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Business Model for Financially Sustainable Electric Vehicle Charging Station Using EV Charging Financial Analysis Tool

by

Dilli Prasad Sapkota

A THESIS

SUBMITTED TO THE DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER IN ENERGY SYSTEM PLANNING AND MANAGEMENT

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

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APPROVAL PAGE

The undersigned certify that they have read, and recommended to the Institute of Engineering for acceptance, a thesis entitled "**Business Model for Financially Sustainable Electric Vehicle Charging Station Using EV Charging Financial Analysis Tool**'' submitted by Dilli Prasad Sapkota in partial fulfilment of the requirements for the degree of Master of Science in Energy System Planning and Management.

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ABSTRACT

The development of EV technology is growing day by day throughout the world. For Nepal, this is the golden opportunity sector to decrease its oil consumption which in turn help to lower the trade deficit. Government of Nepal has also announced several regulatory measures and national strategies to respond to the country's rising trend of electric vehicle (EV) adoption. The availability of charging station plays a vital role for customer's range anxiety problem. In this study, an EV charging financial analysis tool was used to analyzed various scenario of business cases. The three potential partners that can collaborate in this project are owner-operator partner, private sector partners and public sector partner. Discounted Cash Flow (DCF) method is used to calculate the financial parameters such as NPV, IRR and DPP for all partners. Three different scenarios were analyzed in this work. In the first scenario, NPV is obtained as -$63,590 and both IRR and DPP are not available. In second scenario, all three parameters were infeasible for owner operator and public sector. For private sector partner, NPV is -$34,756 IRR and Payback period is unavailable. Lastly, in third the NPV stand at +53,614, IRR is 17.7% and DPP is 6 year for owner operator. For private sector partner, NPV is positive, with 10% IRR and 7 year of payback period. For public sector partner, the project is in breakeven zone. I. Five more different cases were analyzed under scenario C by reducing CAPEX cost from 10% to 50%.

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LIST OF ABBREVIATION

AC	Alternating Current
CAPEX	Capital Expendicture
CCS	Combined Charging System
CHAdeMO	CHArge de Move
DC	Direct Current
DCF	Discounted Cash Flow
DCFC	DC Fast Charging
DoTM	Department of Transport Management
DPP	Discounted Payback Period
EBIT	Earnings Before Interest and Taxes
ERC	Electricity Regulatory Commission
EVs	Electric Vehicles
EVSE	Electric Vehicle Supply Equipment
IEC	International Electrotechnical Commission
IRR	Internal Rate of Return
kW	kilowatt
LDVs	Light Duty Vehicles
MW	MegaWatt
N/A	Not Available
NPV	Net Present Value
OCPP	Open Charge Point Protocol
OPEX	Operating Expenditure
RFID	Radio Frequency Identification
SOC	State Of Charge
USAID	US Agency for International Development
WACC	Weighted Average Cost of Capital

CHAPTER ONE: INTRODUCTION

1.1 Background

The development of electric vehicles (EVs) has become a good opportunity for Nepal to decrease oil consumption and enhance air quality in major urban city. In current scenario, almost all consumed petroleum oil is imported from India which is increasing trade deficit of Nepal (Khanal & Khanal, 2020). Similarly, petroleum product along cover 23% of total import by Nepal in FY 2018/1019 (Singh, 2018/2019). Nepal imports all petroleum products, with more than two-thirds of them used in the transportation sector. On the other hand, the total installed electricity generation capacity of Nepal is 1377.9 MW (DOED, 2021) and some import from India in dry season is fulfilling today's demand. By 2030, the clean energy generation will be 15,000 MW (SNDC, 2020). Similarly, Nepal Electricity Authority (NEA) has done Power Purchase Agreement (PPAs) for 5978.134 MW (NEA, 2020). From this we can say that Nepal will have surplus electrical energy in coming years. This surplus energy supply can be balanced by creating demand from growing number of EVs through EV charging station.

Ministry of Finance have plan of encouraging electric vehicles to control the adverse effects of environment pollution on human health and promote clean and environment friendly development. A strategic plan will be formulated and implemented by 2031 AD (2088 BS) to replace the light vehicles powered by fossil fuels by electric vehicles (MOF, 2021/2022). According to Motor Vehicles and Transport and Transport Management act 2049, Light Vehicles are those having weight less than four tons (4,000 kg). Which includes almost all sport utility vehicle (SUV) and small vans. Similarly, second NDC making target of EV sales of 25% of all private passenger vehicles, including two wheelers and 20% of all four wheelers public passenger vehicles by 2025 (SNDC, 2020). On the other hand, Nepal Electricity Authority (NEA) is planning to establish charging station infrastructure in different part of country to increase demand of electricity (NEA, 2020).

To achieve these goals, charging station infrastructure is major inevitable necessities for widespread acceptance of EVs. The rate of EV intake is majorly dependent on the availability of proper charging infrastructure with minimal charging time (Mishra, et al., 2021). There are various types of barrier which influencing the growth of EVs (Adhikari, Ghimire, Kim, Aryal, & Khadka, 2020) and identified seventeen barriers and categories them in five categories which is importance against the diffusion of EVs in Nepal. They found that infrastructure barriers (24.60%) is the major barrier among other which hindering the uptake of EVs in Nepal. Range limitation is also one of the major obstacles that influencing the growth of EVs. Customer will not buy an EVs if they cannot assure that constantly-available and compatible charging station is present to solve the range anxiety problem (Bonges III & Lusk, 2015). The other major problem for EV charging is its charging time. It depends upon the vehicle battery capacity and charging power. Level 1 charging (slowest), Level 2 charging (moderate) and Level 3 charging (DC-fast) are the three method of charging EVs (Yilmaz, 2012). For public charging station, Level 3 charging, whose charging power level is above 50kW is best option to reduce charging time of EVs. DC fast charging (DCFC) can recharge an EV in approximately 30 minutes (Kettles, 2015). Presently, there exists four types of DC fast charging system used globally. Which are CCS/COMBO (Combine Charging System) (North America and Europe standard), CHAdeMO (Japanese Standard), Tesla Supercharge (Tesla only) and GB/T (Guobiao standards).

Development of EV technology parallelly carry out new infrastructural facilities into business (Bagherzadeh, Ghiasian, & Rabiee, 2020). As there is issue in range of EVs, there is need fast charging station in between long-distance travel. This incorporate the necessity of charging station in desired location. This has created a new business sector. It is currently difficult to build a beneficial business case for publicly available EV charging investments for numerous reasons. These consist of high initial investment costs, low and unsure near-term demand for publicly available charging, and commercial charging competing with home charging (Nigro & Frades, 2015). There is various factor that affect the economic/financial status of public charging station. Those factors that affect directly to the economics of public charging station were called direct factors and that affect indirectly are called indirect factors (Zhang, et al., 2018). Direct factor includes Charging Demand, Charging Price, No. of PEVs, Construction Subsidy, Operation Subsidy, Location, Unit cost of Charging Piles, No. of Charging Piles, Electricity Price, Maintenance Cost, Ground Rent. Similarly, indirect factor includes Charging Infrastructure Tech, EV Technologies, Policies on EV, Battery Technologies, Psychological Factors and Behaviors of EV Customers (Zhang, et al., 2018). To attract private sector to invest in EV charging station, total revenues must be greater than the project's cost (Nigro & Frades, 2015).

Direct and Indirect Revenue (R) > Capital Costs(C) + Operating Costs(O)+ Cost of Funds(F)

Where:

- Capital Costs are the cost of equipment and Installation
- Operating Costs are the ongoing costs to maintain
- Cost of Funds are the cost of paying interest on debt and investor returns on equity
- Direct Revenue are from sell of electricity and other direct fee
- Indirect Revenue are funds that came through sale of other products in charging station premises.

By varying the charging utilization, direct and indirect revenue, and equipment and operating costs, the sensitivity analyses were performed to find the profitability and investment payback using EV Charging Financial Analysis Tool (Nigro, Seki, Davis, & Smith, 2019).

1.2 Statement of Problem

It is currently challenging to build a profitable business case for EV charging infrastructure investments for number of reasons. These include high initial cost of investment, low and uncertain future demand, and commercial charging competing with home charging.

1.3 Objective

The research objective are as follows:

Main Objective:

- To find out business model for financially sustainable electric vehicle (EV) charging station using EV charging financial analysis tool.

Specific Objectives:

- To analyze and estimate the growth rate of EVs in Nepal.
- To develop EV charging business models that capture corporate value in addition to selling electricity.
- To Identify the role of government in promoting business models.

1.4 Assumptions and Limitations

Following assumptions were made for the study

- Only Light Duty Vehicles (LDVs) is considered.
- State of Charge (SOC) of the vehicle while incoming is considered not less than 10% and full charge of EV is considered at 80%. Beyond 80% SOC of vehicle, the rate of charging at decaying current can be half (Berman, 2019).
- 2021 Kia Niro EV is taken for charging time calculation.
- Exchange rate of US Dollar to Nepalese Rupees is taken as average of a month July 15, 2021 to August 15, 2021 (1 US Dollar = NPR.119)
- This study took number of electric vehicles from different EV seller company in Nepal. The result would be better if accurate number of electric vehicles were available.

CHAPTER TWO: LITERATURE REVIEW

2.1 Overview of EV Charging Station

The EV charging station comprises of utility grid, transformer, charging equipment, EV charger, energy meter, software platform, network operating center and other relevant components (Saxena, 2021).

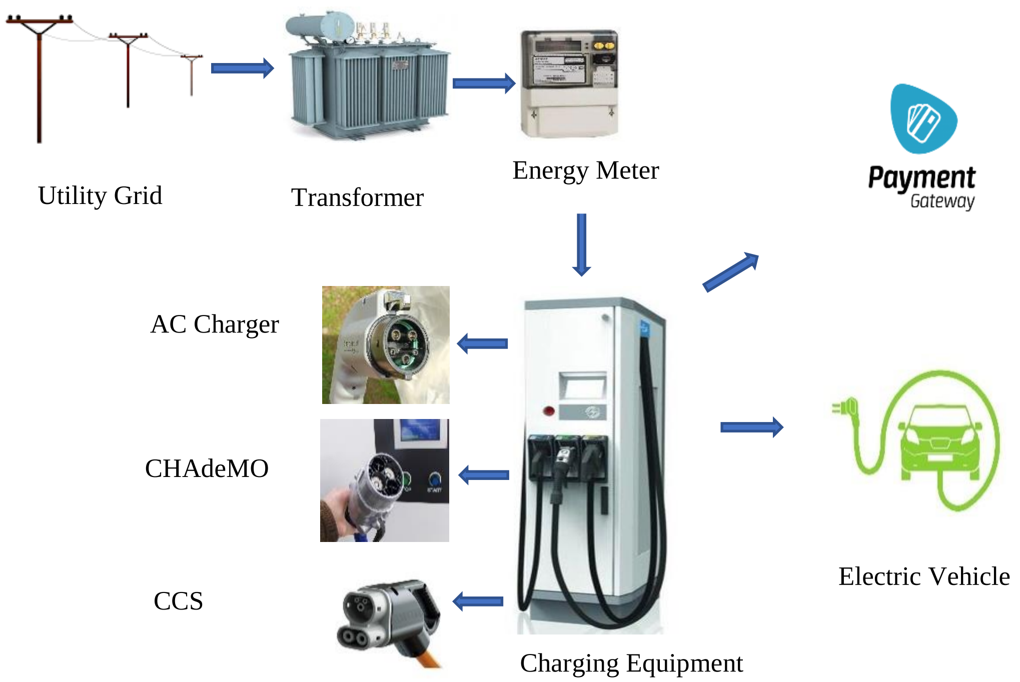


Figure 2. 1: Overview of EV Charging Station

EV charging equipment provides different power output for EV charging. Based on the power output of charging equipment, four modes of charging were defined in international standard IEC 61851-1 (IEC, 2017) .

