic effect obtained, the EV promotion policy is considered reasonable and significant.

2-5-3 Political and policy aspects

The RGoB targets “autonomous, comprehensive and green socio-economic development,” in the development plan. The RGoB has adopted a position whereby the state engages in environmental considerations. In addition, the RGoB engages in tourism promotion, with “untouched nature⁴” a major selling point and underlining its image as an environmental protection state. Under such circumstances, the EV promotion policy, which is environmentally friendly, can be expected to help maintain and improve the national image.

2-5-4 Technical aspects

There are EV dealers in Bhutan, through which spare parts are available. Conversely, there is no effective maintenance system capable of ensuring proper spare parts replacement and repair, given the lack of technicians. Since the roll-out of EVs is only just getting underway, situations where maintenance is required, such as repairs, do not occur. However, as maintenance is expected to become necessary over time, there is a need to develop a system which ensures the pleasant use of EV.

For QC, in this pilot project, installation work has been carried out with supervision of Japanese experts. Also, based on the initial operational guidance provided, including maintenance, technicians could learn about its technique and knowledge to some extent.

⁴ http://www.travel-to-bhutan.jp/where_to_go

Chapter3 Implementation of the pilot project

Chapter 3 Implementation of the pilot project

3-1. Issues and proposed solutions to develop QC stations

Before installing the QC stations, the following items were examined.

Table 3-1 Items examined before installing QC stations

Item	Method	Result
Natural conditions (altitude, climate, etc.)	Weather data	Obtained the data through the GNHC and reflected them in the specifications of the equipment.
Relevant laws, regulations, and systems (Ownership and management of the station, collection of charge, etc.)	Inquiry to relevant government agencies	There is no specific legislation on QC stations. For the pilot project, the government (GNHC) owns equipment, operation and maintenance work is outsourced. Electricity for charging is free of charge.
Conditions relevant to power supply (supply and demand, transmission and distribution standards, existing facilities, power supply connection work)	Inquiry to Bhutan Power Corporation	Possible impact of QCs on grid system, protection of QC from lightning, and power supply connections were examined.
QC installation ancillary works (buildings, etc.)	Inquiry to Bhutan Power Corporation	Need of a warehouse for each installation site was examined.
Conditions relevant to implementation system (functions and roles of related organizations, installation and maintenance of equipment (availability, organizations, and members' ability of private contractors), etc.)	Discussion with government agencies or inquiry to private companies, etc.	Tentative implementation structure for procurement and installation of QC was built up through meetings with the EV Task Force of RGoB. Nomination of designated implementation agency and establishment of O/M structure are required for further discussion within RGoB.

3-2. Use of QC stations

To determine how the stations should be used, the following points were checked:

Table 3-2 Points checked before planning the use of the QC stations

Item	Method	Result / Future action
Collect and analyze information on plans and strategies of the Bhutanese government for introduction and promotion of EV	Interviews with government agency officials, verifying information collected in preliminary literature research	With interviewing GNHC, it was confirmed that official policies and plans remained under preparation and that apart from an EV sales tax exemption, incentives such as subsidies including those for QCs, are under examination.
Understand the extent of EV penetration in Bhutan	Inquiring to local agencies	With an interview to Thunder Motors, the number of EVs sold was obtained.
	Questionnaire survey among EV users	Conducted a questionnaire survey among EV taxis and other users
	On-site driving test	Conducted a driving test on Saturday, September 5, 2015 with an EV taxi
Collect information from existing documents and relevant organizations concerning prospects of future traffic conditions, number of vehicles registered, etc. required for the EV demand forecast	Literature search	From several sources
	Checked the number of vehicles registered with the Road Safety & Transport Authority (RSTA)	From the web site of RSTA
	Questionnaire survey among users	Conducted a questionnaire survey among EV taxis and other users
Check past support programs and future plans by other aid agencies for introduction and spread of EV	Collected information through a literature research, inquiry to other aid agencies, etc.	Obtained the WB report through GNHC. Inquiry to UNDP officials

3-2-1. Questionnaire survey

The following questionnaire survey among EV taxi drivers and other users was conducted:

1) Method

▪ EV TAXI DRIVERS

The Study Team directly interviewed 4 EV taxi owners.

▪ Other EV users

The questionnaire was distributed to 41 other EV users from home charger installation contractors. 16 responses were received (response rate of 39%).

2) Results

The survey results were as follows:

Q1: How often do you drive your electric vehicle?

- EV TAXI DRIVERS: 7 Times/week
- Other EV users: 5 - 7 Times/week

Q2: How far do you drive your electric vehicle per outing?

- EV TAXI DRIVERS: 70 - 150 km
- Other EV users: 30 - 50 km

Q3: How often do you charge your electric vehicle at your home?

- EV TAXI DRIVERS: 7 - 14 Times/week
- Other EV users: 3 - 7 Times/week

Q4: If there were a quick charge station, where do you think it would be best located?

- EV TAXI DRIVERS: Thimphu core area, Paro Airport
- Other EV users: Thimphu, Puntling, Paro, Paro Airport, Punakha

Q5: If there was a quick charge station, would you pay to use it?

- EV TAXI DRIVERS: Yes (if 50Nu or less per charge)
- Other EV users: Yes

Q6: Would you consider an electric vehicle for your next vehicle or an additional vehicle?

- EV TAXI DRIVERS: Yes and No evenly divided
- Other EV users: Yes and No evenly divided

Q7: How far would you want the range of an electric vehicle to be per charge?

- EV TAXI DRIVERS: 70 - 120km
- Other EV users: 200 - 300km

3-2-2. Actual driving test

Presuming that mileage per charge varied according to running conditions (differences in elevation, running speed, road gradient, loading weight (shared taxis - Thimphu taxis often run fully loaded)), the study team ran EV taxis in two modes, one in and around the city of Thimphu via different elevations and the other on the well-maintained road between Paro and Thimphu with fewer undulations and determined how far they could travel on one charge, etc. as data to help determine where to install QC stations, etc. For the tests, the study team used taxis as the most probable QC users.

- Purposes of the test: To actually drive an EV and check its cruising distance
- Date of the test : Saturday, September 5, 2015; Weather: cloudy

- Test routes : As a test route in the city of Thimphu, the study team chose a mainly uphill course for the outward journey and mainly downhill for the return. Further, considering that we plan to install a QC station at Paro Airport, we selected three more routes, including the town of Paro.
 - Route 1: Clock Tower Square (altitude: about 2250m) - Motithan district (altitude: about 2370m)
 - Route 2: Clock Tower Square (altitude: about 2250m) - Golden Buddha (altitude: about 2544m)
 - Route 3: Clock Tower Square (altitude: about 2250m) - Paro International Airport (altitude: about 2172m)
- Test method: Under each test condition, check the cruising distance of the EV taxi by recording the distance actually run and the cruising distance displayed on the vehicle at the start and end of the journey.
- Test conditions

Routes 1 and 2 were tested under the following conditions:

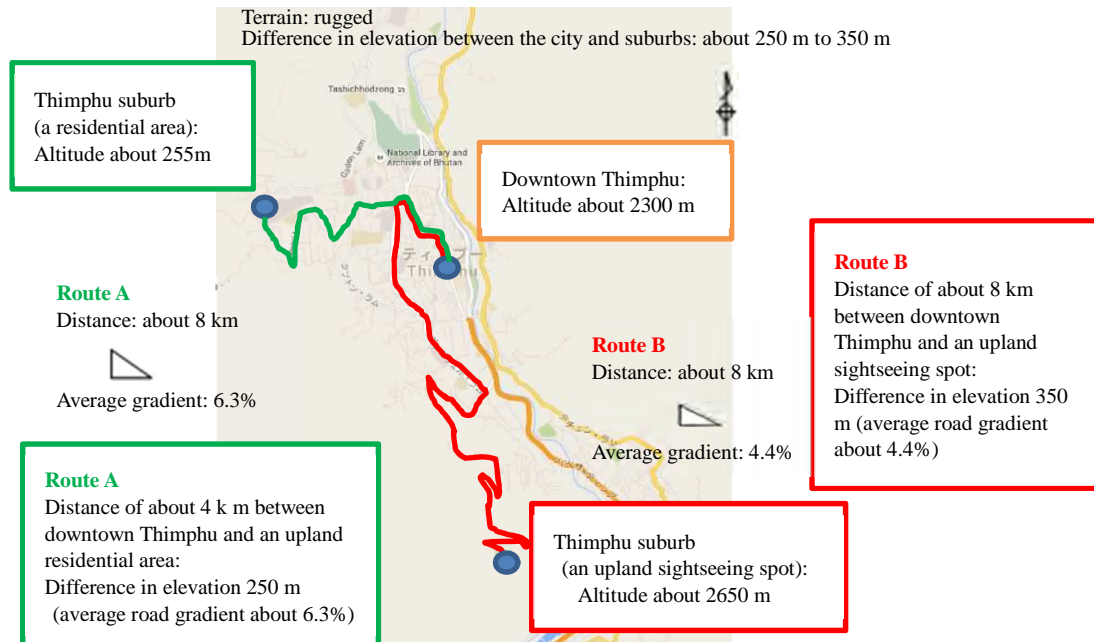
 - First trip : A round-trip with the driver and one passenger onboard.
 - Second trip : A round-trip with the driver and three passengers onboard
 - Third trip : A round-trip with the driver and three passengers onboard, with the air-conditioner blasting

Route 3 was tested under the following conditions, but only in one trip considering that no QC was available at Paro Airport:

 - Journey outward: With the driver and one passenger onboard.
 - Journey back : With the driver and one passenger onboard, with the air-conditioner blasting

The results of the actual driving tests were as shown in the table below (km).

Actual Driving test areas 1



Actual Driving test areas 2

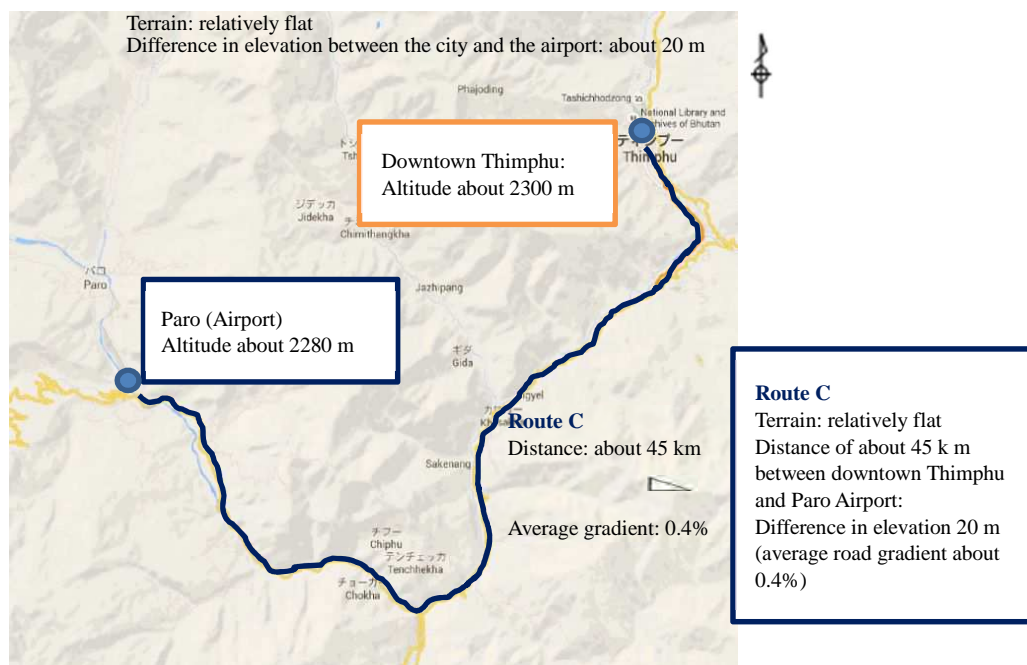


Figure 3-1 Actual driving test areas

Table 3-3 Results of the Actual driving tests

		First trip		Second trip		Third trip	
		actual distance	cruising distance	actual distance	cruising distance	actual distance	cruising distance
Routes 1	Clock Tower	667	106	673	99	679	89
	distance 3km		($\Delta 20$)		($\Delta 26$)		($\Delta 37$)
	Motithan	670	86	676	73	682	52
	distance 3km		(+13)		(+16)		(+24)
	Clock Tower	673	99	679	89	685	76
Routes 2	Clock Tower	685	69	697	67	710	48
	distance 7km		($\Delta 55$)		($\Delta 37$)		($\Delta 62$)
	Golden Buddha	692	41	704	30	717	16
	distance 6km		(+26)		(+18)		(+12)
	Clock Tower	697	67	710	48	723	28
Routes 3	Clock Tower	440	146	—	—	—	—
	distance 44km		($\Delta 49$)	—	—	—	—
	Paro International Airport	484	97	—	—	484	103
	distance 47km	—	—	—	—		($\Delta 57$)
	Clock Tower	—	—	—	—	531	46

Figures in parentheses show the differences in cruising distance before and after the journeys.

3-3. Installation of QC stations

3-3-1 Selecting sites

According to a basic policy of choosing the candidate installation sites from the city of Thimphu, the town of Paro (at the airport) and between Thimphu and Paro (Chunzom), the study team proposed a total of seven locations as shown below to GNHC, considering the following:

- Select some candidate pilot sites considering the ease of maintenance and management, convenience for target users, publicity effect for the spread of EV, etc.
- Select sites without any hindrances related to land acquisition, installation permit, installation work, etc., or if any, with those which the Bhutanese government may certainly clear by the time of installation.
- Take into consideration the 20 sites listed in the World Bank report.
- Avoid six locations presented by the local automobile dealer (Thunder Motors), where they would install chargers.
- Examine safety measures (electric leakage, electric shock, fire, etc.) and crime prevention measures required.

The list of candidate sites selected and the QC installation is as shown in the following chart:

Table 3-4 Status of the candidate sites selected (as of September 2015)

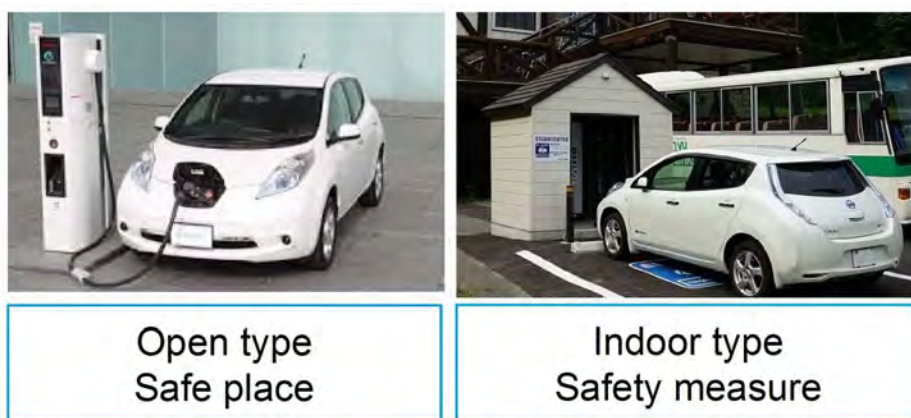
Promotor/No.	Location	Status	Convenient access for the target user					Land acquisition		Power supply	Space	Access	Safety	Team
			Government	Public	Private	Tourism	Taxi Driver	City/Public	Private					
Thimphu										Close to the Transformers				Propose
Thunder Motors 1		Installed and Operating Aug 2015												
Thunder Motors 2	Next to BPC station near Sunday Market	Land lease contract to be signed		○	○		○	○		○	○	○	indoor	
JICA T1	Road parking area near Clock Tower	NIL		○	○			○			○	○	indoor	
JICA T2	Near Bhutan Post Office	NIL	○	○	○			○			○	○	indoor	○
WB Report (identified by Thimphu Thromde)	1. Simtokha lap - Bus Terminal (near Damchen Petroleum)	NIL		○	○			○		X	X	X	indoor	
	2. Lungtenphu lap (near Chang Plaza)	NIL		○	○			○		○	○	X	indoor	
	3. Changjui Colony. this has ample parking facilities where multiple connections charging stations can be installed.	NIL		○				○		○	△	X	indoor	
	4. Changzamtoe below school near Telecom tower	NIL	○	○	○			○		○	○	○	indoor	○
	5. Memorial Chorten (off-street parking)	NIL	○	○	○	○	○	○		○	○	○	indoor	○
	6. NMPF colony	NIL	○		○			△	△	X	△	○	indoor	
	7. Core area - MLCP site 2 (below Imtrat)	NIL	○		○		○	○		○	△	△	indoor	
	8. Core area - Changlam (opposite Jolo)	NIL		○	○	△	○	○		○	△	○	indoor	○
	9. Core area - MLCP site 1 (Zangtogepele complex)	NIL			○		○	○		○	△	○	indoor	
	10. Core area - Milkbooth (off-street parking)	NIL	○	○	○		○	○		△	○	○	indoor	○
	11. Core area - Veg. Market area- near BT's one stop shop	NIL		○	○		○	○		○	○	○	indoor	TM
	12. Core area - Near TT's plant nursery		—	—	—	—	—	—	—	—	—	—	—	
	13. Near Thron Lam - within old UNDP colony area	NIL		○	○			○		△	△	○	indoor	
	14. Changangkha Lhakhang parking	NIL		○	○			○		△	○	△	indoor	
	15. Mothithang Lower - Above children's park next to the bus stop, undeveloped piece of land on the main road	NIL	○	○	○			○		○	○	△	indoor	
	16. Dzong area	NIL	○	○	○	○		○		△	△	△	indoor	
	17. Sententing Node	NIL		○	○				○	△	△	△	indoor	
	18. Langjophakha	NIL		○	○				○	△	△	△	indoor	
	19. Take an undeveloped dirt road location or about 100 m from the main road, a possible location in 2015 when the dirt road is changed to asphalt and connected to the new bridge to the west side	NIL		○	○				○	△	△	△	indoor	
	20. Dechencholing satellite town, roadside location with power connection close by, this is the northernmost location in Thimphu and could serve the area with about 10,000 people and villages above Thimphu with another 15,000 people	NIL		○	○				○	△	△	△	indoor	
Thimphu-Paro														
Thunder Motors 3	Chunsum	Location identified												
JICA T01	Chunsum	NIL		○	○	○	○	○		X (New Setting)	○	○	indoor	○
Paro														
Thunder Motors 4	Near airport gate (outside of the premises)	Permit/consent acquired, installation work to be launched in mid Sep												
JICA P1	Inside airport area/parking plot?	NIL	○	○	○	○	○	○		○	○	○	outdoor	○



Figure 3-2 Status of the candidate sites for QC installation

The survey team proposed a total of seven candidate locations (Table 3-5). The proposal was approved as candidate sites for the trial quick charger installation in the EV Task Force meeting, which was held on September 1, 2015, whereupon the survey team proposed taking the following conditions into consideration:

- Convenience for users: Sites should be easily accessible to government employees, public transportation, the general public, tourism industry members and taxi drivers, etc. In particular, answers of the questionnaire survey given by taxi drivers were reflected.
- Many roads are divided and with medians that force the driver to make a detour while coming to and returning from the station.
- Land: Site must be government-owned lots (If not, it would take too long and be too costly to acquire land from scratch).
- Power supply: There must be a existing power network and transformer with sufficient capacity nearby.
- Space: There must be a space allowing QC installation and vehicle parking.
- Safety measures are examined as to which open or indoor types are suitable for each candidate installation site.



After a joint on-site survey conducted by the relevant agencies and the study team on September 4, 2015, the parties agreed on the four sites shown below:

- Bhutan Post
- Memorial Chorten
- Chunzom
- Paro

We initially assumed the candidate site in Paro would be within the premises of the international airport, but changed to another location in the town for the following reasons:

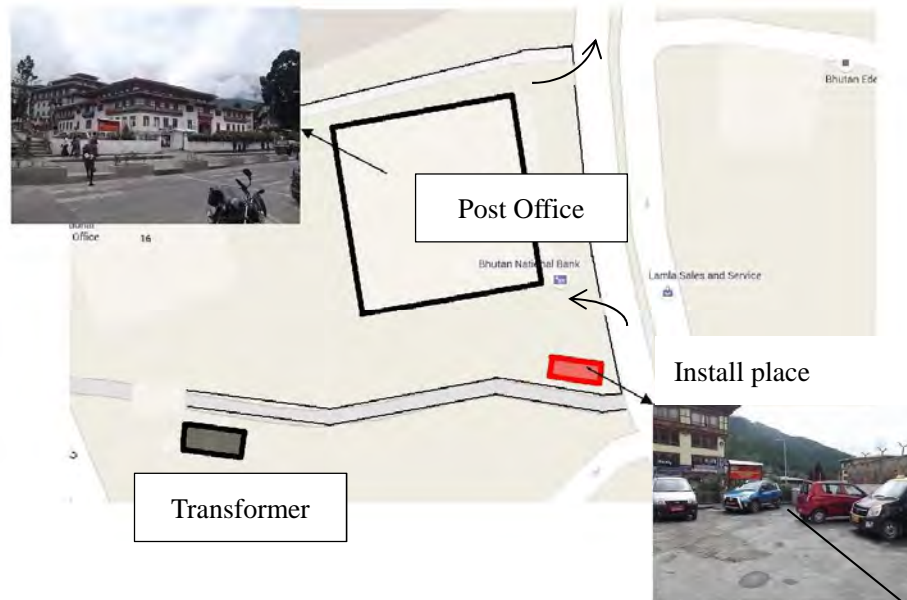
- (i) An inquiry to the airport authority revealed that they were planning overall renovation of airport facilities. More specifically, the renovation work will include relocating the airport entrance gate, extending the terminal and relocating the power reception and distribution stations, expansion of the parking space, etc. and it is very likely that relocation of the pilot QC will be required (The power supply to all airport facilities is controlled by these stations and, if they would be moved, the wiring and other electrical work for the QC should be required again).
- (ii) While exploring other candidate sites in the town of Paro, we inquired among many non-EV taxi drivers awaiting customers. Many said they would consider changing their vehicles to EV if a QC should be installed in the town.

Table 3-5 QC installation place proposed by the study team

	User (access)	Area	Power Supply	Safety
Bhutan Post office	◎ (better than Changlam)	○ Public land	○ Close to the Transformers	24h security Open type
Changzamtog	○	○ Public land	○ Close to the Transformers	Indoor type
Memorial Chorten	◎ (better than Changzamtog)	○ Public land	○ Close to the Transformers	Indoor type
Changlam	○	○ Public land	○ Close to the Transformers	Indoor type
Milkbooth	○	○ Public land	△ Not close to the Transformers	Indoor type
Chunzom	○	○ Public land	○ Close to the Transformers	Indoor type
Inside airport area	◎ (Available at using of airport)	○ Land for Airport	○ Close to the Transformers	Indoor type

Bhutan Post

Reason for selection: Convenient access, public land, close to transformers, accommodating two or three cars, 24h security



Memorial Chorten

Reason for selection: Convenient access, public land, close to transformers, accommodating two or three cars



Chunzom

Reason for selection: Convenient access, public land, close to transformers, accommodating two or three cars



Paro

Reason for selection: Convenient access, public land, close to transformers, accommodating two or three cars



3-3-2 QC specifications

Considering that most of the EVs currently circulating in Bhutan are Nissan Leaf, the study team chose CHAdEMO from among various international standards for the QCs to be installed in this project. Further, specifications for highlands types were considered, given that all the installation locations are above 2,000m in altitude. The draft specifications discussed and agreed upon with Bhutan Power Corporation and other relevant agencies are as follows:

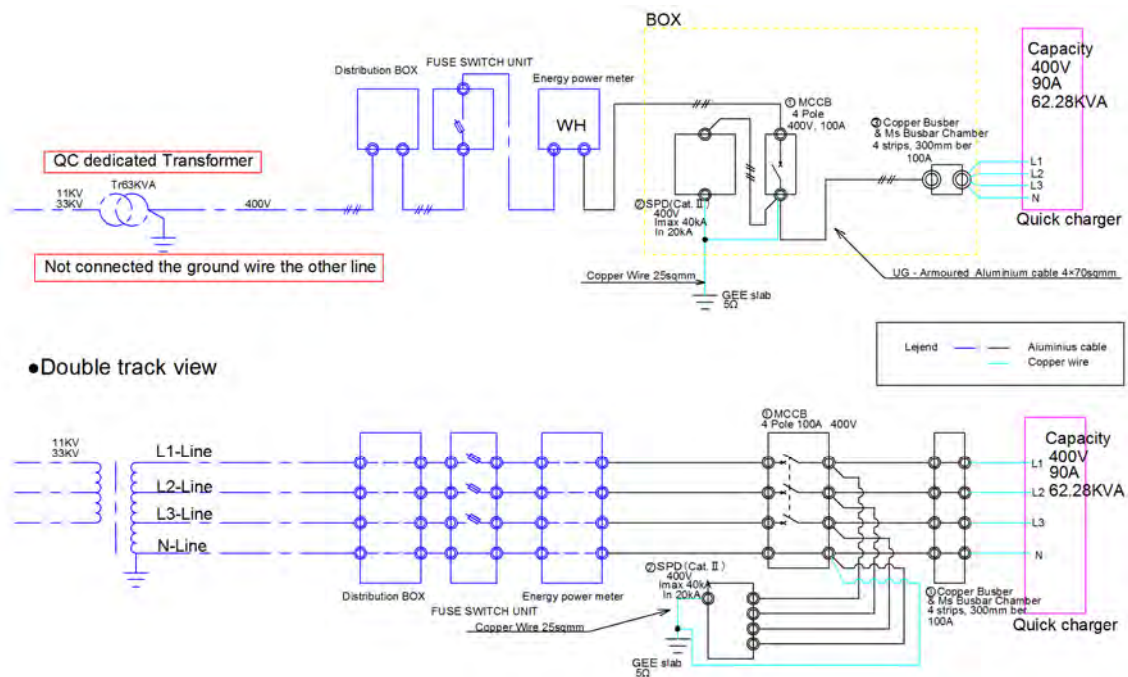


Figure 3-3 Wiring system diagrams

In response to a request from the Bhutanese side, the procurement of spare parts was included in the pilot project, which should be needed for regular maintenance of three years after installation (one cable with charging plug, one fan, and three filters). There was also a request to include a charging fee collection system, but it was agreed to keep it out of the scope, because it would be technically difficult to introduce this new system which would require an additional survey on communication systems, and to maintain such sensible systems as using cards for fee collection.

3-3-3 Status of installation work

It was initially assumed that the Bhutan Power Corporation would take charge for all the installation work (electrical and building construction work), but eventually it was

revealed that BPC would not be able to complete the work within due construction period of the pilot project. Accordingly, Bhutan Power Corporation was agreed to be responsible for the only receiving-side work including installation of transformers. Other works were outsourced to a local contractor, such as electrical connection work with a transformer and building construction work.

As for necessity for the hut to protect QCs against mischiefs and crimes, it was decided to construct a hut for each project site except for the Bhutan Post site which was monitored by 24-hour security guards and located next to a police station. While studying the building issue, some suggested to utilize abandoned kiosks (Chunzom and Paro), it was found this idea as not feasible for the reasons shown below.

- (i) The old kiosks have only small entrances and the doors could open inwards, so it would be required to destroy walls and replacing doors for installation.
- (ii) The old kiosks were built for election activities and shall be re-used in future on the same purpose

The QCs were installed on each site as follows:

Bhutan Post

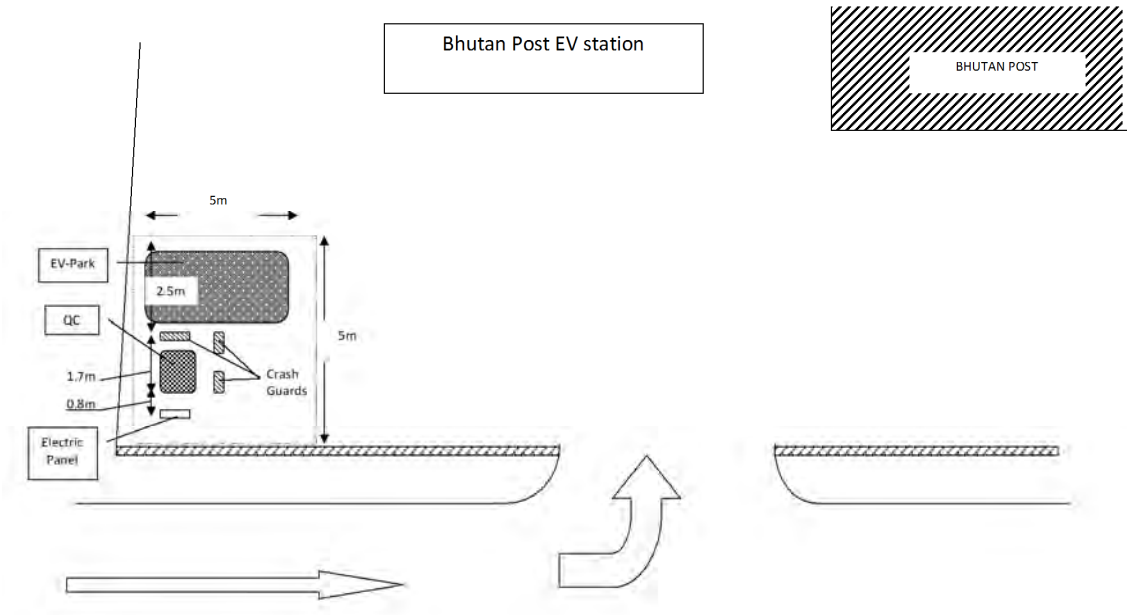


Photo	Note
	•Installation of Quick charger planned location.
Photo	Note
	•Foundation was completed. 1,000mm × 1,000 × 460mm

Photo	Note
	After painting of foundation.(Before to install QC.)
Photo	Note
	Setting of QC.
Photo	Note
	Setting of QC.
Photo	Note
	Fixing of QC to foundation.


Photo	Note
	QC was installed.(Front view)

Photo	Note
	QC was installed.(Side view)

Photo	Note
	Excavate for grounding.