- Mode 1: It refers to the connection of an EV to AC supply of less than 250V for single phase and less than 480V for three phases at 50-60 Hz. It uses normal household socket system not exceeding 16 A of current. This is the slowest mode of EV charging which charges an EV at the rate 1.3 kW and can go up to 7 kW. It takes 4 to 8 hours of time to full charge depending upon the battery capacity and vehicle type. This is the most basic form of EV charging which is mainly used at home and office.
- Mode 2: It refers to the connection of an EV to the AC supply with the same voltage limits as for the Mode 1 not exceeding 32 A of AC current. The rate of EV charging

will be higher than mode 1 and it takes 2 to 4 hours of charging time. It is differ from mode 1 on the fact that it includes a control pin in vehicle inlet and connector. The supply network side might not contain control pin as the control function is provided by control box. This mode of charging is used for dedicated private facilities.

- Mode 3: It refers to connection of the EV to the AC supply using an electric vehicle supply equipment (EVSE) and current limit is below 63 A. Control equipment is permanently embedded to AC supply. This is the fastest charging for AC system which can charge an EV within 1 to 2 hours depending upon the battery capacity and vehicle type at 50/60 Hz. It contains control and signal pin for both sides of the cable. The rate of an EV charging will be around 43 kW. This mode of charging is typically used in public charging station.
- Mode 4: All above three modes of charging has AC supply where on board charging convert AC to DC and then battery charging. By doing so, we cannot get higher rate of EV charging which is crucial for long range drive. In this mode of charging an EV, the supply AC is first converted in DC in charging station and then it delivers to vehicle directly. This is also called as DC fast charging which can charge an EV within 30 minutes from 0% to 80% of state of charge (SOC). The allowable current limit is 125 A and voltage of 500 V for CHAdeMO standard connector (Hõimoja, Rufer, Dziechciaruk, & Vezzini, 2012). Off-board chargers were used to charge an EV. DC fast charging stations require the installation of dedicated three-phase power supply equipment that draws significantly higher amperage than AC. This mode of charging is best for public charging station to remove anxiety range.

Table 2. 1: IEC 61851-1 Charging Modes

Charging Mode	Max. Current per phase	Charging Time	Vehicle Battery Charger
Mode 1	16 A	4-8 h	On Board
Mode 2	32 A	2-4 h	On Board
Mode 3	63 A	1-2 h	On Board
Mode 4	400 A DC	30 min	Off Board

2.2 Electrical Vehicle Connectors

The charging cable may be connected to the car inlet using a variety of connections. IEC 62196-2 specifies AC connections, whereas IEC 62196-3 specifies DC connectors.

- Type 1 connector (SAE J1772)

Three big pins – comparable to the power outlet arrangement at home – and two smaller pins for the car connection characterize the J1772 connector. Phase, Neutral, and Ground are represented by the three large pins, while communication between the charger and the electric vehicle is represented by the two small pins (Pilot Interface).

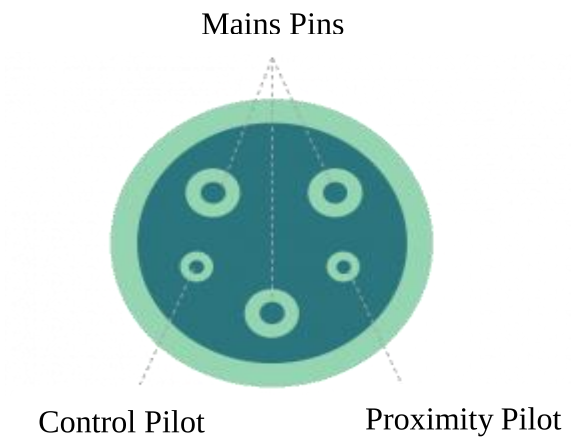


Figure 2. 2: J1772 (Type 1) Charger

(Source: IEC 62196-2)

It has a power output range of 3 to 7.4 kW and only supports single phase with a maximum current of 32 A. It has an additional security feature that locks the connector when charging, preventing third-party disconnection.

It is mostly used in the United States and Japan, although it is also widely recognized in Europe.

- Type 2 connector (IEC 62196-2)

With an AC charging station, a Type 2 connection is utilized.

This connection type has been accepted as a European standard. The connection has a distinctive shape that is rounded on the top yet flat on the bottom. It features a pin distribution identical to type 1, but with two additional pins to correspond to the two extra phases required for three-phase charging.

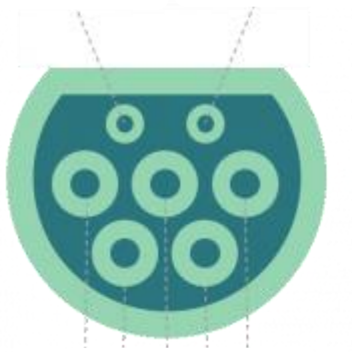


Figure 2. 3: Mennekes (Type 2) Charger

(Source: IEC 62196-2)

With an AC charging station, a Type 2 connection is utilized.

This connection type has been accepted as a European standard. The connection has a distinctive shape that is rounded on the top yet flat on the bottom. It features a pin distribution identical to type 1, but with two additional pins to correspond to the two extra phases required for three-phase charging.

It supports single phase up to 16 A and three phases up to 63 A and can recharge between 3 and 43 kW. The T2-S is an upgrade of this connection that adds an extra lock to the connector.

- Type 3

This connector has been taken out in favor of the type 2 connector.

CHAdeMO

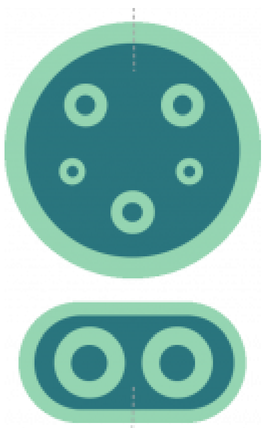
With a DC charging station, a CHAdeMO connection is utilized.

"Charge Move" is abbreviated as CHAdeMO. However, the acronym appears in a Japanese sentence: "O cha demo ikaga desuka," which means " You will have tea while the car is charging." This statement encapsulates the intention of the group, which includes Toyota, Mitsubishi, and Nissan, among others: rapid charging using direct current. As a result, car makers can install it next to an alternating current charging socket as a second socket.

It has a maximum power output of 62.5 kW and a maximum current of 125 A, however the updated CHAdeMO 2.0 specification allows for a maximum power output of 400 kW.

Combined Charging System (CCS) Combo 1

J1772 (Type 1)



DC Connector

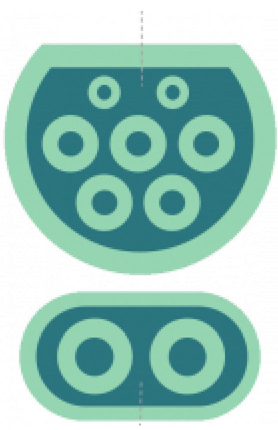
Figure 2. 4: CCS Combo 1 Charger

(Source: IEC 62196-2)

The CCS Combo 1 connection is based on the J1772 Type 1 connector; however, it has two extra pins. The DC Fast Charging System is designed for the Combined Charging System. The connection can charge up to 350 kW in both AC and DC modes

Combined Charging System (CCS) Combo 2 (IEC 62196-3)

Mennekes (Type 2)



DC Connector

Figure 2. 5: CCS Combo 2 Charger

(Source: IEC 62196-3)

The CCS Combo 2 connection is based on the Type 2 connector with two extra pins. The DC Fast Charging System is designed for the Combined Charging System. The connection can charge up to 350 kW in both AC and DC modes.

GB/T Connectors – China (AC & DC)

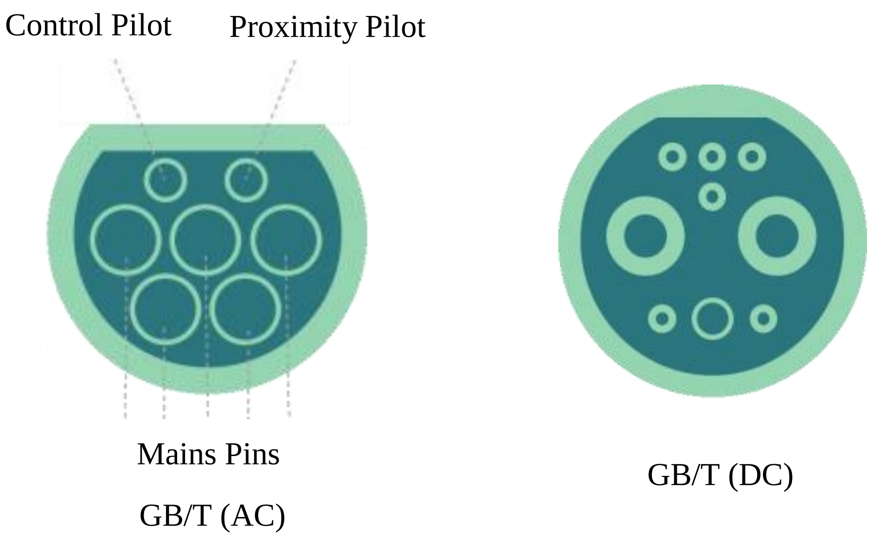


Figure 2. 6: GB/T Charger

(Source: Guobiao standard 20234.2-2015)

Chinese-made connections are unique in comparison to the rest of the globe, as China has the world's highest EV market share.

For basic AC charging, the GB/T (Guobiao standard) is basically the inverse of the Mennekes standard.

Tesla Connectors – AC & DC combined

Tesla has sold more electric vehicles than any other company and is frequently ahead of the competition in terms of research and development.

Tesla, unlike all other manufacturers, does not have a separate AC and DC charging port design. Instead, the same physical connection is used for both. The sole difference between Tesla Type 1 and Tesla Type 2 is that Tesla Type 1 is for North America and Tesla Type 2 is for Europe.