Photo	Note
	Instalitaion of grounding. Salt,charcoal and soil were constructed around grounding panel in order.





Photo	Note
	Grounding was installed.
	Additional grounding panel. There should be needed below 5 ohms. but we could not get it so installed two additional grounding panels.(Total 4 panels)
	BPC measured grounding. (3. 17ohms) Finally got below 5 ohms.
	Position of BPC wiring. Cable is under the ground.(BPC)


Photo	Note
	Position of BPC wiring. Cable is under the ground.(BPC)


Photo	Note
	Condition of control panel.(For out side type)


Photo	Note
	Condition of wiring in control panel. Phase rotation is clockwise.

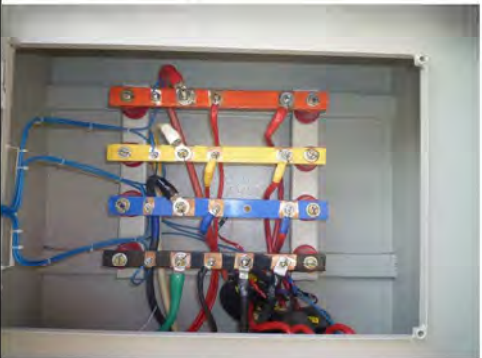
Photo	Note
	Condition of connecting.



Photo	Note
	<p>Condition of wiring in QC.</p>

Photo	Note
	<p>Wiring connection to ELCB.</p>

Memorial Chorten

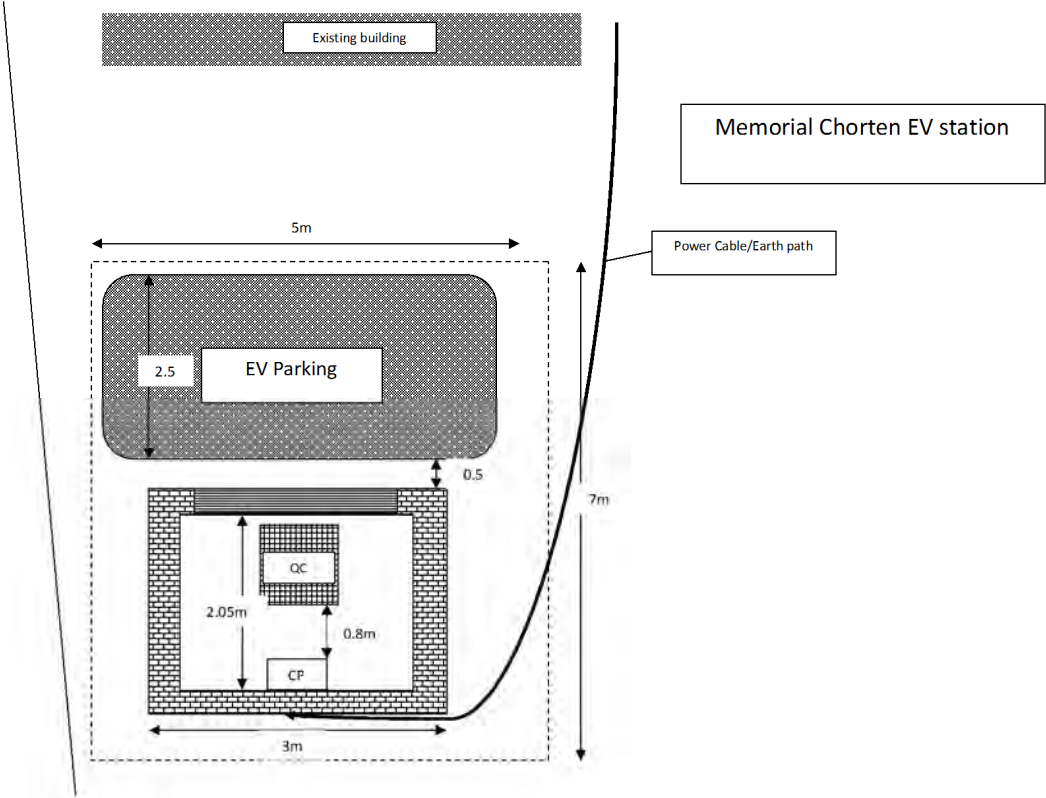




Photo	Note
	•Installation of Quick charger planned location.
Photo	Note
	•Foundation was completed. 1,000mm × 1,000 × 530mm


Photo	Note
	After fill up around foundation.


Photo	Note
	After painting of foundation (Before to install QC.)


Photo	Note
	Setting of QC.


Photo	Note
	Setting of QC.


Photo	Note
	Fixing of QC to foundation.

Photo	Note
	QC was installed.(Front view)


Photo	Note
	QC was installed.(Side view)

Photo	Note
	Excavate for grounding.





Photo	Note
	Instalitaion of grounding. Salt,charcoal and soil were constructed around grounding panel in order.
	Grounding was installed.
	Additional grounding panel. There should be needed below 5 ohms. but we could not get it so installed an additional grounding panel.
	BPC measured grounding. (4. 6 ohms) Finally got below 5 ohms.


Photo	Note
	Grounding plate(Representative plate) GI plate(Galvalume steel plate) Wiring also GI strip 175sq.


Photo	Note
	Condition of control panel


Photo	Note
	Condition of wiring in control panel. Phase rotation was opposite from substation. Changed wiring RED and WHITE.

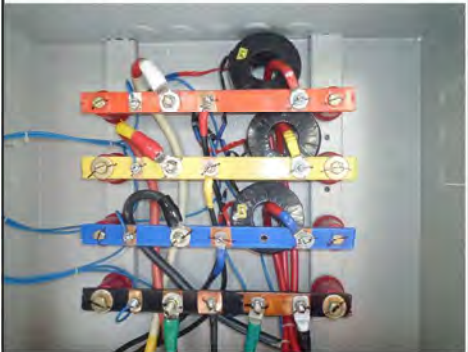
Photo	Note
	Condition of connecting.


Photo	Note
	Condition of wiring in QC.


Photo	Note
	Wiring connection to ELCB.

Photo	Note
	Meeting for installation of QC.





Photo	Note
	Guidance situation.

Photo	Note
	Guidance situation.
Photo	Note
	After installation
Photo	Note
	Members of Maintenance Training

Chunzom

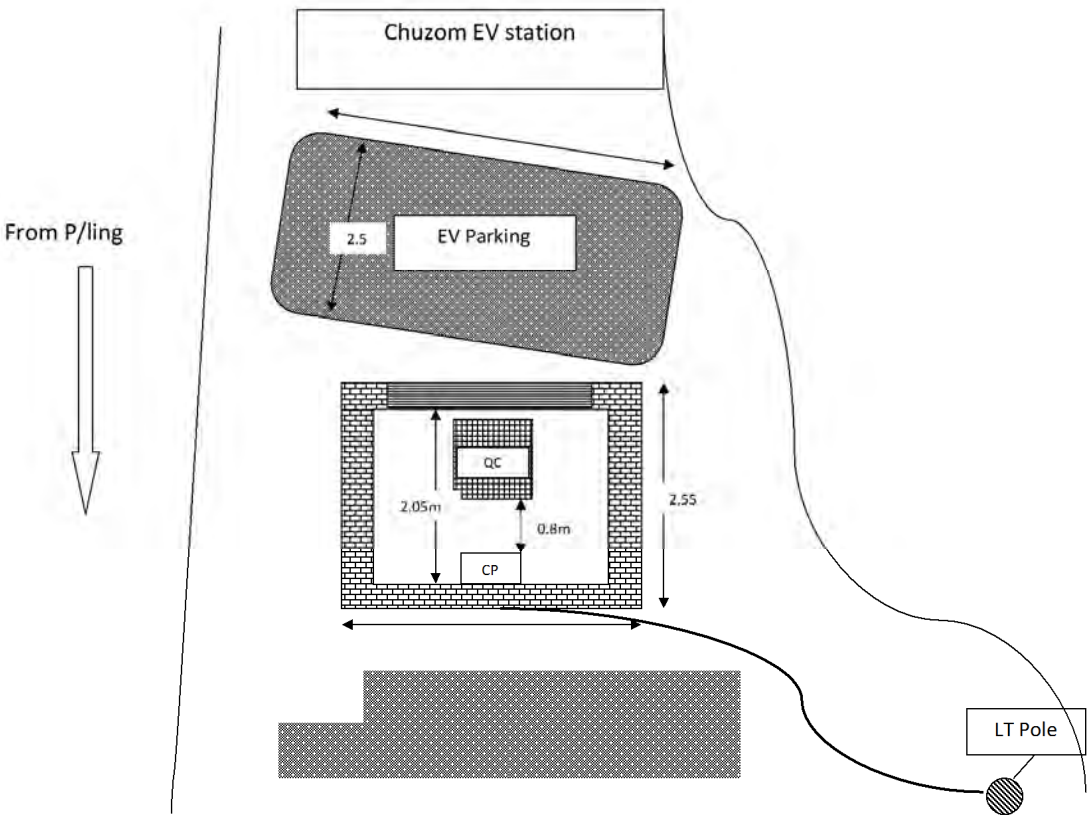


Photo	Note
	•Installation of Quick charger planned location.
Photo	Note
	•Foundation was completed. 1,000mm × 1,000 × 465mm


Photo	Note
	After painting of foundation.(Before to install QC.)
Photo	Note
	Setting of QC.
Photo	Note
	Setting of QC.
Photo	Note
	Fixing of QC to foundation.

Photo	Note
	QC was installed.(Front view)
	QC was installed.(Side view)
	Grounding was installed.
	BPC measured grounding. (1. 64ohms) Finally got below 5 ohms.


Photo	Note
 An aerial photograph showing a river valley. A red line is drawn across the middle of the image, indicating a substation location. The surrounding area is dry and hilly, with some buildings visible in the background.	Substation


Photo	Note
 An aerial photograph showing a river valley. A red line is drawn across the middle of the image, indicating the installation of wiring by BPC. The surrounding area is dry and hilly, with some buildings visible in the background.	Installation of wiring by BPC.


Photo	Note
 An aerial photograph showing a river valley. A red line is drawn across the middle of the image, indicating the installation of wiring by BPC. The surrounding area is dry and hilly, with some buildings visible in the background.	Installation of wiring by BPC.




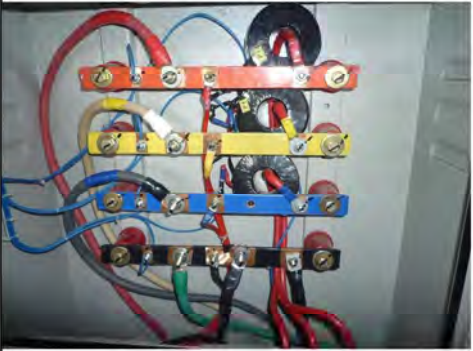

Photo	Note
 A close-up photograph of an electric pole. A red line is drawn across the middle of the image, indicating the connection point of the electric pole. The surrounding area is dry and hilly, with some buildings visible in the background.	Connection point of electric pole.

Photo	Note
	Condition of control panel.
	Condition of wiring in control panel. Phase rotation is clockwise.
	Condition of connecting.
	Condition of wiring in QC.

Paro

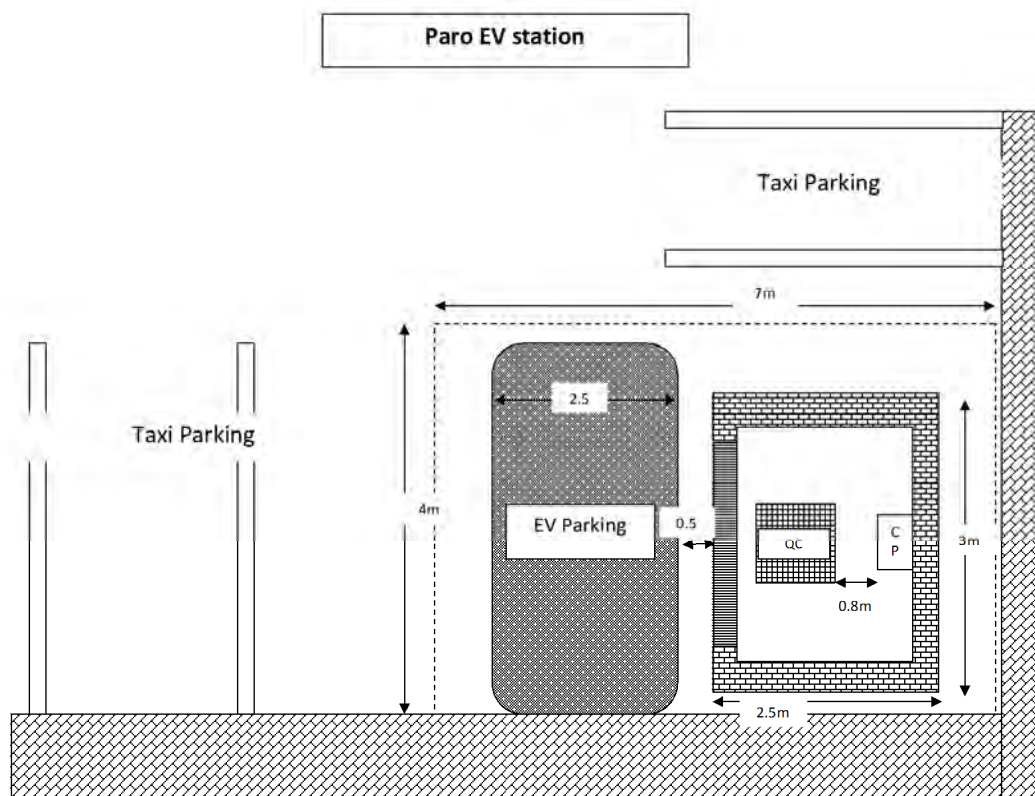


Photo	Note
	<ul style="list-style-type: none"> •Installation of Quick charger planned location.


Photo	Note
	<ul style="list-style-type: none"> •Foundation was completed. 1,000mm x 1,000 x 460mm


Photo	Note
	After painting of foundation.(Before to install QC.)


Photo	Note
	Setting of QC.


Photo	Note
	Setting of QC.

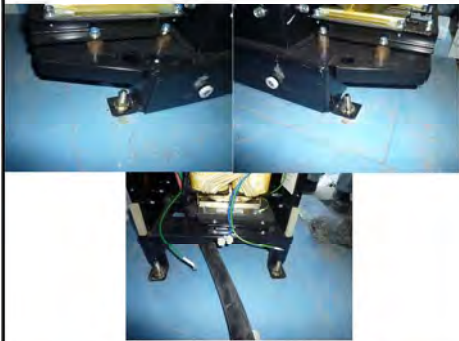
Photo	Note
	Fixing of QC to foundation.

Photo	Note
	QC was installed. (Front view)

Photo	Note
	QC was installed. (Side view)


Photo	Note
	Grounding was installed.


Photo	Note
	BPC measured grounding. (4. 09ohms) Finally got below 5 ohms.


Photo	Note
	Substation

Photo	Note
	Installation of wiring by BPC.


Photo	Note
	Installation of wiring by BPC.

Photo	Note
	Installation of wiring by BPC.




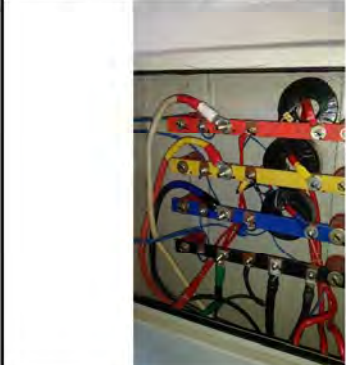

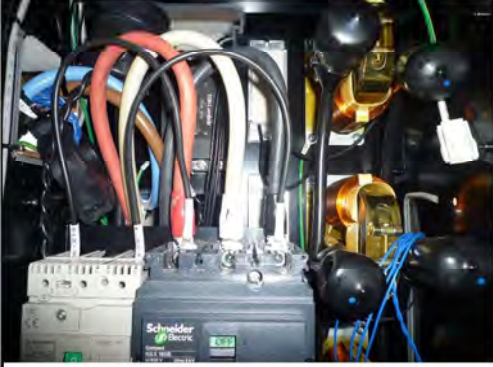
Photo	Note
	Installation of wiring by BPC.
Photo	Note
	Condition of control panel.
Photo	Note
	Condition of wiring in control panel. Phase rotation was opposite from substation. Changed wiring RED and WHITE.
Photo	Note
	Condition of connecting.

Photo	Note
	<p>Condition of wiring in QC.</p>
Photo	Note
	<p>Wiring connection to ELCB.</p>

3-3-4 Provision of operation instruction and maintenance training

As part of the QC installation pilot project, engineers were dispatched from Japan and provided local electricians with technical training on regular maintenance, fault diagnosis and repair of QCs to understand the following items:

- (i) How to work safely while handling high voltages
- (ii) How to handle QCs
- (iii) How to maintain QCs
- (iv) How to replace periodic replacement parts
- (v) How to diagnose faults
- (vi) How to replace major components
- (vii) How to reprogram QCs

At the end of the training, the written and skill tests were conducted and all the participants passed the tests (scored 80% or more). This shows that they understood the lessons in terms of both knowledge and skills so that they would be able to work safely and maintain QCs properly. During the training, they were used to handling high voltages but less attentive to work safety, and it was vigorously put emphasis on checking the power supply and protection tools before starting work and post warning signs during work.

Table 3-6 Training participants

Company	Number of participants
RSTA (Road Safety Transport Authority)	2 Senior motor vehicle inspectors
BPC (Bhutan Power Corporation. Ltd)	2 Electricians
Thimphu Home Care	2 Electricians
Neo Engineering	3 Electrician
Spark Engineering	1 Electric Engineer



Figure 3-4: A scene from the training class

3-3-5 Use of the QCs installed

After installation, the use of the QCs was monitored for one month (from February 8, 2016 to March 9, 2016). The use of the QC on each site was as follows:

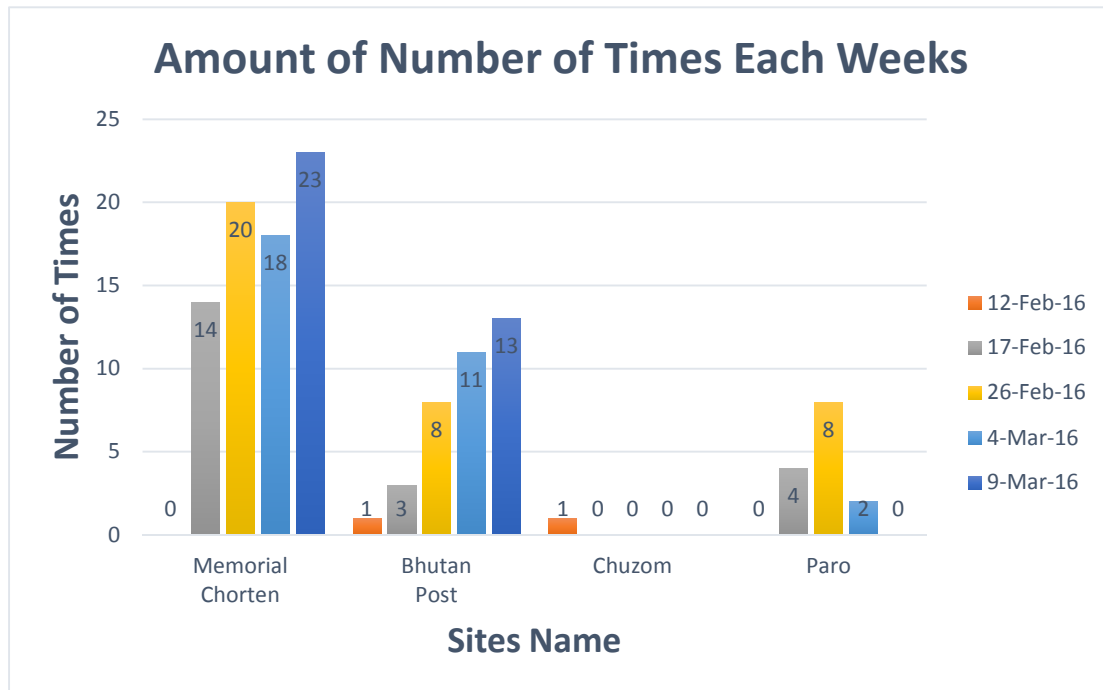


Figure 3-5 Number of uses by users (from February 8, 2016 to March 9, 2016)

Table 3-7 Frequency of uses by user (from February 8, 2016 to March 9, 2016)

The Amount of Charging times				
	Memorial Chorten	Bhutan Post	Chuzom	Paro
12-Feb-16	0	1	1	0
17-Feb-16	14	3	0	4
26-Feb-16	20	8	0	8
4-Mar-16	18	11	0	2
9-Mar-16	23	13	0	0
Total amount	75	36	1	14

The number of uses was low just after operation of QCs, while it increased thereafter as people seemed to get aware that stations were accessible to all kinds of EV users.

In addition, two months later of inauguration, the use on each site was as follows:

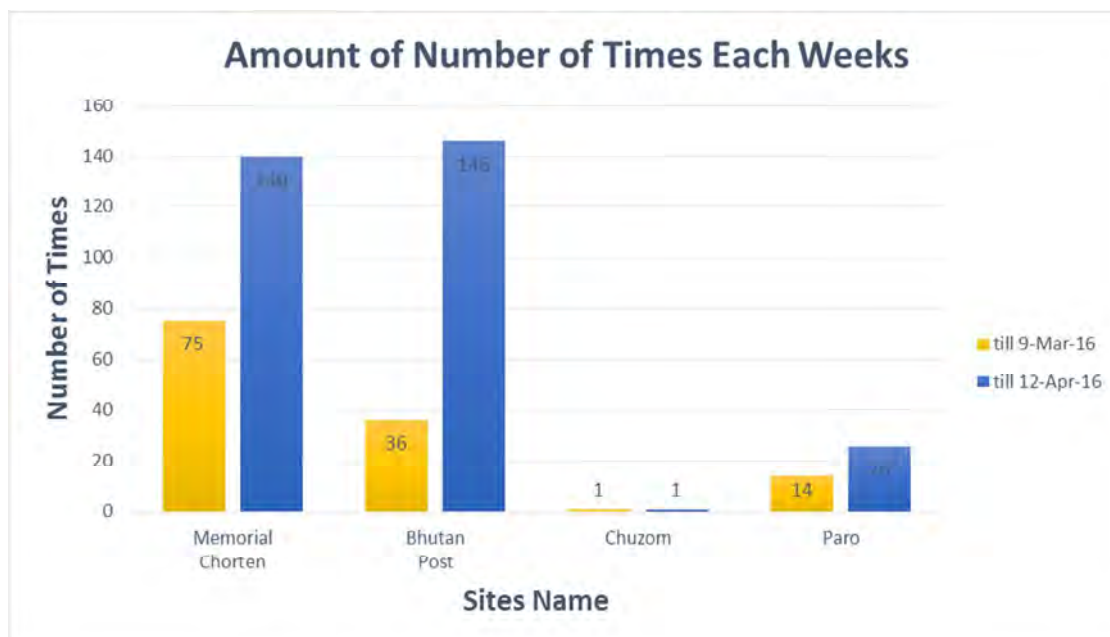


Figure 3-6 Number of uses by users after two months

Table 3-8 Frequency of uses by user after two months

The Amount of Charging times				
	Memorial Chorten	Bhutan Post	Chuzom	Paro
till 9-Mar-16	75	36	1	14
till 12-Apr-16	140	146	1	26
Total amount	215	182	2	40

The analysis of how each QC station was used was as shown below.

- Bhutan Post

After two months, the number of users has increased fourfold compared with the first month. The use of privately owned vehicles also increased fourfold. This station seems to be used most frequently by privately owned vehicles on their way to shops, etc. Its parking space is smaller than those of the other stations, but the station offers better access to banks, ATMs, post office, etc. because it is located in the downtown of Thimphu, so people would realize the convenience of its location.

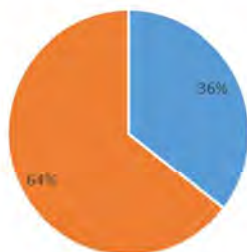


Figure 3-7 The February proportion of Bhutan Post users

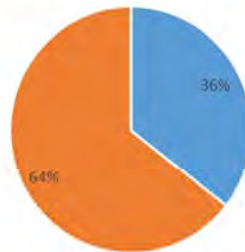


Figure 3-8 The March proportion of Bhutan Post users

- **Memorial Chorten**

Most users are taxis. Taxi drivers welcomed the installation of the station, saying that it was now much easier for them to use a QC and that they could now go to Paro with peace of mind, etc. With a large parking space, the station also seems to attract taxi drivers who use it for a break, too. With a gradual increase in the number of privately owned cars, the station seems to continue attracting numerous users in a stable way. In March, government vehicle users also started using the facility.

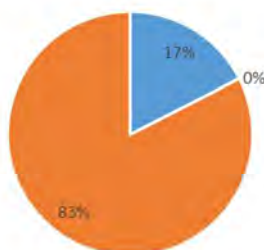


Figure 3-9 The February proportion of users at Memorial Chorten Station

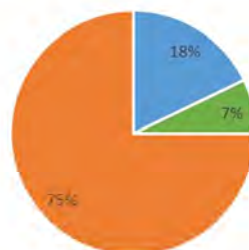


Figure 3-10 The March proportion of users at Memorial Chorten Station

- **Chunzom**

The station attracts very few users. This is presumably because drivers knew that, if they charged their car in Thimphu or Paro, they would not need to charge it again halfway between Thimphu and Paro. Meanwhile, the station will attract more and more users if traffic volume toward Phuentsholing increases in future and can also function as a backup when the QC station in Paro gets out of operation.

- Paro

In the first month, it was only used by taxis from Thimphu. However, from the second month onward, privately owned vehicles also started using it, since the public became aware of QC installed there. The QC installed in Paro made it possible to reciprocate Paro and Thimphu, whereupon the number of public users was increased.

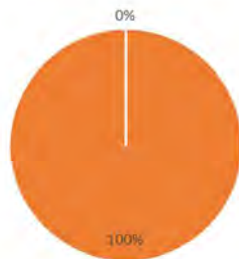


Figure 3-11 The February proportion of users at Paro

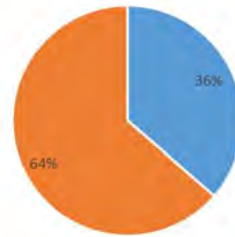


Figure 3-12 The March proportion of users at Paro

3-4 System to operate and maintain QC stations

With a series of discussions with the GNHC and brainstorming meetings with the EV Task Force, the following items were identified for the pilot QC operation and maintenance:

- GNHC outsources a contract of operation and maintenance, and the QC stations should be available to all users free of charge. GNHC should secure the necessary budget (electricity, operation and maintenance contract, land lease, etc.), at least during the study period.
- The stations would be operated on a self-charging basis (on the other hand, the selected contractor proposed to assign operators for each station).
- The stations would be closed at night and neighboring kiosks would unlock and lock the station huts.

3-4-1 TOR of the operation and maintenance contract

The study team proposed a draft TOR for the outsourcing contract and GNHC finalized the bid document with the draft TOR. The operation and maintenance service was initially outsourced for a short six-month term and then expected to make another contract with revised TOR for longer period. Thimphu Home Care was selected as a contractor of the former contract.

Table 3-9 Operation and maintenance outsourcing schedule planned by GNHC

	2015	2016							
Activities	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
Short Term O/M									
Tender Opening		(contract with Thimphu Home Care)							
Award of O/M work									
O/M									
Monitoring, evaluation of methods of O/M by GNHC									
Long term O/M									
Tendering									
O/M									

3-4-2 Implementing agency

GNHC took the role of the implementing agency of the QC pilot project and the Bhutanese side decided to continue discussion as to nomination of a designated agency taking into consideration results and suggestions made by the pilot project.

3-4-3 Monitoring operation and maintenance after installation

After installation, the study team monitored how the stations were operated and maintained. The results are shown as follows:

(i) State of the equipment

Monthly maintenance by the O/M service provider (Thimphu Home Care (THC)) such as filter cleaning was implemented and it was found that the equipment had been used properly without any damage, etc.

(ii) Mode of Operation

Bhutan Post and Memorial Chorten stations were initially manned by THC staff from Monday through Saturday, 9:00 to 17:00, to help users connect the charging plugs, etc. Afterwards, following a request from taxi drivers, Memorial Chorten station turned available on Sundays from April 1. Although Bhutan Post station is unmanned after 17:00, it is open till 22:00 with self-service available.

Chunzom and Paro stations were usually locked and opened when the THC operators were called out by phone. They are available also on holidays and overnight by taking the same procedure.

3-5 Lessons learned through the pilot project

3-5-1 Installation work

The problems that arose during the installation work in this project were as follows: Since the QC installation work involves high-risk electrical work, it is necessary for those in charge in Bhutan when installing QCs in future to ensure that all work should be directed by an experienced technician.

(i) Drawings not prepared or checked in advance

While monitoring the contractor's on-site work, it was found that they had not checked the wiring drawings provided in advance by the study team upon the outsourcing contract. Local workers also only referred the drawings for the first time when they were to start the electrical work, all of which underlined a lack of awareness of the need to understand the nature of work assigned in advance.

(ii) Materials not ready or construction method not determined at the start of the work

The contractor had not held any meeting with all workers to read drawings together or discuss and decide how to proceed, etc., which meant not all the necessary materials and equipment could be prepared in advance. This reveals their lack of awareness of the need to be well prepared for a first-time job.

The list of the most noticeable lack of readiness in this work is as follows:

- During the grounding work, ground plates were not prepared
During the grounding work, the contractor had not prepared ground plates (this time galvalume steel plates of 600 x 600 mm called GI plates) though the contractor knew that bore holes would be completed anytime soon. This lack of preparation led not to install ground plates immediately on completion of the bore holes.