Tesla

Figure 2. 7: Tesla Supercharge

(Source: Tesla.com)

The Supercharger is a DC fast charger that can only be used by Tesla automobiles. Before the Supercharger station will enable access to the electricity, the electric car must be recognized as a Tesla model.

It uses the CAN protocol over the CP pin, same as the CHAdeMO. It also has the capacity to communicate via digital protocol rather than analogue protocol.

Tesla's latest cars are moving towards the Type 2 model over the Type 1 connector.

2.3 Previous Research

Research on "Methodology for assessing electric vehicle charging infrastructure business models", obtained the economic analysis of the impact of three electric vehicle (EV) charging scenarios on various electro-mobility actors. The needed charging station (CS) consumption is estimated in each of them so that the charging service operator (CSO) can pay its expenditures while the pricing for EV charging remains competitive with that of internal combustion engine (ICE) cars (Madina, Zamora, & Zabala, 2016).

Research on "The business case of electric vehicle quick charging – no more chicken or egg problem" found two important findings. First, to make one EV rapid charging station viable, the target consumers must first be identified. Users that require regular rapid charging to enable effective use of cars or vehicle fleets, such as delivery businesses, professional transportation, and public service vehicles, and who are willing to commit to frequent usage of the charging service, are target consumers. The total number of electric cars in the specified area is minor. Second, the required expenditure to establish a suitable charging infrastructure for electric vehicles is not insurmountable. Customers may charge at domestic places or parking garages, thus the demand for rapid charging stations is smaller than usually assumed (Markkula, Rutiainen, & Järventausta, 2013).

Study on “Long-term profit for electric vehicle charging stations: A stochastic optimization approach” found that a combined commercial-technical model for electric vehicle charging stations has been developed with the goal of increasing the CS owner's long-term profit (Bagherzadeh, Ghiasian, & Rabiee, 2020). A stochastic optimization problem has been constructed for the model to account for random factors such as power price and vehicles arrival.

Research on “Long term profit maximization strategy for charging scheduling of electric vehicle charging station” found that maximizing profit at each interval does not always imply maximization of the CS owner's long-term profit (Rabiee, Ghiasian, & Chermahini, 2018). According to the findings of case studies, the profit maximization strategy for each interval would result in an increase in the number of cars in lower-price lines, and hence an increase in their waiting time.

Report on “Assessing the Business Case for Hosting Electric Vehicle Charging Stations in New York State” conclude that making a financial case for charging stations is difficult, and there is no one-size-fits-all formula for overcoming expenses and achieving the level of utilization required to turn a profit at each location (Nigro, Seki, Davis, & Smith, 2019). The amount of money a charging station makes is determined by the length of each charging session, the number of charging sessions per day, and any charging-use costs.

2.4 Policy Review

Budget -Fiscal Year (FY) 2078/79

In public announcement of Income-Expenditure details of Fiscal Year 2078/2079, government set out a long-term strategic vison for electric vehicle sector.

The following are major provisions for electric mobility in the budget:

- Electric vehicle use will be encouraged in order to reduce the negative impacts of pollution on human health and to promote clean, environmentally friendly growth. By 2031 AD, a strategic strategy will be developed and implemented. Electric vehicles will gradually replace light automobiles fueled by fossil fuels. A task force will be formed for this purpose.

- There will exemption of renewal fee and road construction and maintenance fee for 5 year if the vehicles operated from fossil fuels are converted into electric vehicles.
- Companies that manufacture and assemble the world's top ten brands of electric vehicles will be encouraged to establish factories in Nepal. In addition to the tax incentive, the government would lease the land necessary for such businesses at no cost.
- In the following fiscal year, 5 hundred charging stations, terminal buildings, and other infrastructures will be built in various parts of the nation, including the Kathmandu valley, in collaboration with the private sector, in order to boost the usage of electric vehicles.
- To boost domestic consumption of power and promote the use of environmentally friendly modes of transportation, excise duty will be removed and significantly lowered customs tariffs on the import of electric cars.

Monetary Policy -Fiscal Year (FY) 2078/2079

This policy is prepared by Nepal Rastra Bank (NRB), whose goal is to achieve macroeconomic goals such as stability, growth, full employment, and a positive pay balance.

The following major provisions were made for electric vehicle sector in this policy:

- The bank has to disburse loans at cheap interest rates to build the necessary charging stations for electric vehicles. NRB has made such provision in the monetary policy of the current fiscal year. Now refinancing will be available on such loans. Its interest rate is up to 5 percent.

Second Nationally Determined Contribution (NDC)

Following Articles 4.2 and 4.11 of the Paris Agreement, as well as Decision 1/CP.21 paragraphs 23 and 24, and other relevant provisions of the Paris Agreement, the

Government of Nepal hereby presents its enhanced NDC for the period 2021-2030 under the Paris Agreement. In light of national conditions, the NDC considers the idea of common but differentiated duties and respective capacities.

The SNDC targets that address the transport sector include:

- Expand clean energy output from roughly 1,400 MW to 15,000 MW by 2030, with 5-10% coming from small and micro hydropower, solar, wind, and bio-energy.
- Electric vehicles (e-vehicles) will account for 25% of all private passenger vehicle sales, including two-wheelers, and 20% of all four-wheeler public passenger vehicle sales in 2025 (this public passenger target excludes electric rickshaws and electric-tempos).
- Increase e-vehicle sales to 90 percent of all private passenger vehicle sales, including two-wheelers, and 60 percent of all four-wheeler public passenger vehicle sales by 2030 (the public passenger target excludes electric rickshaws and electric tempos).

CHAPTER THREE: RESEARCH METHODOLOGY

This chapter presents the whole research process and methodologies used to solve the research topic. The main objective of the research is to build the business model for financially stable EV charging station. For this, EV charging financial analysis tool is used. The tool uses different inputs parameter from three different potential partners owner operator, private sector and public sector. The primary market data were collected from different entity in unstructured format as the data lacks a proper sequence or format. The secondary data were collected from different resources. Thus, collected inputs parameter were entered in tool to get outputs for three partners. All together three different scenarios were analyzed by varying the different input parameters such as electricity cost, government subsidy, indirect revenue sources etc.

The chart below summarizes the research framework.

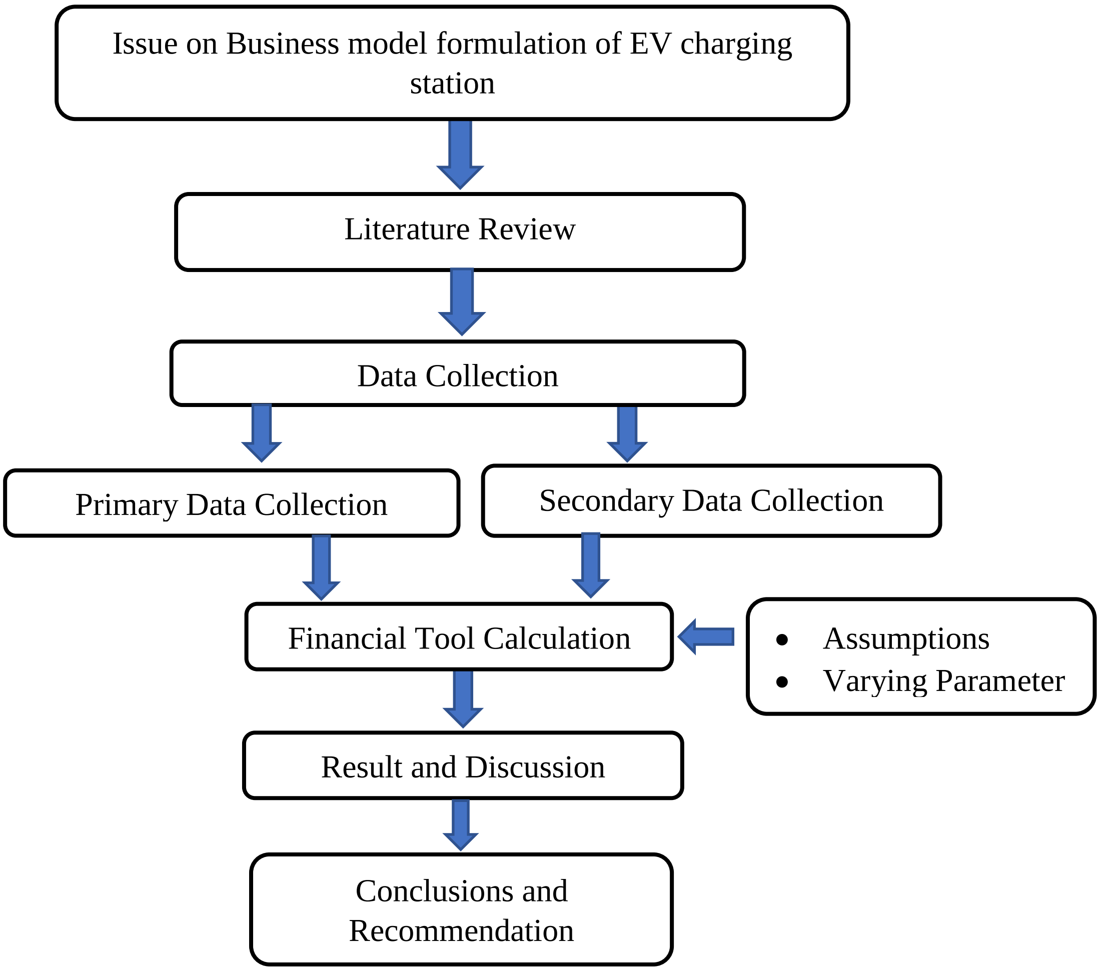


Figure 3. 1: Research Framework

3.1 Data Collection

Primary data collection and secondary data collection are the two methods utilized to acquire data. The primary data were collected from unstructured interview/questioner.

3.1.1 Primary Data Collection

In order to calculate the financial parameters for three partners, following data were collected.

- Electric Vehicles (EVs) Number

The total number of EVs (as LDVs) registered till mid 2021 is not available in DoTM sources. To find the number of EVs as LDVs, the data were collected from almost all major EV seller company such as Build Your Dreams (BYD), Mahindra, KIA, Hyundai, Morris Garages (MG) etc. We have taken unstructured interview/questioner to the respective EV seller's sales manager to find the more accurate number of EV sales in Nepal till mid-2021. The total number of EV sales was found to be 2500.