Further, the contractor failed to prepare GI plates (35 x 4,000 mm), which were used to replace grounding wires. This resulted in wasting time by waiting for them to be prepared. If all materials were prepared in advance, it could have completed all this in one on the day of the grounding work, but it had to interrupt the grounding work for a while.
- When connecting wires, grounding wires and terminals were not prepared.
When working on connections from the ground plates to the QC station hut using GI plates as grounding wires, it emerged that copper wires to connect the GI plates and bus bars in the distribution panel had not been prepared. Due to this unpreparedness, it was not possible to complete all work on the day of connection work to the distribution panel.

(iii) Work schedules not created

Workers were unaware of their schedules on the day until instructed by the foreman. Accordingly, the study team requested that the contractor should create a work schedule in advance and make a progress report and hold meetings with workers to ensure that their assignments would be well understood and thus their work output would be enhanced.

(iv) Measuring instruments not owned

Since the grounding resistance had been measured by BPC, the local contractor did not have any grounding resistance meters. If the contractor would be able to measure the grounding resistance when installing ground plates, it could immediately be judged whether or not the work was successful. But since the contractor had to request BPC for that measurement after installing ground plates, measuring the grounding resistance took some time, which stalled the work.

Furthermore, to check electrical phase rotation the contractor brought a small motor and checked its rotation direction by applying voltage. Even though this is the standard checking practice in Bhutan, the study team does not recommend this procedure because it could involve the risk of electric shock.

(v) Technical standard on the range of grounding resistance is narrow

In Bhutan, there are only two values for grounding resistance: 5Ω or below 10Ω . With the standard for distribution lines, etc., there are some parts involving potentially dangerous work due to the lack of standards for customer wiring.

3-5-2 Operation and maintenance

Issues to be addressed when operating and maintaining QC stations are as follows:

(i) Implementation system

During this pilot project, GNHC was the implementing agency of the government. Presumably due to lack of personnel, GNHC could not fully monitor project progress.

(ii) Operation and maintenance service provider

It was observed that requests from users were responded by the service provider even overnight and on holidays, and that the QC stations were operated and maintained properly. Meanwhile, the response to failures or damage in Paro and Chunzom will take a certain time because the service provider will dispatch their designated staff from Thimphu. When considering deployment plan of QC stations countrywide in future, the locations and number of QC stations should be selected by taking into account the required time to respond to such failures.

(iii) Electricity expense

The electricity expense (from February 8, 2016 to March 9, 2016) was about 1,400 Nu per month for Memorial Chorten, which counts the most users. It was used 126 times per month and the electricity expense was about 20 Nu per use.

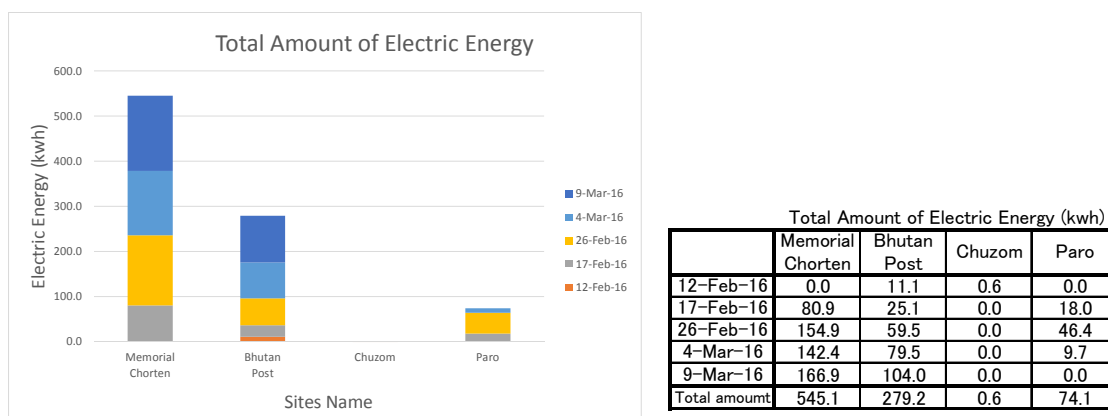


Figure 3-13 Power consumption at each station (till March 9, 2016)

In addition, one month later (till April 12, 2016), the use of the QC on each site was as follows:

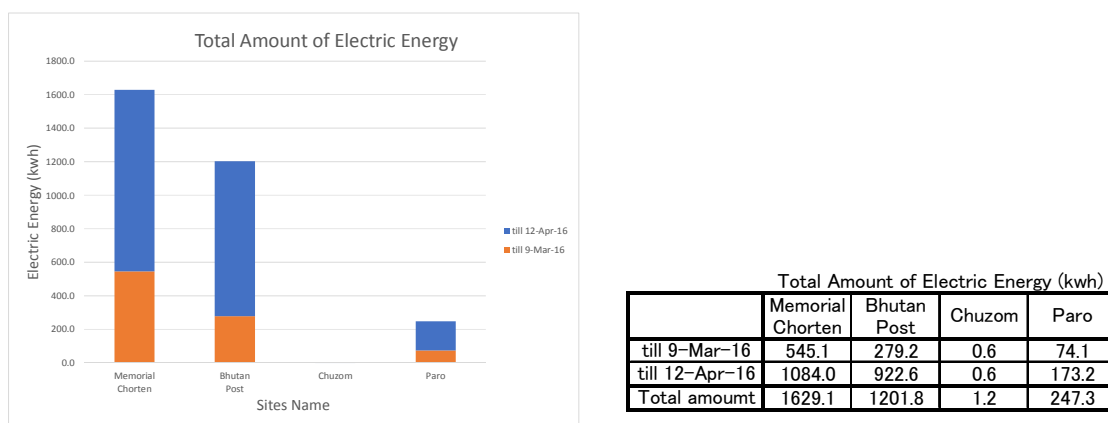


Figure 3-14 Power consumption at each station (till April 12, 2016)

From March 9 to April 12, about 2,200kWh of electricity had been consumed and the electricity bill was estimated as 6,800Nu. QC was used 313 times in a month and the cost of one-time usage was approximately 20Nu.

By calculating the times of usage per month based on the number of EV and QC, it is assumed that four taxis charge twice a day, which makes $2 \times 30 \times 4 = 240$ times, given the

fact that in Memorial Chorten, the use of taxis accounts for 75% and others account for 25%, the total amount of QC use account for $240 \times 100 / 75 = 320$ times. Since the estimated number resembles the number in the actual usage (313 times), the monthly electricity bill is considered to reach the upper limit. Therefore, it is envisaged that electricity fees for pilot QC stations would not be financial burden on the government of Bhutan under the current circumstances.

Chapter4 Proposals for the spread of EV

Chapter 4 Proposals for EV promotion

4-1 Candidate implementing bodies

The study team discussed with Bhutan’s relevant agencies and GNHC was selected as the implementing agency for the pilot project.

However, various measures are needed to promote the spread of EV, including subsidies and installation of charging facilities. It is now imperative that the government reviews experience gained through installing QCs in this pilot project, draws lessons for future promotion, determines the designated implementing agency and establishes implementation structure for budget-related and other necessary measures.

Under such circumstances, the RGoB is considering to transfer the implementing agency from the GNHC to the MoIC (Ministry of Information and Communication). It is expected that this takeover will help establish a cooperative mechanism between government agencies and reinforce the implementation system of measures.

The government agencies who were examined as candidates for the implementing agency in this study are listed as follows:

4-1-1 GNHC

An organ directly under the Prime Minister, the Gross National Happiness Commission (GNHC) is tasked with coordinating among government agencies and donors in promoting EV in Bhutan. GNHC is a coordinating body without its own system or experience to directly perform specific projects. In addition, its personnel are not sufficient to fully develop and implement EV promotion initiative.

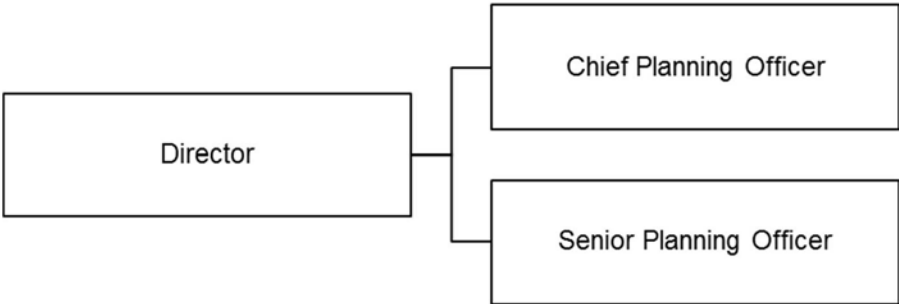


Figure 4-1: GNHC Implementation system for pilot project

Promoting EV requires coordination with the wide-ranging actors involved in disseminating EV (road traffic), installing QCs (electricity), maintenance (private sector), subsidies and tax rate (finance), land use (municipality), etc. Therefore, it appears appropriate for GNHC to remain in

its role of coordinator, while GNHC would be still required to develop institutional structure and increase the number of its personnel.

4-1-2 Bhutan Power Corporation Limited (BPC)

BPC is a public institution¹, whose jurisdiction is power transmission and distribution, operation and maintenance of facilities and collection of electricity bills. BPC is highly relevant to the spread of EV since it will be BPC who supplies electricity to charging facilities and collect electric bills. In particular, when installing charging facilities, BPC's cooperation is vital because it will install new transformers, cables and equipment according to its standards. Likewise in this pilot project, it was BPC who connected the QC to the network, supplied electricity and dispatched its engineers to QC maintenance training and thus gained experience in installing and maintaining QCs. BPC is also responsible for power transmission and distribution as well as power system operation nationwide. Therefore, given its branch offices and personnel in each province, it would be able to provide technical support for the nationwide deployment of quick chargers in future.

As seen above, BPC could be regarded as a potential implementing agency with sufficient capacity for installing and maintaining QCs. However, spreading EV also requires that the government should develop and implement relevant policies on subsidies, taxation, etc., which are out of BPC's scope. Accordingly, it would be appropriate to expect BPC as one of the organs supporting development of the quick charging system.

In addition, the Royal Government of Bhutan (RGoB) had requested BPC to be the implementing agency. After studying commercial viability of installing and operating quick chargers, the Board of Directors of BPC rejected this offer. Therefore, when incorporating BPC into the implementation system as the agency to install and maintain charging facilities, there is a need for RGoB to establish appropriate budgetary measures as well as a payment mechanism for the electric work and power charges, etc.

4-1-3 Bhutan Postal Corporation Limited (Bhutan Post)

Bhutan Post was listed as a candidate for the implementing agency, because it runs operation of city buses, the only public transportation in the city of Thimphu as well as a long-distance bus between Thimphu and Phuentsholing. In addition, it has a total of four Regional Central Post Offices in the east, west, south and center and a total of 31 post offices nationwide. Judging

¹ Bhutan Power Corporation Limited (BPC) is the country's only Power Transmission and Distribution Company, fully owned by the Royal Government of Bhutan under the umbrella of the Druk Holding and Investments Ltd (DHI). It began operations from July 1, 2002 and was incorporated under the Companies' Act of the Kingdom of Bhutan, 2000 on August 8, 2002.

from these facts, the study team recommended in an EV Task Force meeting that Bhutan Post could be a candidate institution. GNHC approached Bhutan Post in response, but Bhutan Post Council rejected to take this responsibility due to its lack of technical knowledge and ability.

Conversely, Bhutan Post is not only technically unrelated to EV, but is not necessarily highly involved in developing and implementing various measures for spreading EV. Further, considering that Bhutan Post is a financially independent in the same manner as BPC, nominating Bhutan Post as the implementing agency will involve studying and examining the viability in detail, including organizational and financial aspects.

It should be noted that after setting up a quick charger in Thimphu Central Post Office in the pilot project, which is located in the heart of the city with good access to banks, ATMs and shops, the number of users has been gradually increasing.

Meanwhile, when RGoB deploys promotional activities nationwide in future, Bhutan Post may be a good candidate as a provider of spaces for charging facilities, given its country-wide network of branch offices.

4-1-4 Department of Road, Ministry of Works and Human Settlement (DoR)

Since it governs all national roads, DoR seems to be a good candidate as the implementing agency, given the need to install and run QC stations along the main highways for the nationwide penetration of EV. On the other hand, considering that QC stations are likely to be located not only along roads but also at various points in major cities and so on, the aptitude of DoR as the agency supervising the spread of EV is relatively low. Conversely, DoR can be counted as a major party concerned because the installing QC stations along main highways is closely connected with DoR's road development planning.

4-1-5 Ministry of Information and Communication (MoIC)

MoIC will make a good candidate as the implementing agency. This is because, on the one hand, it is the government agency that controls traffic and, conversely, it is possible in future to collect charging fees through information and communication technology. Meanwhile, as stated above, to spread EV (vehicles and charging stations) widely, it is imperative to ensure effective cooperation and coordination among all parties concerned and hence establish an implementing system centered on the implementing agency.

For nominating MoIC to the implementing agency, it is necessary to develop its institutional structure, systems, budgetary measures and so on. The figure below shows the implementation system when MoIC is chosen as the core implementing agency:

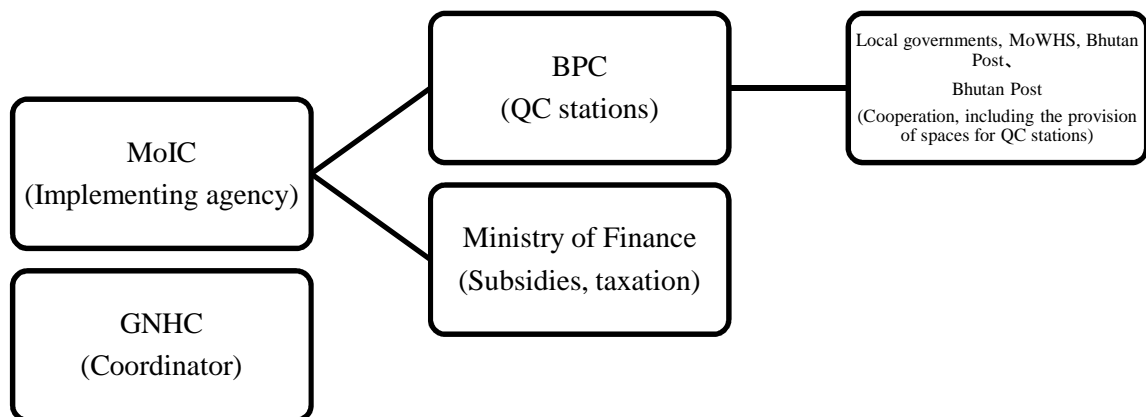


Figure 4-2: Implementation system by Bhutanese government agencies (Draft)

4-2 QC operation and maintenance system

Following discussions with the parties concerned in the Bhutanese government, it was agreed that QCs in the pilot project would be operated and maintained by a local contractor outsourced by the Bhutanese government.

GNHC, the implementing body for this pilot project, selected a private company by the bidding process and signed an operation and maintenance contract for a six-month pilot period and started running the QC stations. In the maintenance training program carried out upon the installation of the QC station, not only for the company who was awarded the maintenance contract, but also other unsuccessful bidders were invited so that they can eventually get involved in operating and maintaining QC stations.

Under the operation and maintenance contract, the contractor's duties include operating the QC stations (opening and closing them, assisting users for charging), conducting periodic inspections and responding to failures, etc. Throughout the monitoring period that followed the installation of QC stations, the equipment was kept in a good condition and monthly inspections were performed properly. The contractor also stated that there was no problem in the operation and maintenance of the stations because the task was simple and that in the event of failure, the problem would be readily dealt with by technicians dispatched from Thimphu who attended the maintenance training program. However, this is mainly because the limited number of EVs and QC stations, and it would be too early to happen failures or accidents. To respond properly to failures, it would be necessary to install them at intervals sufficiently close to back up the station in failure and include a provision in the outsourcing contract that requires the contractor to respond to the problem swiftly.

Further, users of QC stations such as EV taxi drivers demand to extend opening hours and such

requests may rise with the increasing number of EVs (At the beginning of the pilot project, the stations were open and manned from 9:00 to 17:00, Monday through Saturday, but available only on request during holidays and overnight, while the service period was not specified in the outsourcing contract. Subsequently, following discussions between GNHC and the operation and maintenance contractor of the pilot project, weekend services were also provided from April 1. For EV promotion, it is vital to ensure QC stations are user-friendly, so such requests should also be reflected in the outsourcing contract. In addition, as well as promoting the use of quick chargers, promoting electric vehicles will also involve implementing public relations activities such as installing guide plates on the charging facility (such as those specifying the location of the fast charger).

To operate and maintain QC stations, rather than ensuring dedicated staff in government agencies with additional labor budget despite financial challenges, it may be desirable to achieve cost savings and efficiency via an outsourcing system. When expanding the initiative into rural areas, it would be necessary to consider outsourcing the tasks to several and different subcontractors, given the limited resources of private companies in Bhutan who own its nationwide network.

During this pilot project, in line with RGoB and GNHC policy, they do not levy charging fees against EV users. Conversely, there is a need for GNHC to pay electricity bills for the use of quick chargers to BPC. During this pilot project, the operation and maintenance contractor settles the electricity bill to BPC and GNHC is assumed to reimburse this payment to the contractor. It may be possible to continue free charging for a certain period until EV prevails to some extent, but as the number of EV and QC stations rises, as EV spreads to provinces, or as QC stations get deteriorated and require a number of spare parts in the future, RGoB will have to reconsider whether or not to collect charging fees. Moreover, if fee collection would be introduced, it is necessary to carefully study the system of levying and collecting charges.

4-3 Various measures to promote EV penetration

As stated above, to help EV penetrate, RGoB needs to pursue specific projects to develop and improve the charging system, while implementing various measures, including subsidies, to help EV penetrate. It is examined that, among the three EV diffusion scenarios presented by World Bank report, the closest to the current actual status is Scenario 1. To further promote EV diffusion, RGoB needs to keep striving to bring the status closer to Scenario 2.

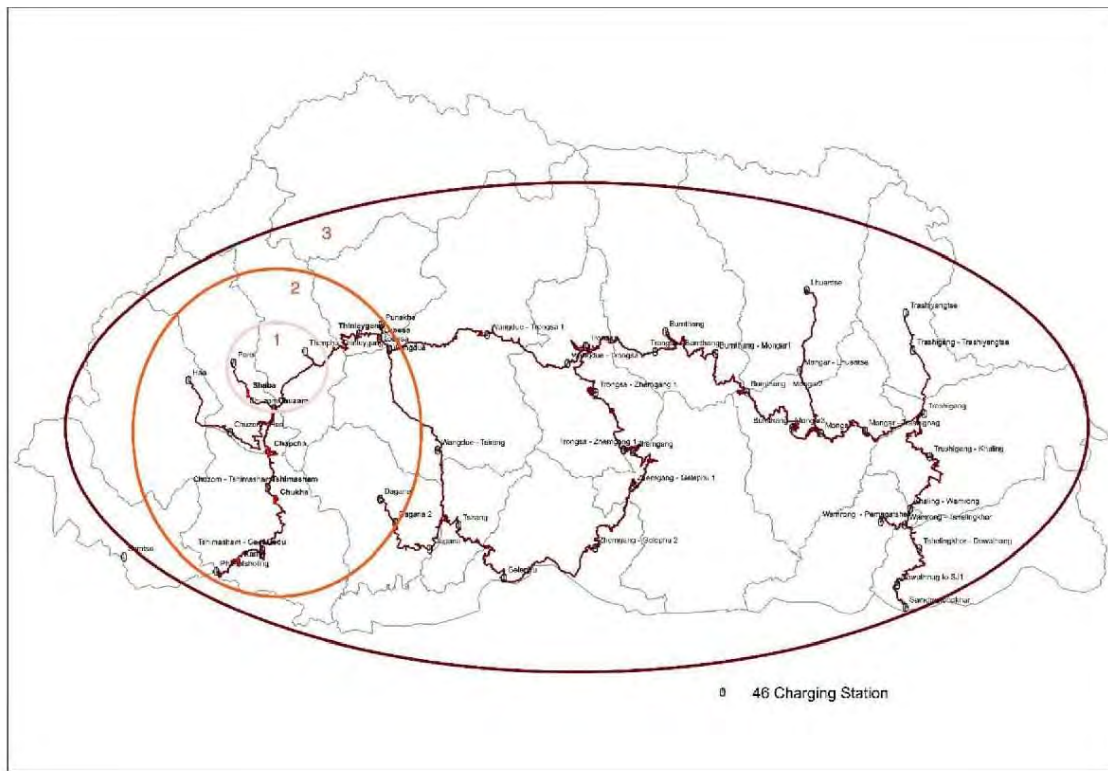
Table 4-1: EV diffusion scenarios spread presented in the World Bank Report

Unit: Number of vehicles

	Year	Taxi	Government	Private	Total
Scenario 1	2015	15	3	54	72
	2020	75	21	323	419
Scenario 2	2015	74	10	161	245
	2020	441	62	969	1,472
Scenario 3	2015	736	17	269	1,022
	2020	4,414	104	1,615	6,133

Source: World Bank Analysis

In addition, the WB report scenario shows an enlarged penetration area with an increased number of EVs.



Source: World Bank Analysis

Figure4-3: EV diffusion scenarios

(1) Measures to promote purchase of EVs

Despite tax-exemption for imported EVs, they remain much costlier than conventional vehicles. To help EVs penetrate, RGoB needs to take the purchasing capacity of the general public into account, one solution can be subsidies. In this study, RGoB confirmed that a subsidy policy is currently being considered. It is important to clearly show the public with those measures to be taken and ensure that they shall be fully implemented. Further, given that restrictions on the import of used EVs appear to have been relaxed based on certain criteria, it is important to clarify the extent of such relaxation to boost people's awareness and understanding toward EV market.

(2) Public relations

The opening ceremony held by the Bhutanese government for the installation of QC stations under this pilot project was acclaimed, with the Bhutanese Prime Minister and Japanese ambassador in attendance. Conversely, there were rather negative reports in local papers (for example, complaints from the taxi driver that the mileage per charge was shorter than explained by the local automobile dealer), which can be one reason why the general public's understanding of EV has been slow to get matured.

According to an interview survey among EV users one month after the stations were opened, the reasons for not using QCs included “seemed not operational because the shutter is closed,” “unsure of the charging method”, “worried about battery deterioration due to quick charging comparing to home slow charging,” and “dedicated to the use of emergency”. These answers show how people were unaware that the general public could also use the stations.

This demonstrates the importance of public relation activities to raise awareness and understanding among the general public in spreading EV more widely.

(3) The introduction of various clean-energy vehicles

Although RGoB currently focuses on EV promotion, diffusing plug-in hybrid EVs (PHEV) is also an option. In this pilot project, three QC stations were opened, two in the capital Thimphu and one in Chunzom, located halfway between Thimphu and Paro, venue of the international airport.

The road between Thimphu and Paro is mountainous and traverses different elevations. However, as well as maintaining it in relatively good condition, installing the QC stations significantly reduced the risk of power shortage



Figure 4-4: A plug-in hybrid EV

and extended the distance EVs could travel with peace of mind. Conversely, most of the Bhutanese territory is in mountainous areas connected by mountain roads winding through different elevations and under development, which means stable driving remains difficult. In addition, it remains unclear how the installation of QC stations in provinces will be implemented in future. Under such circumstances, spreading EV seems difficult due to the difficulties in developing infrastructure.

Since PHEV can be used as either conventional vehicles or EVs, it could run as conventional vehicles for long distance drives and as EVs in and around cities where QCs are readily available.

Further, given the compact size of many taxis, it would help EV penetration to communicate the existence of compact EVs and various other vehicles known to people.



Figure 4-5: A compact EV

Japan is also on the way to transfer public buses to electric buses. Conversely, if it is limited to public buses in the Thimphu city area because of the short distance involved, it is also conceivable to examine feasibility studies and a sufficient verification test on this field.

As shown above, it is essential to develop implementation structure and systems among relevant agencies first, and then study and determine various measures to be taken. Also, considering that the country's current road conditions and financial situation would not allow to spread EV nationwide in one go, it could be more realistic to plan the diffusion in stages, along with the installation of QC stations and diffusion of PHEV. Given that implementing these measures requires financial support such as tax incentives, subsidies and the need to install, operate and maintain QC stations, it would be necessary to pursue the use of multiple funds. It will be required to sort out measures by each fund's nature, implementation timing, etc. and carefully examine what kind of schemes and which donors are best suited for possible EV promotion measures.

Appendix-1

**DATA COLLECTION SURVEY
FOR
ELECTRIC VEHICLE PROMOTION IN BHUTAN**

RECORDS OF TECHNICAL DISCUSSIONS ON THE SURVEY

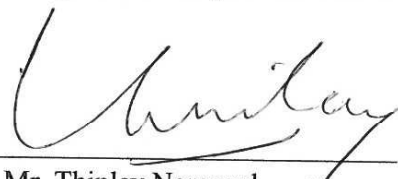
The Survey Team held several discussions for technical matters with the Royal Government of Bhutan (hereinafter referred to as “RGoB”). In the discussion, both parties have confirmed the technical items as described in Annex-1.

The Survey Team will proceed to further works for the trial installation of quick chargers and prepare the Survey Report. RGoB confirmed that Japan International Cooperation Agency (hereinafter referred to as “JICA”) should make final decision on the number and location of quick chargers through its examination of the Records of Technical Discussions.

At GNHC Thimphu. 10th September 2015.



Mr. Tadanori Kumano,
Chief Consultant
INGEROSEC Corporation
JICA Survey Team



Mr. Thinley Namgyel,
Director
Gross National Happiness
Commission

1. Installation Site Selection of the Trial Quick Charger (QC)

- (1) RGoB and the Survey Team confirmed to install a maximum of four (4) QCs.
- (2) RGoB and the Survey Team agreed the results of the joint survey for selection of the potential installation sites as **Attachment-1**.
- (3) RGoB and the Survey Team selected four (4) highly prioritized sites on the basis of the aforementioned results of the joint survey as follows;
 - in the premises of Bhutan Post Headquarters, near an ATM (open type),
 - parking area near Memorial Chorten (indoor type),
 - near the gate in Chunsom (indoor type), and
 - taxi parking area in Paro (indoor type).

The location map is shown in **Attachment-2**.

- (4) The relevant agencies (GNHC, Bhutan Power Corporation Ltd, Bhutan Postal Corporation Ltd, Thimphu City Corporation, and Paro District/Province Government) confirmed the aforementioned candidate sites as acceptable and feasible.
- (5) Installation type (indoor or outdoor) was determined by security situation and available safety measures at this moment.

2. System of the Installation

(1) RGoB

- 1) Coordination with relevant agencies
- 2) Acquisition of the necessary permit, mainly for land allocation and electricity supply (by 18th September 2015)
- 3) Tax-free customs clearance of QCs and related equipment
- 4) Other support to installation work

(2) JICA

- 1) Procurement of quick chargers and related equipment
- 2) Installation work with local subcontractors

(3) BPC

- 1) Power supply and related work
- 2) Implementation of related electrical work is due to the adjustment of the survey team.

3. Business Plan and System of the Operation and Maintenance (O/M)

- Operation and maintenance services shall be outsourced to private sector.
- Self-charging method shall be selected.
- RGoB shall be responsible for any expenditure for operation and maintenance of trial quick chargers, such as land rent, electricity consumption, and management contract.
- RGoB shall not collect any charging fee from users of the trial quick chargers at the initial stage, whereas the future business plan shall be examined during the Survey.

4. Responsibilities of the Operation and Maintenance (O/M)

(1) RGoB

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- 1) To determine the O/M designated government organization, and inform the Survey Team of the name of organization and contact information by 7th October
 - 2) To determine operators responsible for unlocking and locking each QC station, and inform the Survey Team of the names of operators and contact information by 13th November
 - 3) To coordinate with relevant agencies to support the O/M designated organization
 - 4) To allocate necessary budget (land acquisition, electricity charges, other O/M cost) by 9th October 2015
- (2) JICA
- 1) To provide initial technical guidance of operation and maintenance
 - 2) To monitor operation for about one (1) month after installation
- (3) O/M designated government organization
- 1) To establish total management system for operation and maintenance
 - 2) To determine (a) focal point(s) in charge of the trial QCs and inform the Survey Team of the name and contact information by 13th November
 - 3) To award contract to outsource operation and maintenance services and inform the Survey Team of the name of subcontractors and contact information by 13th November

5. Schedule and actions to be taken for the QC installation and O/M system establishment

Responsible Agency	Actions to be Taken	Deadline
RGoB	Acquisition of the necessary permits for QC installation (land acquisition, electricity supply, etc)	18 th September 2015
RGoB	Nomination of the designated government organization for O/M	7 th October 2015
RGoB	Allocation of the budget for O/M (land acquisition, electricity charges, and other O/M cost)	9 th October 2015
RGoB (O/M Organization)	Nomination of operators for unlocking and locking of the QC stations.	13 th November 2015
O/M Organization (RGOB)	Nomination of (a) focal point(s) in charge of the trial QCs.	13 th November 2015
O/M Organization (RGOB)	Award of outsource contract on operation and maintenance services	13 th November 2015

6. Specification of Equipment and Related Work

The Survey Team and relevant agencies of RGoB confirmed the specifications of quick

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charger, electrical work, and installation & construction work as shown in **Attachment-3**, **Attachment-4** and **Attachment-5** respectively.

7. Request from Electric Vehicle Task Force

The Survey Team took note on the following requests from the EV Task Force of RGoB and shall examine its technical feasibility in Japan. JICA shall inform RGoB of its decision to be made with the consultation of the Survey Team.