Table 3. 1: Number of EV sales in Nepal

<table>
<tr><th>Brand</th><th>Model</th><th>Type</th><th>Total EV sales till 2021</th></tr>
<tr><td>BYD</td><td>e6</td><td>EV</td><td>90</td></tr>
<tr><td>BYD</td><td>New e6</td><td>EV</td><td>0</td></tr>
<tr><td>BYD</td><td>M3</td><td>EV</td><td>5</td></tr>
<tr><td>KIA</td><td>SOUL</td><td>EV</td><td>100</td></tr>
<tr><td>KIA</td><td>NIRO</td><td>EV</td><td>290</td></tr>
<tr><td>Hyundai</td><td>IONIQ</td><td>EV</td><td>25</td></tr>
<tr><td>Hyundai</td><td>KONA</td><td>EV</td><td>450</td></tr>
<tr><td>Mahindra</td><td>e20 plus (P8)</td><td>EV</td><td rowspan="5">670</td></tr>
<tr><td>Mahindra</td><td>e20 plus (P4)</td><td>EV</td></tr>
<tr><td>Mahindra</td><td>e20 plus (P6)</td><td>EV</td></tr>
<tr><td>Mahindra</td><td>E-verito</td><td>EV</td></tr>
<tr><td>Mahindra</td><td>E-Supro</td><td>EV</td></tr>
<tr><td>MG</td><td>MG3</td><td>EV</td><td rowspan="4">350</td></tr>
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<tr><td>MG</td><td>MG ZS</td><td>EV</td></tr>
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<tr><td>Thego</td><td>Danfe</td><td>EV</td></tr>
<tr><td>Thego</td><td>e-Bus</td><td>EV</td></tr>
<tr><td>Derry</td><td>EV7</td><td>EV</td><td rowspan="2">60</td></tr>
<tr><td>Derry</td><td>New e6</td><td>EV</td></tr>
<tr><td colspan="3">Others</td><td>380</td></tr>
<tr><td colspan="3">Total Sales</td><td>2500</td></tr>
</table>

- Indirect Revenue

There are different indirect sources of revenue which exist with the placement of charging station. These sources of revenue have major role whether charging station financially survive or not. Such as grocery sell, advertisement revenue, sales increase from hospitality sector (hotels/ resort) etc.

Revenue from hotels/resort is taken from Riverside Spring Resort, Kurintar, Chitwan which lies in Pritivi Highway. There exist DC fast charging (50 kW) from past 4 year.

Table 3. 2: Indirect Revenue from Hotel/Resort

Indirect Revenue (Hotel/Resort)	
Resort	Riverside Spring Resort
Per Day EV flow	5
Average Passenger in one EV	4
Total Passenger flow per day (Only EV)	25
Average Revenue per EV customer (NPR)	500
Total Revenue per day	10000
Working hour of charging station	2.5
Revenue Per Customer Per Minute (NPR)	3.3
In US Dollar ($)	0.03

Revenue from grocery sell is taken from the resort itself and Sangam Kirana Store and Riverside Resort, which lies nearby of resort.

Table 3. 3: Indirect Revenue from grocery sales

Grocery Revenue	
Shop	Sangam Kirana Store and Riverside Resort
Per day customer flow	20
Per Customer Revenue	250
Total Revenue	5000
Working Hours	2.5
Revenue Per Customer Per Minute (NPR)	1.67
In US Dollar ($)	0.01

3.1.2 Secondary Data Collection

- Initial Investment

The CAPEX and OPEX for a public charging station were taken as follows:

The charging equipment sample taken for the analysis is ‘Ark 120 kW DC and 22 kW AC Output Electric Car Charger Stations for EV Charging in CCS CHAdeMO AC Type-2 with RFID and OCPP1.6.’ The cost of equipment is NPR. 28,24,290 (Nanjing Ark Tech Company Ltd, 2020) and added 10% as shipping cost which is equivalent to the shipping cost based on per kg. 13% VAT is also added on it.

Table 3. 4: Capital Expenditure (CAPEX)

CAPEX		
Items	Description	Cost (NPR)
Charging Equipment (kW)	142	28,24,290
Shipping Cost	10%	2,82,429
TAX	13%	3,67,158
Total		34,73,877
Electrical Cost		
Transformer (KVA)	200	10,23,900
Transformer Mounting Set (Channel, Bracing Angle, Bracing Band, Nut Bolt, V-Arm etc. all complete)	1	50,000
Steel Tubular Pole (11m Long)	2	39,100
Other Accessories (Lighting Arrestor, DO fuse, GO Switch, Pin and Disc insulator, stay set, earthing set etc)	1	29,355
Panel Board, TOD Meter, MCCB	1	97,540
HT Cable (3 core*25mm XLPE HT 11KV Al Cable, and termination set, m)	150	43,250
4 core 185sq. mm XLPE CU Cable(m)	50	453,200
TOTAL		17,36,345
VAT	13%	2,25,725
TOTAL ELECTRICAL COST		1,962,070
Civil Cost		
Civil Works (Flooring, Painting)		70,000
TOTAL CAPEX		5,435,947
TOTAL CAPEX in US Dollar		$ 45,680.22

The cost of the electrical equipment such as 200 KVA transformer, cabling, panels, energy meter and other accessories (transformer mounting set, steel tubular pole, lighting arrestor etc) is NPR.19,62,070 ((Kathmandu District Price Rate, 2020).

Similarly, for OPEX, site maintenance is taken as 5 % (atlas assumption). The other operating cost such as Network service provider fee, EVSE management software fee, payment gateway fee were NPR. 130,584 (Shah, 2019) . Land leasing cost is ignored for this study, as most of the EV seller are placing their charging station in hotels area, resort area for free.

Table 3. 5: Operating Expenditure (OPEX)

OPEX		
Descriptions		Cost (NPR.)

Network Service Provider Fee	1	9,600
Payment Gateway		9,600
EVSE Management Software Fee (considered as 10% of net margin on electricity charges)		1,855
TOTAL OPEX		130,584
TOTAL OPEX in US Dollar		1097.34

The cost of electricity for EV charging station for medium voltage user (11KV) is NPR. 5.60/kWh (Electricity Regulatory Commission, 2077).

- Indirect Revenue Sources

Revenue from advertisement is NPR.6,95,314.29 (Pixeltouch, 2021). This revenue is based on per minute cost model. Following assumption were made to calculate advertisement revenue.

- Daily Working Hour for charging station - 16 hr
- Per Year Working Days - 360 days

Table 3. 6: Advertisement Revenue

Indirect Revenue (Advertisement Revenue)			
	Type A (full year)	Type B (6 month)	Type C (monthly)
Unit cost per minute (NPR)	5	10	20
Average cost per hour	300	600	1200
Occupancy			
80%	240	480	960
60%	180	360	720
40%	120	240	480
30%	90	180	360
20%	60	120	240
Average	60	120	240
Overall average	120.7		
Yearly (NPR)	6,95,314.29		
Revenue	$ 5,842.98		

(Source: Pixel Touch Pvt. Ltd)

- Electricity Tariff rate

To help the growth of number of Electric Vehicles in Nepal, government entity called as Electricity Regulatory Commission (ERC) made tariff structure for EV charging station.

For middle level voltage (11KV), energy charges (kWh) is NPR. 5.60 and demand charges per KVA is NPR. 230 (Electricity Regulatory Commission, 2077).
ERC has given permit of 20% benefit in charging station electricity sell.

- Existing EV charging network in Nepal

Currently automakers like BYD, Hyundai, Kia motors, Mahindra and government entity NEA installing charging station throughout the country. Leading automaker installing charging station at their service center or EV selling dealer for their own vehicle customers.
NEA did bid for 50 charging station and Chinese company for the supply, installation, test, operation and maintenance of the charging station equipment. Following are the location of 50 charging station placement from NEA:

Table 3. 7: Province wise charging station number

Province Number	Number of Charging Station
1	5
2	7
3	13(outside Kathmandu valley) +7 in Ktm
4	6
5	8
6	1
7	3

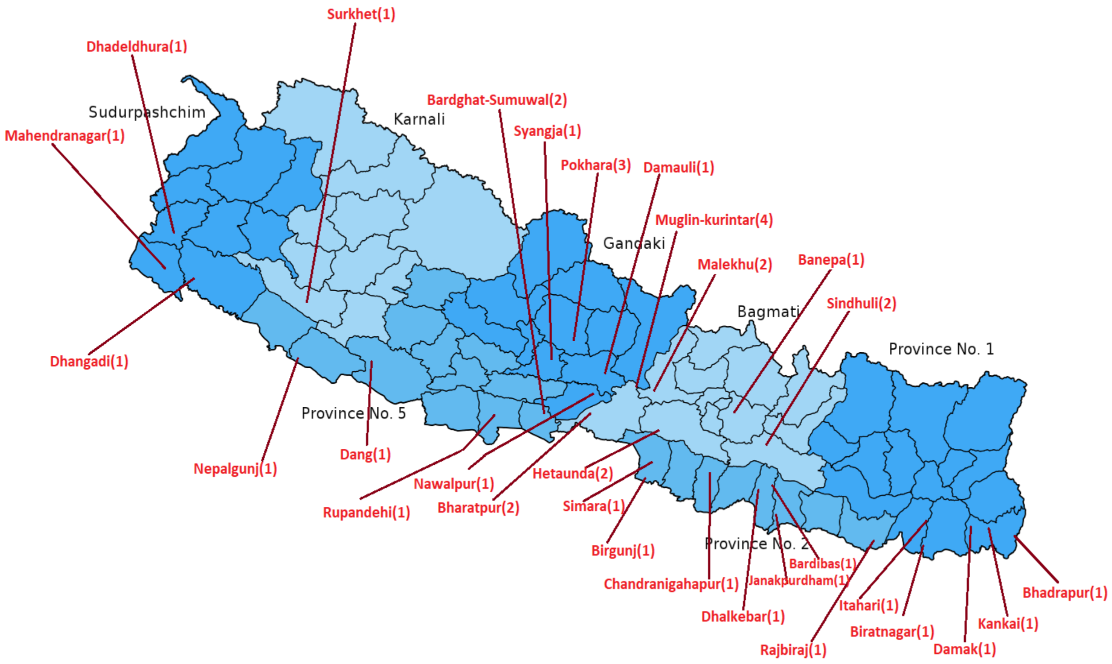


Figure 3. 2: Location of Charging Station to be installed by NEA

(Source: NEA,2020)

From the Private Automaker side, BYD have more charging station than other. Currently automaker focus on Kathmandu valley only and some outside valley which are as follows:

Table 3. 8: Location and number of charging station from BYD

Main Office (Bhatbhateni)	2
NEA	2
President Office	1
Singhadarbar	4
Medical Education Counsil, Bhaktapur	1
Sajha Yatayat, Pulchowk	1
Tinkune	1
Pokhara	1
Butwal	1
Chitwan	1
Bardibas	1
Itahari	1

Lumbini Development Trust	13

(Source: BYD Nepal)

- Registration of Light Duty Vehicles (LDVs)

LDVs mainly contain cars, jeeps, vans, pickups and microbuses having weight less than four tons (4,000 kg) (Nepal Law Commission, 2018). Department of Transport Management (DoTM) manage the registration of vehicles in Nepal. There is only car/jeep/van as LDVs till 2001 (Department of Transport Management, 2019). From 2002, other two categories of LDVs, pickup and micro were added in the list. So, for the sound calculation, vehicles registration from 2002 were taken for the analysis.