- (1) To introduce smart billing, metering and security system of QC stations
- (2) To include the following items into the scope of QC supply contract; system commissioning, appropriate warranty, Annual Maintenance Contract (AMC) and spares parts

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Results of the Joint Survey of the Potential Installation Sites

The Electric Vehicle Task Force of RGoB and the Survey Team agreed the selection criteria and priority of the potential installation sites as follows;

- (1) Access for the target users (government, public/private transportation, tourism)
- (2) Land acquisition (owned by central/local governments or public entities)
- (3) Power supply (access to the transformers)
- (4) Safety (fire, accident, crime prevention)

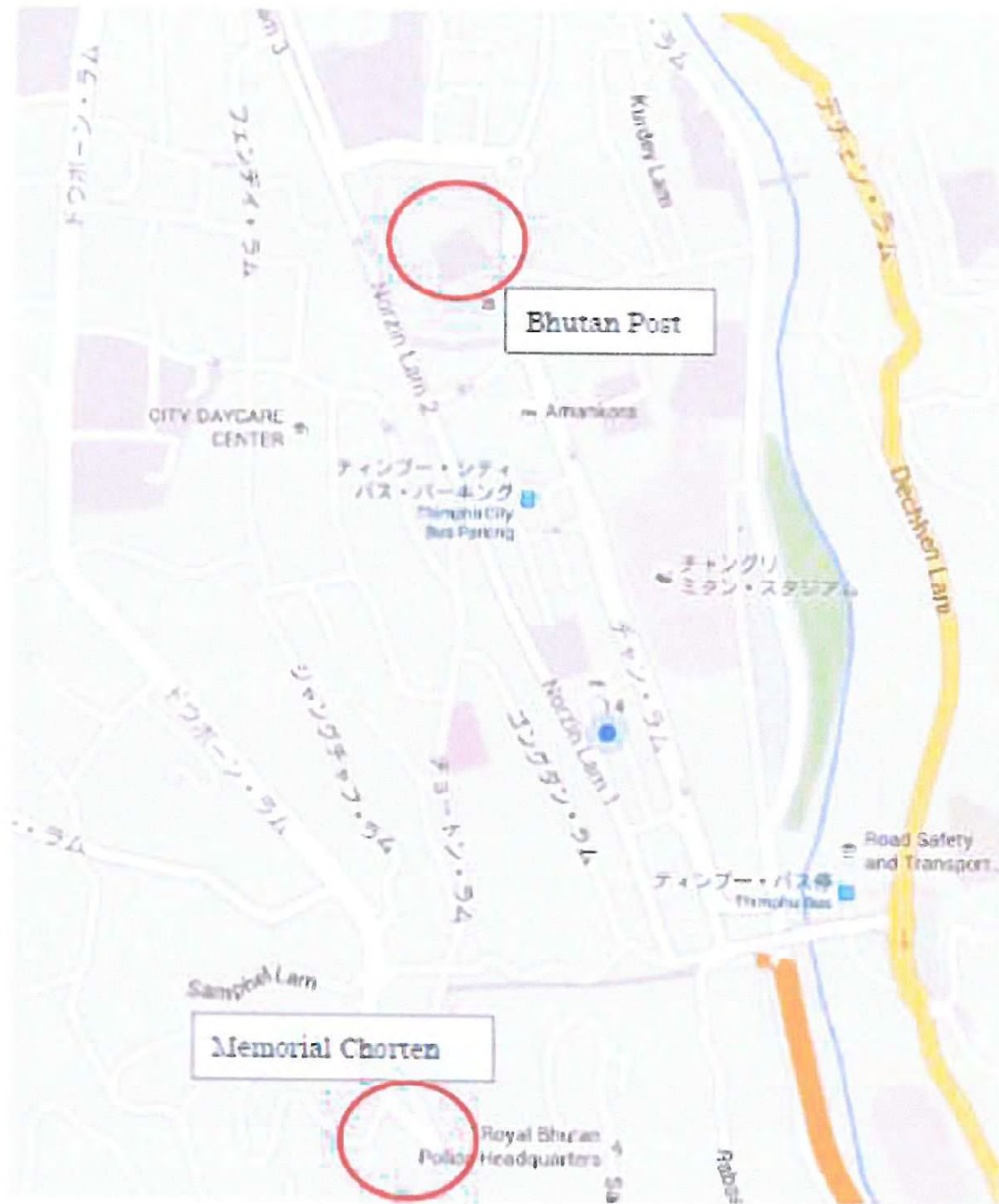
Location	Description	Rank
Thimphu		
Bhutan Post Office Headquarters	(1) Easy to access, (2) Public land (Bhutan Postal Corporation Ltd), (3) Near transformer, (4) 24h security guard allocated	1
Memorial Chorten	(1) Easy to access (Tourism), (2) Public land (Thimphu City Corporation) , (3) Near transformer, (4) Safe place with a potential operator for unlocking and locking a shed of equipment (kiosk)	2
Changlam	(1) Easy to access, (2) Public land (Thimphu City Corporation), (3) Near transformer, (4) Security measures required during a night time and no potential operator for unlocking and locking a shed of equipment	3
Milkbooth	(1) Back road, (2) Public land (Thimphu City Corporation), (3) Not near transformer, (4) Security measures required during a night time. There is a potential operator for unlocking and locking a shed of equipment.	4
Changzamtog	(1) Easy to access yet close to existing QC, (2) Public land (Thimphu City Corporation), (3) Near transformer, (4) There is a potential operator for unlocking and locking a shed of equipment.	5
Between Thimphu and Paro		
Chunsom	(1) Easy to access (Tourism), (2) Public land (Paro provincial government), (3) new establishment of transformer required, (4) There is a potential operator for unlocking and locking a shed of equipment (police).	1
Paro		
Near the taxi parking	(1) Easy to access, (2) Public land (Paro provincial government), (3) Near the transformer, (4) There is a potential operator for unlocking and locking a shed of equipment (shop)	1
Near Paro police	(1) Back road, (2) Public land (Paro provincial government), (3) Near the transformer, (4) There is no potential operator for unlocking and locking a shed of equipment.	2
Airport	(1) Easy to access (Tourism) yet close to another charger to be installed by private sector, (2) Public land (Paro Airport), (3) Near the transformer, (4) 24h security guard allocated <u>* The terminal building and parking area to be renovated</u>	3

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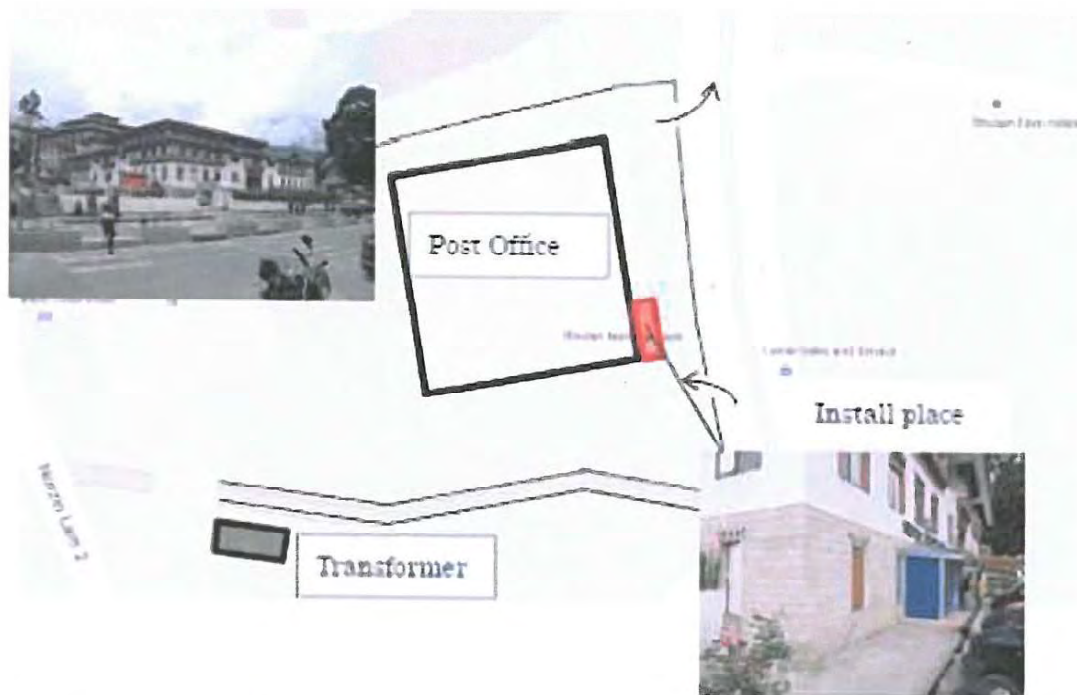
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1) Bhutan Post

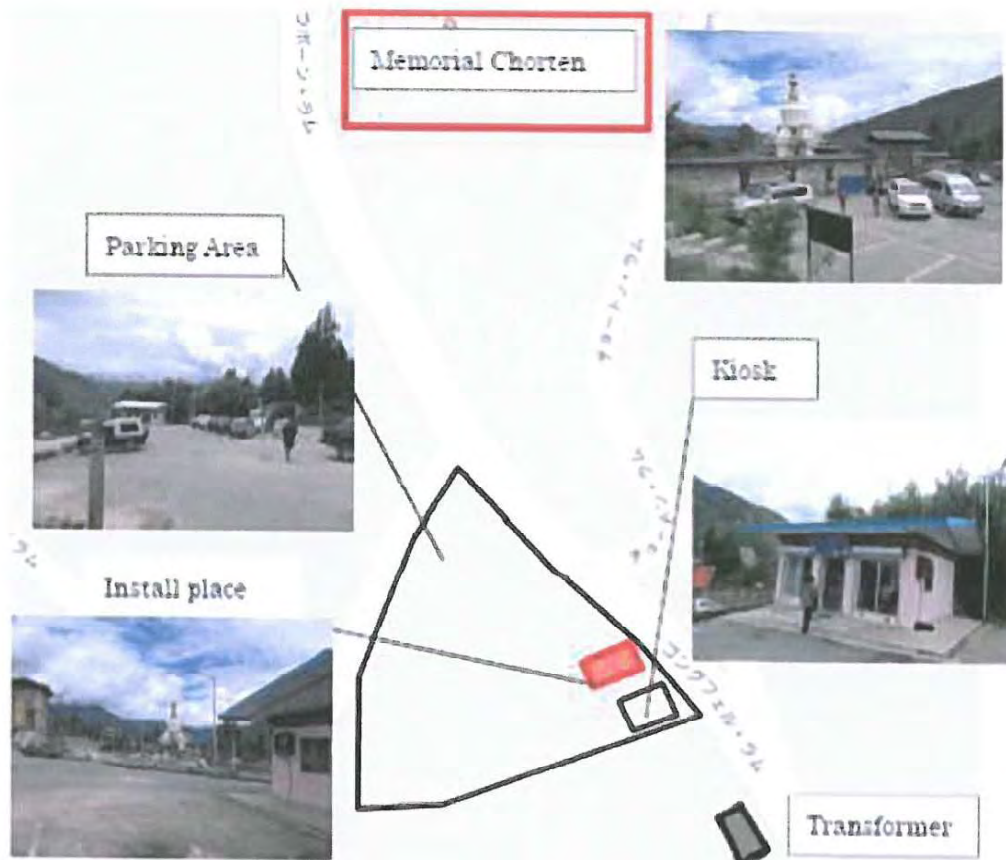


User	: Convenient access
Area	: Public land
Power Supply	: Close to the Transformers
Space	: possible 2 cars space
Safety	: 24h security Open type

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2) Memorial Chorten



User	: Convenient access
Area	: Public land
Power Supply	: Close to the Transformers
Space	: possible 2 or 3 cars space
Safety	: Indoor type

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(2) Chunsom



- | | |
|--------------|------------------------------|
| User | : Convenient access |
| Area | : Public land |
| Power Supply | : Close to the Transformers |
| Space | : possible 2 or 3 cars space |
| Safety | : Indoor type |

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(3) Paro



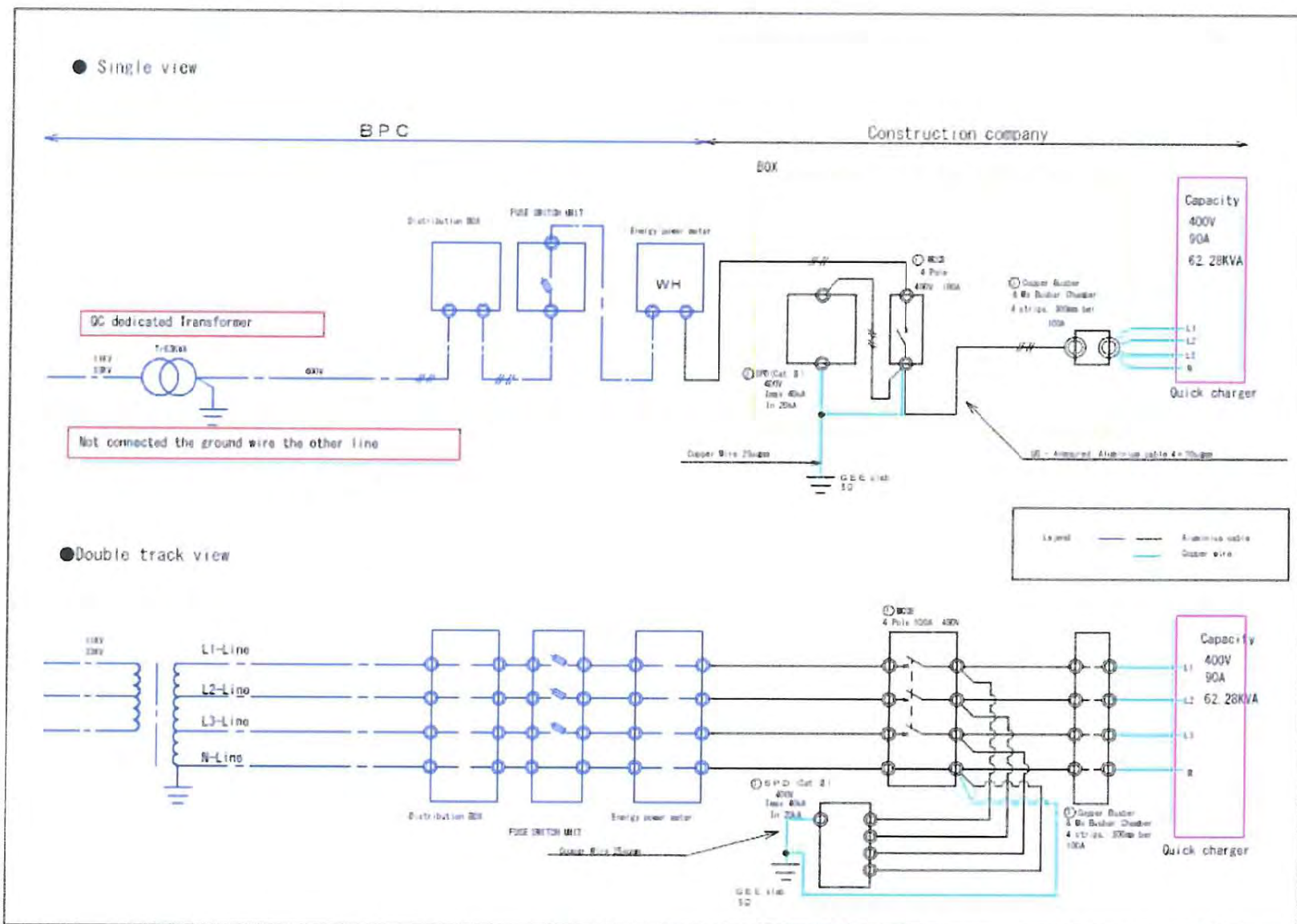
User	: Convenient access
Area	: Public land
Power Supply	: Close to the Transformers
Space	: possible 2 or 3 cars space
Safety	: Indoor type

Specification of the Trial Quick Charger

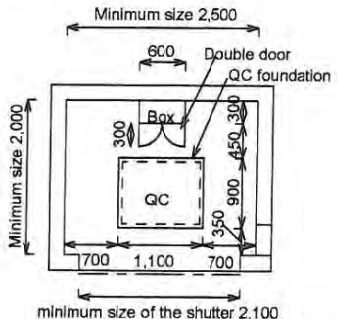
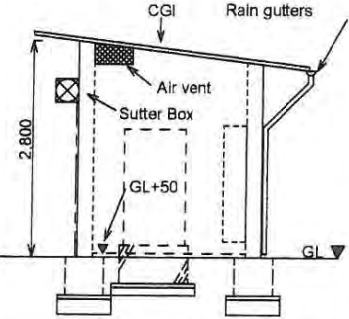
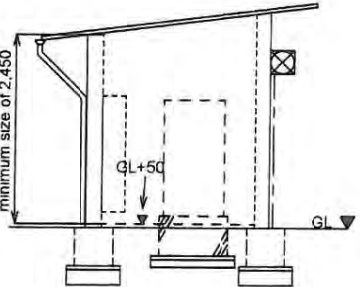
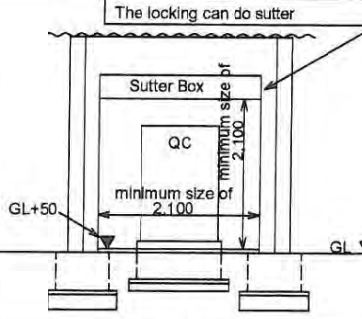
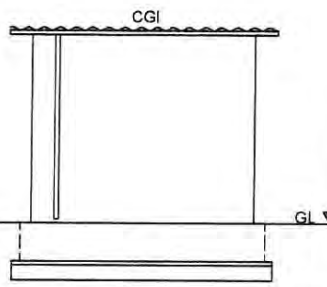
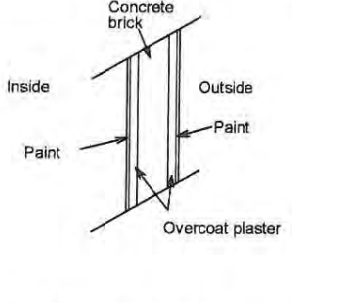
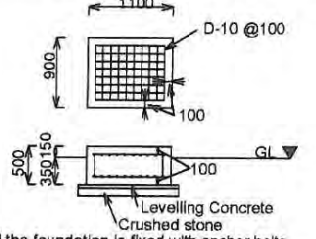
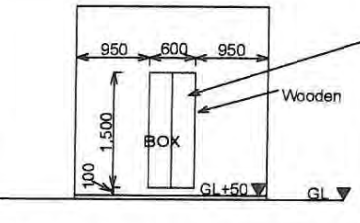
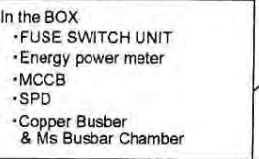
Item	Specification
Location	Indoor / Open
Installation space	W:2200 D:1700 H:2500 (Quick Charger+maintenance apace)
Operating Temperature	Cold specifications:-30 to +40°C
Relative Humidity	30 to 90%(Non-condensing)
Altitude	2000m or more
Input Voltage	AC400V 3phases 50Hz
Use maximum power	62.28kVA up to
Input AC Power Connection	3 phases 4 wire system
Insulation coordination	Conforms to IEC60664
Charging cable connection port	CHAdeMO standard

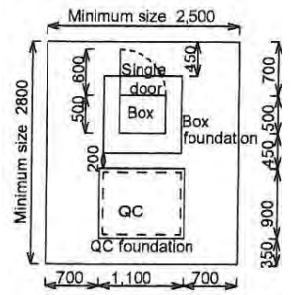
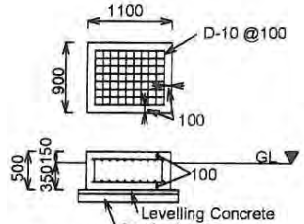
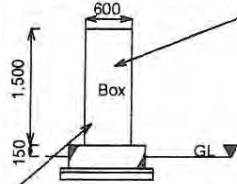
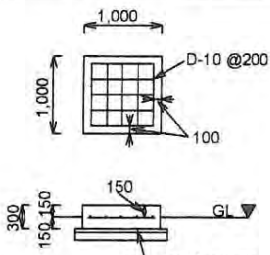
TK

LK



The Specification of construction
1) Indoor type

<p>Indoor type</p> 			<p>Important Notice</p> <ul style="list-style-type: none">• Notation unit mm• Size strict observance of internal building• The consultant will ensure the minimum size of door• wire mesh should be placed at Air vents to avoid birds from entering inside• Finished with floating coat of neat cement
<p>Plan view</p> 	<p>Right side view</p> 	<p>Left side view</p> 	
<p>Front side view</p> 	<p>Rear view</p> 	<p>Wall cross-sectional view</p> 	
<p>QC foundation and reinforcement view</p>	<p>Box attachment position view</p>		

<p>Open type</p> 	 <p>QC and the foundation is fixed with anchor bolts</p>	<div data-bbox="1254 247 1500 406"> <p>In the BOX</p> <ul style="list-style-type: none"> • FUSE SWITCH UNIT • Energy power meter • MCCB • SPD • Copper Busbar & Ms Busbar Chamber </div>  <p>Steel box(Outside paint)</p>	<p>Important Notice</p> <ul style="list-style-type: none"> • Notation unit mm • Size strict observance of internal building
<p>Plan view</p>  <p>Box and the foundation is fixed with anchor bolts</p>	<p>QC foundation and reinforcement view</p>	<p>Box view</p>	
<p>Box foundation and reinforcement view</p>			

2) Open type

Appendix-2

Operation and Maintenance of Quick Charging stations

Terms of reference (DRAFT)

Background

The Royal Government of Bhutan places unparalleled emphasis on environmental conservation as enshrined in the constitution whereby a forest cover of 60% of total land area shall be maintained for posterity. Successive plans and programs have targeted the adoption of sustainable practices and policies. More recently though, the country has been witnessing increasing levels of air pollution which can primarily be attributed to emissions from increased transportation activity. With the objective of mitigating the increasing emissions from the transport sector, the adoption of a more sustainable transport system through the introduction of EV (Electric Vehicle) as an alternative to ICE (Internal Combustion Engine) vehicles was identified. Several policy initiatives ranging from fiscal incentives to launching of various electric and PHEV models and the measures towards creating an enabling environment have been undertaken.

Purpose

In creating an enabling environment to encourage EV adoption, a critical requirement is the installation of a reliable and extensive Quick Charging infrastructure network. Towards this end, the RGoB represented by GNHC Secretariat as the current focal organization is installing 4 Quick Chargers with support from JICA as a pilot project.

The effective and efficient operation and management of the Quick Charging infrastructure will be of paramount importance in instilling confidence in EV users and will further encourage adoption of EVs as a reliable alternative. Hence, an Operation and Maintenance contractor shall be engaged for management of the QC infrastructure.

Objective

The broad objectives of the Operation and Maintenance Contract shall be as follows:

1. To provide EV users access to Quick Charging;
2. To ensure that the Quick Charging stations are functional at all times and maintained regularly as required.

Scope of the Contract:

The successful bidder's scope of work shall include, amongst others, but not limited to the following, within the primary responsibility of operating and managing the QC stations:

1. Unlocking and locking of the QC station daily based on an agreed time schedule between the contracting party and the contractor or manning the QC stations to facilitate QC users and ensure proper usage
2. Regular Inspections of the QC based on the technical specifications provided below.
3. Maintenance based on the technical specifications provided below.
4. Maintain proper power utilization record/data and submission to contracting party.
5. Safeguarding the QC units from potential miscreants/damage.

Technicalities

The sub-contractor shall provide Customer with operation and maintenance services in strict compliance with the Quick Charger (QC) maker's Global Standards. The sub-contractor must also have a qualified technician capable of performing the required maintenance.

Service methods

1. Manning the stations and ensuring access to the QC by the EV users :
2. Regular visit to maintain and check every QC station to ensure proper condition of the charger by qualified technical personnel.
3. Prompt response to complaint or failure by the users.
4. To collect the necessary data from the QC and report to the responsible government agency every month.

Monthly inspection (Visual inspection)

1. Abnormality of appearance
2. Cracking of the LCD
3. Abnormality of the charging cable (deformation, scratches, etc.)
4. Twist of the charging cable
5. Abnormality of the charging cable connector (dirt, deformation, breakage, etc.)
6. Abnormal smell or noise

Annual inspection

- 1) Visual inspection
 - a) Abnormality of appearance
 - b) Cracking of the LCD
 - c) Abnormality of the charging cable (deformation, scratches, etc.)
 - d) Twist of the charging cable
 - e) Abnormality of the charging cable connector (dirt, deformation, breakage, etc.)
 - f) Abnormal smell or noise
 - g) Dust on the filter
 - h) Dirt or dust in the fan
 - i) Dirt or dust inside the charger
- 2) Operation inspection
 - a) The earth leakage breaker inside the charger is operating normally
 - b) The fan is operating normally
 - c) The LCD is operating normally
 - d) The switch operation is operating normally
 - e) The lamps to light normally
- 3) Other inspection
 - a) Error log
 - b) Insulation resistance test

Every three years inspection

1. The contents of the annual inspection
2. Replacement of the charging cable (if necessary)

3. Replacement of the fan (if necessary)
4. Replacement of the filter (if necessary)

Time Frame

The Operation and Maintenance contractor will assume responsibilities starting from the date the contract is signed. Given the unprecedented nature of the contract, the RGoB intends to award the initial contract on a short term basis for a period of 6 months with the possibility of extension based on the performance of the O&M contractor and the efficiency and effectiveness of such a modality. After the expiration of the initial contract, either the existing ToR will be applied or a revised ToR will be adopted if the current terms are assessed to be inadequate or excessive.

Financing

The contractor shall be paid by the GNHC or any other designated agency of the RGoB for the Operation and Maintenance services rendered on a monthly basis. All actual electricity charges as billed by the Bhutan Power Corporation will be reimbursed by the government to ensure free charging to EV users. Hence the O&M contractor's bid amount should only include charges for O&M services.

Application and Selection Process

Applications will invited from competent contractors and selection will be based on the Procurement Rules and Regulations, 2009.

Bids with detailed proposal for manning and ensuring greater access to the QC stations will be given preference.

Appendix-3



Innovation
that excites

Quick Charger Maintenance Training

EV and HEV Component Engineering Department
Customer Experience Training Planning Department
NISSAN MOTOR CO.,Ltd

18th-22th January, 2016

DAY 1 @Thimphu

Time	Training item	Training contents
9:00-9:20		Opening ceremony Orientation
9:20-11:00	1.Outline	1.What is the Quick Charger 2.EV normal charge system 3.EV quick charge system outline 4.How Does QC generate DC Power 5.What is CHAdeMO 6. CHAdeMO protocol 7.Nissan QC Specification 8.Charge connector 9.Operating procedure 10.Safety instruction 11. Operating the administrator menu
11:00-11:30	2.Safety	1. High Voltage Precaution 2. Precaution for the parts 3. Impact for human body
11:30-12:20	3.Structure	1. Parts layout 2. Parts list 3. Charge connector 4.Circuit structure
12:20-12:40	4.CHAdeMO sequence	1.CHAdeMO connector interface 2.Chart of charge
12:40-13:00	5.Software	1.Installed software's 2.How to check software version
13:00-14:00	Lunch time	
14:00-15:00	6.LCD Menu	1.Administrator Menu ·Switching to the Administrator Menu ·Explanation of Screen 2.Maintenance Menu ·Switching To The Maintenance ·Description Of Screen Menu ·Master password
15:00-15:20	Structure of the Quick Charger	1.Confirm the Quick charger structure (Out side)
15:20-17:00	Usage of the Quick Charger	1.Operation procedure 2.Confirm the Administrator menu 3. Confirm the Maintenance Menu 4.How to check software version
17:00-17:10		Q&A Information

DAY 2 @Thimphu

Time	Training item	Training contents
9:00-9:10	Information	
9:10-10:30	7. Maintenance	1.Daily inspection 2.Periodical inspection 3.Recommended periodical replacement 4.Insulation resistance measurement 5.Ground short protection test
10:30-12:40	8.Cover removal	1.High voltage Precaution 2.Circuit Breaker Cover (ELCB) 3. Heat Sink Cover 4. Plate assy- Back (Upper,Lower,Side,Middle) 5. Side plate assy- (Front panel) 6.Installations 7. Shielding
12:40-13:00	9.Routine work for inspection	1.Routine work before starting inspection (Confirmation of the capacitor discharge and primary power source shutdown) 2.Function check after QC installation
	13:00-14:00 Lunch time	
14:00-16:00	10.Periodic Replacement	1.Display assy (LCD) Settings Backup Battery* 2.Cooling fans and filters 3.Charge cable and connector
16:00-17:00	11.Trouble diagnosis	1.Procedure when faults have occurred 2.Diagnosis by error code 3.Writing procedure of error code to SD card 4.Content of SD card reading 5.Diagnosis menu 6.Diagnosis code Example

DAY 3 @Thimphu

Time	Training item	Training contents
9:00-9:10	Information	
9:10-13:00	11.Trouble diagnosis procedure	Diagnosis Code Example X0003/X0005/X0006/X0007 X0505,X0506,X0507,X050A,X0404
13:00-14:00	Lunch time	
14:00-17:00	11.Trouble diagnosis procedure	Diagnosis Code Example 0510,X0510,X0512,X0513,X0514,X0516,X0519 X051D, X1001,X2001,X2002
17:00-17:10	Q&A Information	

DAY 4 @Thimphu XX

Time	Training item	Training contents
9:00-9:10	Information	
9:10-13:00	12. Assembly work	1.Rectifier diode 2.Converter Assy Matrix.
13:00-14:00		
14:00-17:00	12.Assembly work	3.Contacto r Assy MC1 4.Contacto r Assy MC4, 5. 6.Power Supply Assy (PS3)(PS1)(PS2), 7.(Next day) 8.Contacto r(MC3-2) 9.Coil Assy L4/L5, 10.Thermometo r Assy 11. Transfo rmer Assy(TR1) 12.13. Circuit Breaker ELCB1,CLCB2 14. Operation panel 15.Emergency stop button
17:00-17:10	Q&A Information	

DAY 5 @Thimphu

Time	Training item	Training contents
9:00-9:10	Information	
9:10-12:00	12.Assembly work	7. Controller Assy- Main (PWB1) ADDITIONAL SERVICE WHEN REPLACING PWB1
12:00-12:30	13.Reprogramming	1.LCD reprogramming 2.FPGA reprograming 3.CPU Reprograming
12:30-13:00	Technical report	1.How to write the technical report 2,Technical Report of Handling
13:00-14:00	Lunch time	
14:00-16:00	Trouble shooting test	Skill check
16:00-16:30	Comprehension test	Knowledge
16:30-17:00	Wrap up Closing ceremony	

 Lecture

 Practice

※Take the break time about 10 minutes, every 1.5 hours.