Table 3. 9: LDVs Registration

Year		Car/Jeep/Van	Pickup	Micro	Total
AD	BS				
2002	059/60	2906	581	232	3719
2003	060/61	7079	478	884	8441
2004	061/62	4781	0	584	5365
2005	062/63	5114	36	66	5216
2006	063/64	5156	736	138	6030
2007	064/65	4741	1588	31	6360
2008	065/66	6857	1287	128	8272
2009	066/067	12268	1975	145	14388
2010	067/068	8510	3087	115	11712
2011	068/069	8711	2981	155	11847
2012	069/070	9595	5422	158	15175
2013	2070/71	11372	5668	178	17218
2014	2071/72	13560	6057	932	20549
2015	2072/73	28361	5060	1137	34558
2016	2073/74	21292	10675	841	32808
2017	2074/75	24338	10342	1934	36614
2018	2075/76	17953	6987	1431	26371
Total		192594	62960	9089	264643

(Source: DoTM,2075/2076)

A massive increase in LDV registration (Figure below) occur with an annual growth rate of 16% during the last decade. Out of total vehicle registration, LDVs average share is 8% and about 78% of LDVs are car/jeep/van 19% pickup, and 3% microbus. There is 12% increment in registration of car/jeep/van from 2002 to 2018, followed by 17%

pick-up and 12% van. The annual growth rate of car registration is 12% (Dhonju, Shankar, & Shrestha, 2019).

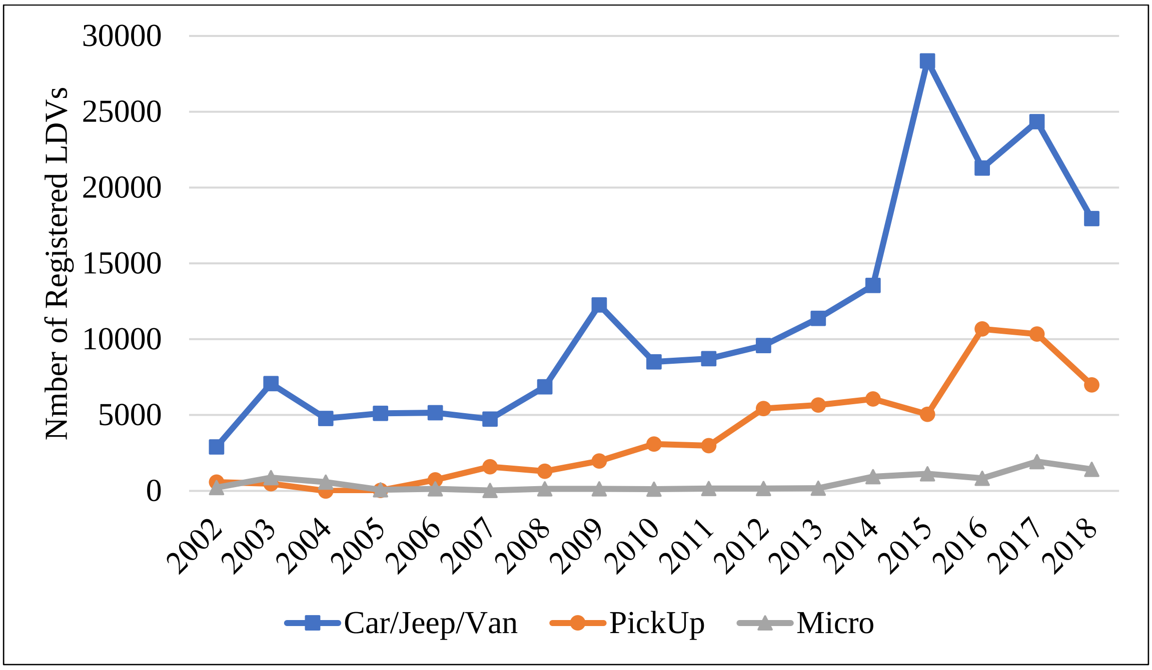


Figure 3. 3: LDVs registration in Nepal from 2002 to 2018

(Source: DoTM,2075/2076)

- Financial Parameters

For owner-Operator Inputs, financial mix of 75% equity and 25% debt is taken (Rajkumar, 2021). The equity portion is funded by private sector or owner operators itself, whereas 25% debt funded by public sector. This division of debt/equity can be changed as per situation.

Risk free rate is taken as 3.24% ((Nepal Rastra Bank, 2019) and market risk premium of 11.54% ((Amatya, 2018). So, the cost of equity for owner-operator comes around 14.78%, which is used to discount the cash flow in future. The cost of debt is considered as 5% (Nepal Rastra Bank, 2021).

Similarly, for private sector inputs, the weighted average cost of capital (WACC) is 12% (USAID, 2020) . Marginal tax rate is taken as 12.5%, which is assign for cable car, trolley bus business (Inland Revenue Department, 2020).

For public sector partner inputs, cost of capital is 5%, which is used to give debt for owner-operator (Nepal Rastra Bank, 2021).

By using all these inputs, discounted cash flow (DCF) is used to calculate NPV, IRR, DPP.

Discounted Cash Flow (DCF):

Financial analysis is necessary to identify the profitability and investment payback. The tool uses discounted cash flow (DCF) method using free cash flow and weighted average cost of capital (WACC) for all partners associated with EV charging station system.

$$E_0 + D_0 = PV_0(WACC_t; FCF_t) \tag{1}$$

Equation (1) indicates that the present value(PV_0) of expected free cash flows (FCF) that the company will generate, discounted at the weighted average cost of debt and shareholder's equity after tax (WACC) will be equal to the value of the debt (D_0) plus that of the shareholder's equity (E_0) (Fernández, 2007).

WACC is given by equation (2):

$$WACC_t = \frac{\{ E_{t-1}Ke_t + D_{t-1}Kd_t(1-T)\}}{\{E_{t-1} + D_{t-1})} \tag{2}$$

Ke is the required rate to equity, Kd is the cost of debt, and T is the effective tax rate applied to earnings. $E_{t-1} + D_{t-1}$ are market values.

By using DCF method, we obtain financial indicators such as Payback period, internal rate of returns and net present value.

$$DPP = \frac{\ln\left(\frac{1}{1-\frac{Ixr}{A}}\right)^{-1}}{\ln(1+r)} \tag{3}$$

$$NPV = -I + \frac{F_1}{(1+r)} + \cdots + \frac{F_n}{(1+r)^n} \tag{4}$$

IRR is given as

$$0 = NPV = -I + \frac{F_1}{(1+IRR)} + \cdots + \frac{F_n}{(1+IRR)^n} \tag{5}$$

Where,

DPP : Discounted Payback Period
NPV : Net Present Value
IRR : Internal rate of return
I : Initial Investment
A : Annual return
F : Future Values

r : Interest rate

Subtracting the present value of cash outflows from the present value of cash inflows yields net present value.

$$NPV = PV_{inflows} - PV_{outflows} \quad (6)$$

The project should be accepted if NPV is positive (i.e. NPV >0) otherwise rejects.

Similarly, IRR is the discount rate which makes NPV=0.

The project will be accepted if the internal rate of return (IRR) is greater than the cost of capital otherwise rejects.

Discounted Payback period is calculated using discounted cash flows of the project at given required rate of return. It gives the number of years for breakeven of project.

3.1.3 Multiple Scenarios

In order to analyzed the financial sustainability of charging station, there are various factor that affect it. Such as government subsidy, indirect revenue sources, electricity price. By varying these parameters, we made three scenarios as follows.

Scenario A: Base Case Scenario

This scenario contains basic calculation in normal case i.e. operation of public charging station alone. There will be no government subsidy nor any indirect revenue sources.

Service life	- 10 year
Electricity selling price	- NPR. 6.72
Discount rate for owner operator	- 14.78 %
Discount rate for Private partner	- 12 %
Discount rate for Public Partner	- 0 %
Equity Funded	- 100 %
Debt Funded	- 0 %
Annual advertisement revenue	- NPR. 0
Revenue other than electricity sell	-NPR. 0

Scenario B: With Government Subsidy but No Indirect Revenue Sources

As the scenario name itself explain, this scenario only contains government subsidy. The revenue from advertisement, grocery sales and other sources were excluded.

Service life	- 10 year

Electricity selling price - NPR. 6.72

Discount rate for owner operator - 14.78 %

Discount rate for Private partner - 12 %

Discount rate for Public Partner - 5 %

Equity Funded - 75%

Debt Funded - 25 %

Scenario C: With government subsidy along with indirect revenue sources

This is the most possible best-case scenario of this project. If any financial parameters were negative, the project will not be financially feasible.

Service life - 10 year

Electricity selling price - NPR. 9

Discount rate for owner operator - 14.78 %

Discount rate for Private partner - 12 %

Discount rate for Public Partner - 5 %

Equity Funded - 75 %

Debt Funded - 25 %

Annual advertising revenue - NPR. 6,95,314

3.2 EV Charging Financial Analysis Tool

3.2.1 Overview of the tool structure

The EV Charging Financial Analysis Tool is a powerful Microsoft Excel based tool that is capable of analyzing different business arrangements, sophisticated public-private partnerships using various financial parameter of electric vehicle charging projects. The tool was developed by Cadmus Group and the Centre for Climate and Energy Solutions and has been maintained by Atlas Public Policy since 2015.

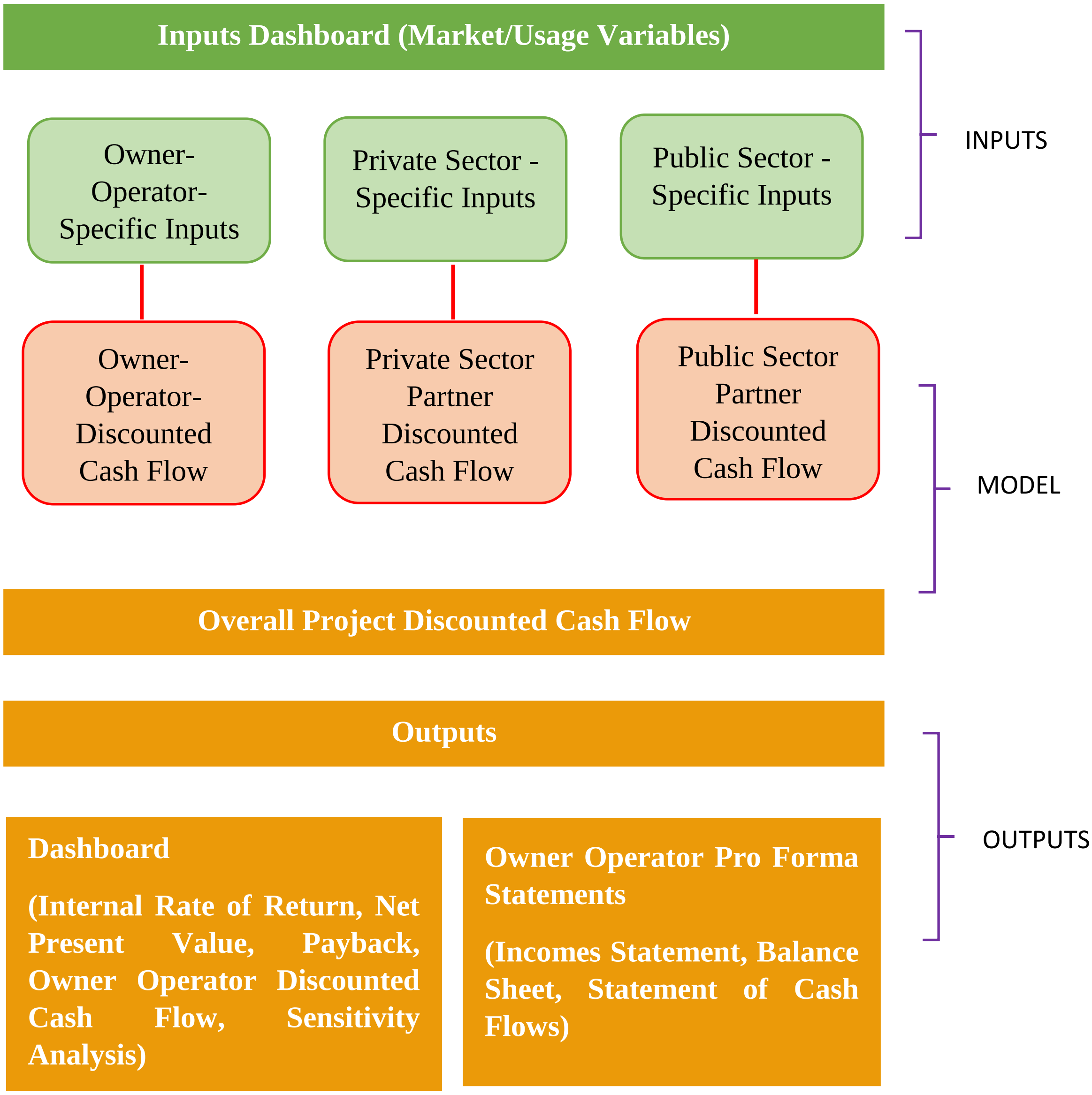


Figure 3. 4: Structure of the EV charging financial analysis tool

There are four functional areas, which consist of multiple like-colored tabs within the spreadsheet, as follows:

- Overview and Setting - Black Tabs
- User Inputs - Light Blue Tabs
- Financial Calculations – Green Tabs
- Analysis Results and Financial Statements – Dark Blue Tabs

Information flows from the user inputs, to the calculations, to the analysis results as shown in figure above.

The tool analyzes the presented EV charging infrastructure investment from the perspective of three different potential partners, a private sector owner-operator, a private sector partner who contributes funding to project establishment, and a public sector partner who contributes funding or in other ways helps financial project deployment. The role of these three partners are describe below. It takes information about the overall EV market and the owner-operator.

- Owner- Operator - They owns and operates the charging station and receives the revenue associated with charging services.
- Private Sector Partner – It is the organization that provide funding to the owner operator, to help pay charging network deployment costs. The establishment of charging infrastructure will benefit this partner by increasing income associated with the provision of EV charging services. This organization is presumed to recognize this benefit and be prepared to share a portion of its revenue or otherwise subsidies the development of EV charging infrastructure.
- Public Sector Partner - A state or local authority that donates funds or enacts rules to help a private owner-operator implement a charging network successfully. The public partner is believed to value charging infrastructure deployment because of the public benefit and is prepared to help the owner-operator through a mix of low-interest financing, subsidies, and other means.

3.2.1.1 User Input Tabs

We can enter the inputs for three different partners for financial analysis. These partners contain following inputs:

- Market Inputs - This section contains information on the projected total demand for EV charging services, as well as the predicted increase of that demand. For use in the public benefit calculations, we may also include market-level assumptions concerning fuel and environmental performance. we have two choices for entering predicted charging station use on this tab.
- Owner- Operator Inputs – This section contains information on charging equipment (the tool allows for up to three distinct types of equipment, each with its own cost, technical, and usage characteristics), revenue sources, costs, investment/funding sources, and other factors that directly or indirectly affect financial statements for the owner operator.

- Private Sector - This section contains information on the private sector partner's income streams and costs. The model provides three types of revenue: revenue from site leasing, revenue from sales as a result of increased site traffic, and indirect revenue (revenue unrelated to the amount of time a client spends at a charging station). These can be used in combination with one another or independently. This tab also specifies how much of the earnings will be split with the owner operator, as well as if the private sector partner will provide extra funding.

Public Sector Partners Inputs - Contains variables that specify the public sector's engagement, such as whether the government would offer low-interest financing, equity, a one-time grant, or continuing financial assistance.

3.2.1.2 Sensitivity Input Field Selection

The tool has many inbuild input parameters from which we can select 10 sensitivity parameters for one-time analysis. The following input parameters were selected for this study.

- Expected annual utilization growth rate (%).
- Projected annual growth rate of EVs as a percentage of total registered vehicles (%).
- Electricity retail price in first year (type 1 station) [$/kWh]
- Average charging energy per type 1 session [kWh/session]
- Annual advertising revenue (In-station advertising) [$]
- Annual maintenance cost as percentage of equipment value (type 1 station) [%]
- Average time of charging session (type 1 station) [minutes]
- Projected annual growth rate of EVs as a percentage of total registered vehicles
- Maximum number of charging sessions per type 1 station [sessions/year/station]
- EV fuel economy [miles per kilowatt-hour]

3.2.1.3 Financial Calculation Tabs

This section shows details of the discounted cash flow (DCF) analysis from the perspective of each of the three partners and for the investment as a whole (total cash inflows and total cash outflows). An investment might have a favorable overall financial performance yet be financially unviable for one or more of the individual members, or vice versa.

3.2.1.4 Output Tabs – Analysis results and financial statements

A dashboard presents the results of the discounted cash flow analysis and a sensitivity analysis on several critical inputs in the dark blue output tabs. The final three output tabs feature financial statements similar to those used by entrepreneurs or private corporations to discuss financial results.

3.2.1.5 Outputs Dashboard

The output dashboard shows major financial performance of each of the partners.
Financial parameters include:

- Total Capital Investment – The total investment by all participating organizations.
- Net Present Value (NPV) - By aggregating incoming and outgoing cash flows over the equipment's lifetime and adjusting for the time value of money, this calculation shows the net profit or loss of an investment. A positive net present value (NPV) suggests that an investment will generate a profit in today's money. In today's money, a negative NPV signifies a net loss.
- Internal Rate of Return – It measure the profitability of an investment, expressed as an annual rate.
- Discounted Payback period – A simple payback period based on cash flows adjusted for the time value of money.

The dashboard also shows other non-financial parameters such as number of charging sites, number of new stations, projected number of charging sessions provided over the analysis period and the total charging energy provided.

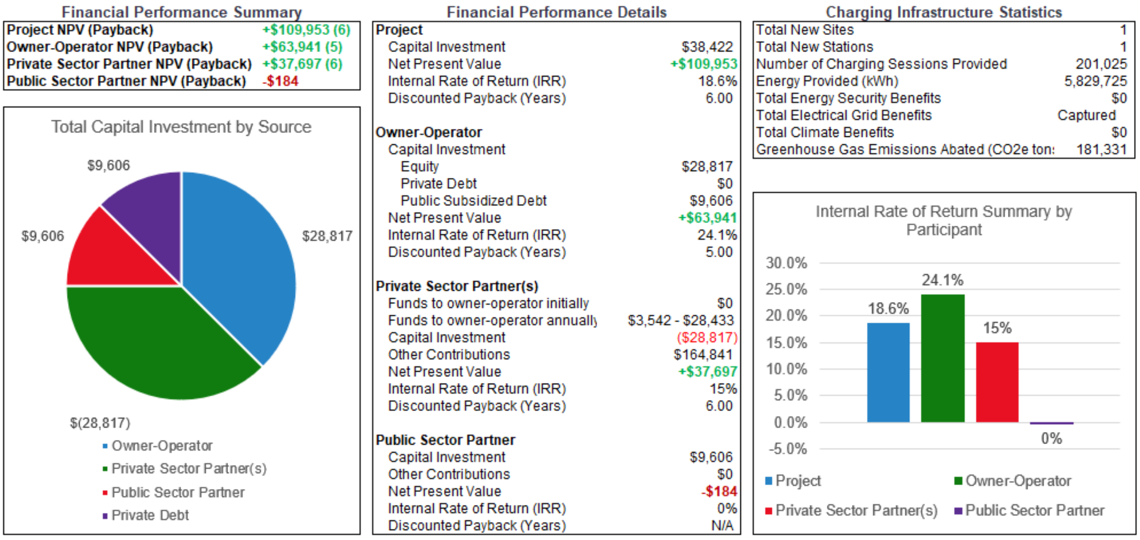


Figure 3. 5: Output Dashboard Display

The dashboard also contains the discounted cash flow (DCF) for the owner-operator, including revenue costs from operating, debt, and equity.

Financial Statements

The tool carries a set of financial statements for the owner-operator business model. These statements include:

- Income Statement - It contains the revenues, costs, and resulting income for the owner-operator over the service life of the equipment.
- Balance Sheet - It shows the assets, liabilities, and resulting equity for the owner-operator over the lifetime of the equipment.
- Statement of Cash Flows – Shows the cash inflow and out flow of the owner-operator organization and the total cash balance over the lifetime of the equipment.

For this study, the tool is used to evaluate single EV charging station which comprise two DC fast charging system (CCS/COMBO and CHAdeMO) and one level 2 AC charging system (22kW)

3.3 Calculation of the EV charging time

Table 3. 10: Charging time for different EV from different power charging station

Vehicle			Empty to full charging time			
Model	Battery	Range	3.3 kW	7.4 kW	22 kW	60 kW
Kia Niro	64.0 kWh	385 km	19 hours	9 hours	2.90 hour	1 hours
BYD e6	71.7 kWh	400km	21 hours	10 hours	3.25 hour	1.19 hours
Mahindra e20	11 kWh	110 km	3 hours	1.4 hour	30 minutes	11 minutes

CHAPTER FOUR: RESULT AND DISCUSSION

Discounted Cash Flow (DCF) is used for all three partners to calculate the financial parameters such as NPV, IRR and DPP. The positive NPV indicates the acceptance or feasibility of the project. It uses separate discount rate for three partners. Similarly, IRR greater than cost of capital indicates acceptance of the project.

4.1 Growth rate of EVs in Nepal

For this research work, only light duty vehicles (LDVs) were taken for the study. Vehicle registration till 2018 were taken from DoTM. For the sake of simplicity, vehicle number from 2002 is taken, as there is only car/jeep/van were registered from 1989 to 2001.

By using scatter with straight line and markers tool and adding exponential fit as trendline, the growth rate of LDVs is found to be 13.5%.

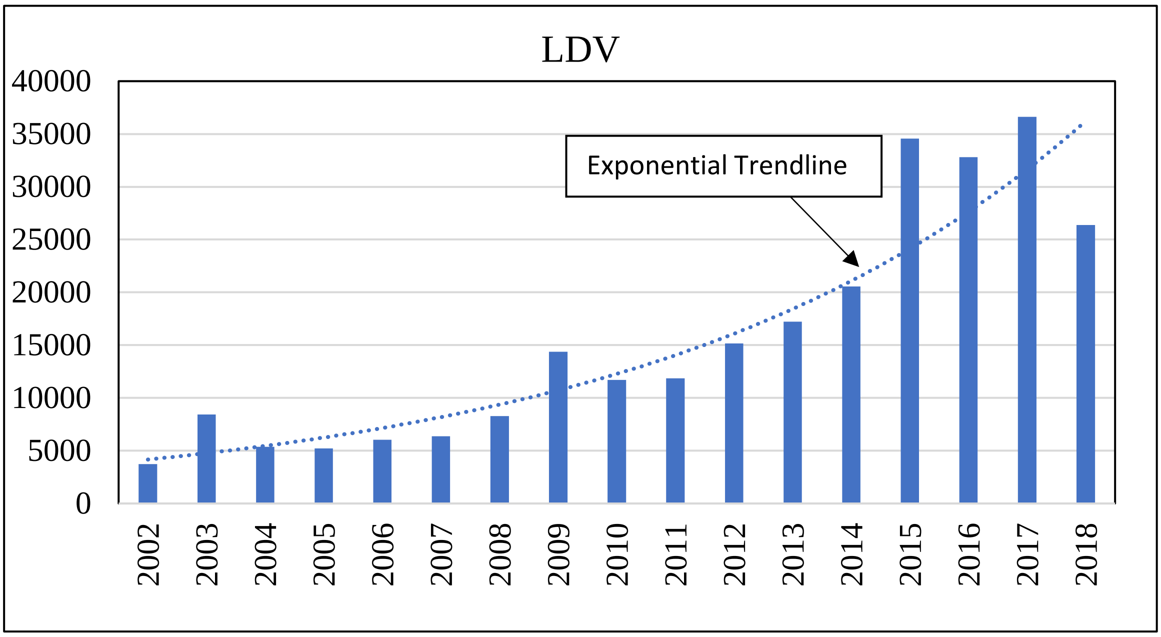


Figure 4. 1: Registration of LDVs in Nepal

Using this data, the number of LDVs till 2031 are forecasted. For forecasting, we used FORECAST.ETS function in Excel tool, which return the forecasted value for a specific future date using exponential smoothing method.

Table 4. 1 Forecast data of LDVs till 2031

Year	Forecasted Data
2021	36212
2022	38092
2023	39977
2024	41776
2025	43645
2026	45514
2027	47383
2028	49232
2029	51114
2030	52989
2031	54865

Based on EVs in Nepal, we found that only 80% vehicle will support fast charging, which means there will be 43,892 vehicles EVs till 2031. To achieve this number of EVs in market, the average annual growth rate of EV registration should be 38%. This growth rate is used as input to financial tool.

Table 4. 2: Average annual growth rate of EV registration

Year	Forecasted Data	Taking 80% Vehicle	Number increment in Fossil Fuel LDV	Respective Increase in EV	EV Number	% Growth for EV
2021	36212	28970			2500	
2022	38092	30474	1504	4172	6672	167%
2023	39977	31982	1508	4183	10855	63%
2024	41776	33421	1439	3992	14847	37%
2025	43645	34916	1495	4147	18994	28%
2026	45514	36411	1495	4147	23142	22%
2027	47383	37906	1495	4147	27289	18%
2028	49232	39386	1479	4103	31392	15%
2029	51114	40891	1506	4176	35568	13%
2030	52989	42391	1500	4161	39729	12%
2031	54865	43892	1501	4163	43892	10%
		Difference	14922		41392	
			Multiplying Factor	2.77	Average	38%

4.2 Financial Analysis of Different Scenario

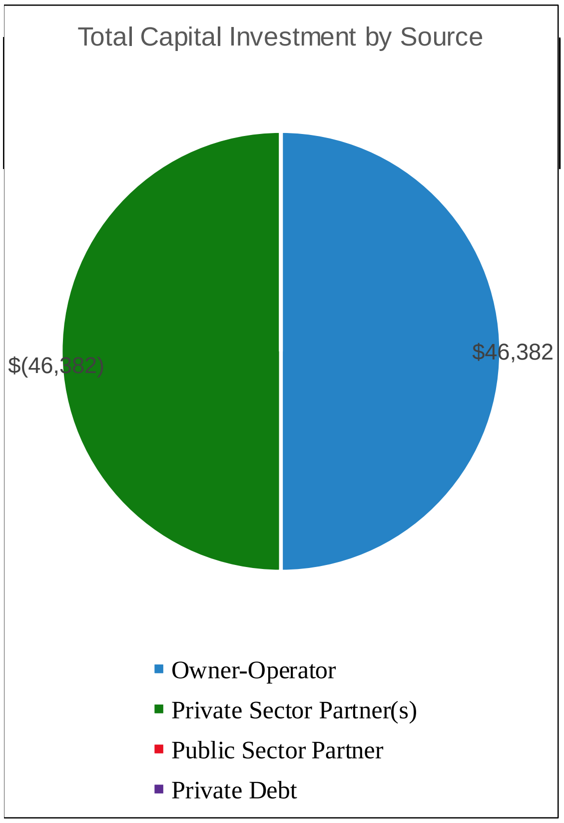
Three different scenarios were made to perform the financial analysis of the project.

4.2.1 Scenario A: Base Case Scenario

For this scenario, only owner-operator exist i.e. there will be no involvement of private funding and government funding. The owner-operator itself is a private sector. Thus, only owner operator DCF is calculated for 10 year of service life.

Financial Performance Summary

Project NPV (Payback)	**-$109,972**
Owner-Operator NPV (Payback)	**-$63,590**
Private Sector Partner NPV (Paybacl	**-$46,382**
Public Sector Partner NPV (Payback)	$0



Financial Performance Details

Project	
Capital Investment	$46,382
Net Present Value	**-$109,972**
Internal Rate of Return (IRR)	N/A
Discounted Payback (Years)	N/A
Owner-Operator	
Capital Investment	
Equity	$46,382
Private Debt	$0
Public Subsidized Debt	$0
Net Present Value	**-$63,590**
Internal Rate of Return (IRR)	N/A
Discounted Payback (Years)	N/A
Private Sector Partner(s)	
Funds to owner-operator initially	$0
Funds to owner-operator annually	$0
Capital Investment	($46,382)
Other Contributions	$0
Net Present Value	**-$46,382**
Internal Rate of Return (IRR)	N/A
Discounted Payback (Years)	N/A
Public Sector Partner	
Capital Investment	$0
Other Contributions	$0
Net Present Value	$0
Internal Rate of Return (IRR)	N/A
Discounted Payback (Years)	N/A

Figure 4. 2 : Financial Summary of Scenario A

The capital investment of the project is $ 46,382 and the NPV value is -$ 109,972. The equity from owner operator is capital investment of the project. The NPV after using equity from owner operator is -$63,590, IRR and discounted payback period are not available as the cash flow throughout the life time is negative.

Owner-Operator Discounted Cash Flow Model

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Revenue	$ -	$ 7,016	$ 9,682	$ 13,362	$ 18,441	$ 25,448	$ 35,119	$ 48,465	$ 56,311	$ 56,311	$ 56,311
Operating Costs	$ -	$ (11,593)	$ (13,855)	$ (17,355)	$ (22,224)	$ (28,998)	$ (38,422)	$ (51,533)	$ (59,137)	$ (59,188)	$ (59,635)
Debt Costs	$ -	$ 842	$ 320	$ 442	$ 609	$ 841	$ 1,161	$ 1,602	$ 941	$ -	$ (6,757)
Equity Costs	$ (46,382)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total	**$ (46,382)**	**$ (3,735)**	**$ (3,852)**	**$ (3,551)**	**$ (3,174)**	**$ (2,709)**	**$ (2,142)**	**$ (1,466)**	**$ (1,885)**	**$ (2,877)**	**$ (10,082)**

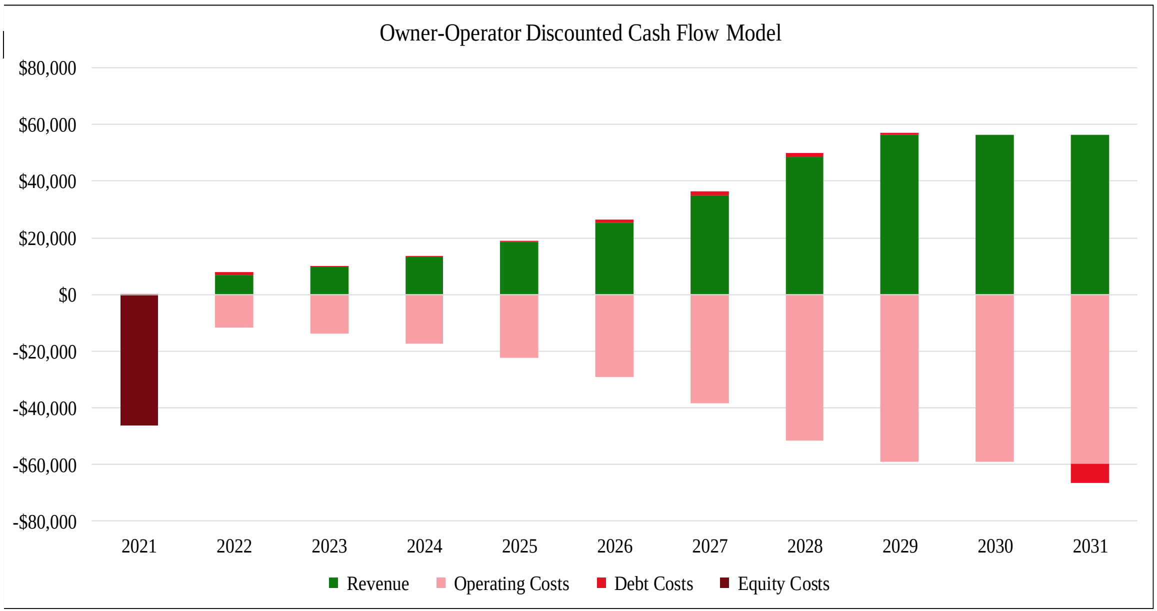


Figure 4. 3: Owner-Operator Discounted Cash Flow Model

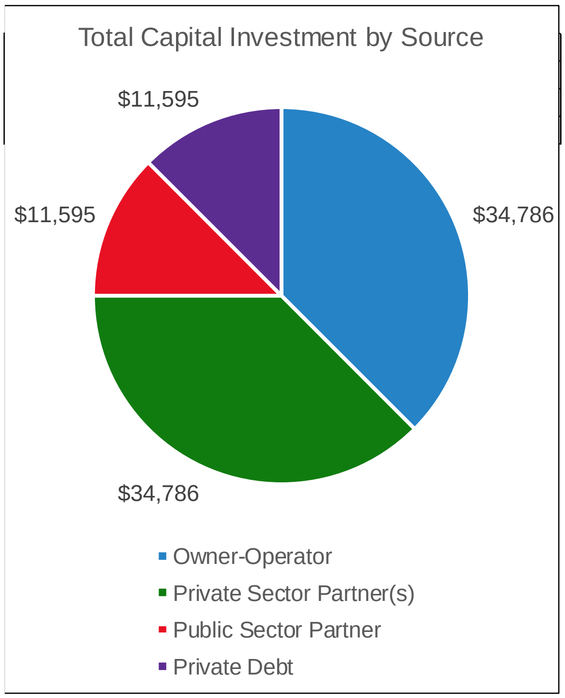
The equity costs in 2021 is $ 46,382 as it is invested only by owner-operator. In next year, revenue will be $7,016 and operating cost will be estimated as $ 11,593. Till 2029, the revenue and operating cost will be increasing exponentially. From 2029 to 2031, revenue generation will be same but the operating cost will be in slightly increasing order. The minimum operating cost will be $ 11,593 in 2022 and the maximum operating cost will be $ 59,635 in 2031. The revenue generation will be maximum in last three year.

4.2.2 Scenario B: With Government Subsidy but no Indirect Revenue Sources

In this scenario, there will be involvement of all three partners. The portion of financial mix will be change to 75% equity and 25% debt. The 75% will be from private sector and 25% debt will be from government side. DCF is used to calculate the financial parameter. This scenario will not have any source of indirect revenue. In this scenario too, the energy cost taken same as that of scenario A i.e. NPR. 6.72.

Financial Performance Summary

Project NPV (Payback)	**-$99,824**
Owner-Operator NPV (Payback)	**-$59,340**
Private Sector Partner NPV (Payback)	**-$34,786**
Public Sector Partner NPV (Payback)	**-$222**



Financial Performance Details

Project	
Capital Investment	$46,382
Net Present Value	**-$99,824**
Internal Rate of Return (IRR)	N/A
Discounted Payback (Years)	N/A
Owner-Operator	
Capital Investment	
Equity	$34,786
Private Debt	$0
Public Subsidized Debt	$11,595
Net Present Value	**-$59,340**
Internal Rate of Return (IRR)	N/A
Discounted Payback (Years)	N/A
Private Sector Partner(s)	
Funds to owner-operator initially	$0
Funds to owner-operator annually	$0
Capital Investment	$34,786
Other Contributions	$0
Net Present Value	**-$34,786**
Internal Rate of Return (IRR)	N/A
Discounted Payback (Years)	N/A
Public Sector Partner	
Capital Investment	$11,595
Other Contributions	$0
Net Present Value	**-$222**
Internal Rate of Return (IRR)	0%
Discounted Payback (Years)	N/A

Figure 4. 4: Financial Summary of Scenario B

The capital investment of the project is $ 46,382 and the NPV value is -$ 99,824. The capital investment from owner side is $ 34,786 which is 75% of the total capital. The NPV after using equity from owner operator is -$ 59,340, IRR and discounted payback period are not available as the cash flow throughout the life time is negative. The involvement of private sector is only in equity portion. By discounting the cash flow at 12% discount rate, it shows negative NPV of $ 34,786, IRR and payback period were not available. Here we are taking government subsidy is only for debt portion, which is 25%. Output shows negative of NPV, and non-availability of IRR and discounted payback period.

Cumulative Discounted Cash Flow (Scenario B)

The first-year discounted cash flow for the owner – operator is -$ 34,786 which is initial investment to the project. This is also similar for private sector partner. Public sector has -$ 11,595 cash outflows at 2021 which is debt from its side. The cumulative cash flow for private sector is same throughout the life cycle as there is no any cash flow except initial investment. Therefore, there is no IRR and discounted payback for private sector in scenario B.

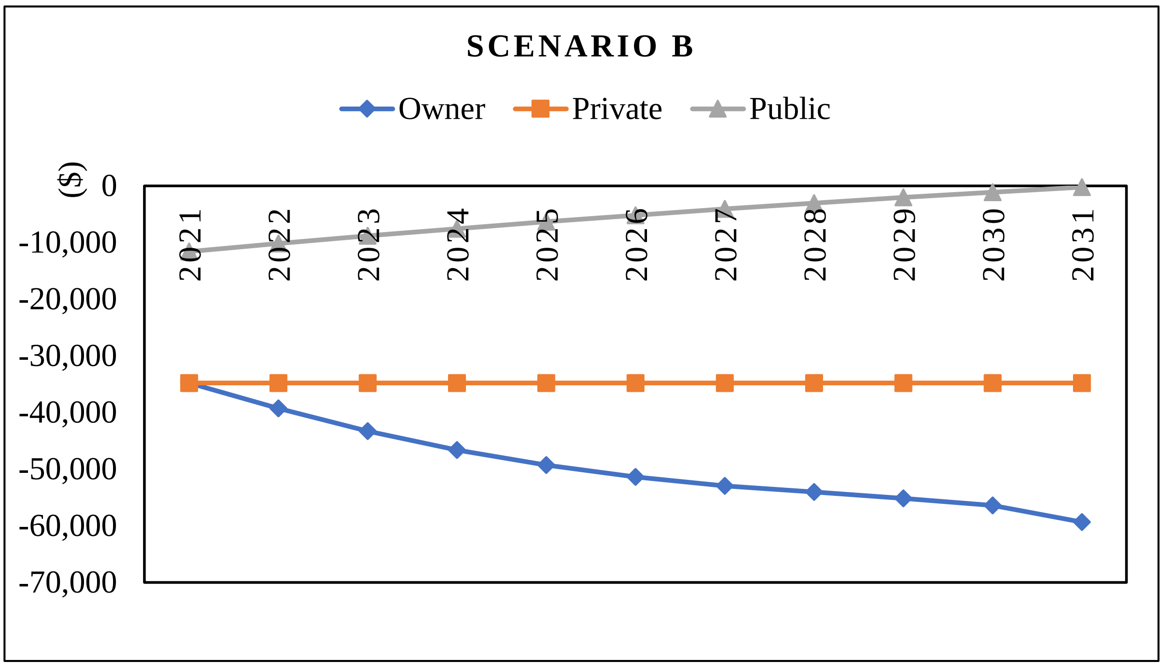


Figure 4. 5: Cumulative discounted cash flow (Scenario B)

Owner – operator has increasing cumulative cash flow in negative area. This is because of negative free cash flow in successive year. This shows increasing operating cost than revenue increment. The end year cumulative cash flow is -$ 59,340, which is NPV for owner – operator. This negative cash flow has no IRR and discounted payback period.

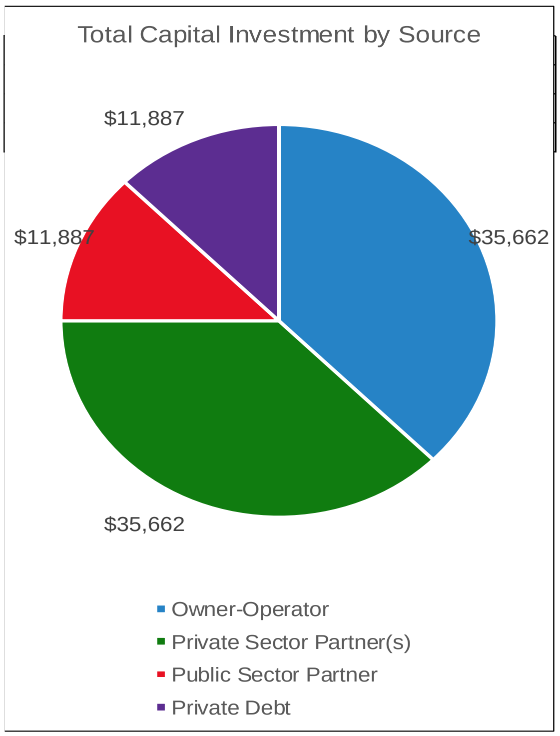
Public sector has increasing cumulative cash flow. The initial investment is -$ 11,595. The cash inflows is from loan repayments from owner operator which is $ 1502 annually. In the last year, the total cash flow is -$ 222, which shows project's NPV negative.

4.2.3 Scenario C: With Government Subsidy and Indirect Revenue Sources

This is the most optimistic scenario for this project. Here we are taking government subsidy along with indirect revenue sources such as advertisement revenue, grocery sales, revenue from hotel/resort sector.

Financial Performance Summary

Project NPV (Payback)	**+$90,164 (7)**
Owner-Operator NPV (Payback)	**+$53,614 (6)**
Private Sector Partner NPV (Payback)	**+$29,229 (7)**
Public Sector Partner NPV (Payback)	**-$228**



Financial Performance Details

Project	
Capital Investment	$47,550
Net Present Value	+$90,164
Internal Rate of Return (IRR)	13.4%
Discounted Payback (Years)	7.00
Owner-Operator	
Capital Investment	
Equity	$35,662
Private Debt	$0
Public Subsidized Debt	$11,887
Net Present Value	+$53,614
Internal Rate of Return (IRR)	17.7%
Discounted Payback (Years)	6.00
Private Sector Partner(s)	
Funds to owner-operator initially	$0
Funds to owner-operator annually	$3,456 - $27,739
Capital Investment	$35,662
Other Contributions	$160,820
Net Present Value	+$29,229
Internal Rate of Return (IRR)	10%
Discounted Payback (Years)	7.00
Public Sector Partner	
Capital Investment	$11,887
Other Contributions	$0
Net Present Value	-$228
Internal Rate of Return (IRR)	0%
Discounted Payback (Years)	N/A

Figure 4. 6: Financial Summary of Scenario C

The project has total capital investment of $ 47,550, which is from private sector as owner-operator and public sector as debt. The project's NPV is $90,164 with IRR of 13.4% and 7 year of discounted payback period. The high payback period is due to the high capital cost as well as slow revenue generation throughout its life cycle.

Owner – operator has 75% capital investment which is same as that for private sector. The NPV is $ 54,614 with IRR of 17.7 and discounted payback period of 6 year. As, cost of capital for owner – operator is 15%, higher IRR shows a good project to invest.

Public Sector, which provides debt for capital investment has NPV of -$ 228, IRR of 0% and non-availability of payback period. NPV shows a bad investment for government entity but IRR shows a breakeven project.

Cumulative Discounted Cash Flow (Scenario C)

The first-year discounted cash flow for the owner – operator is -$ 35,662 which is initial investment to the project. This is also similar for private sector partner. Public sector has -$ 11,887 cash outflows at 2021 which is debt from its side.

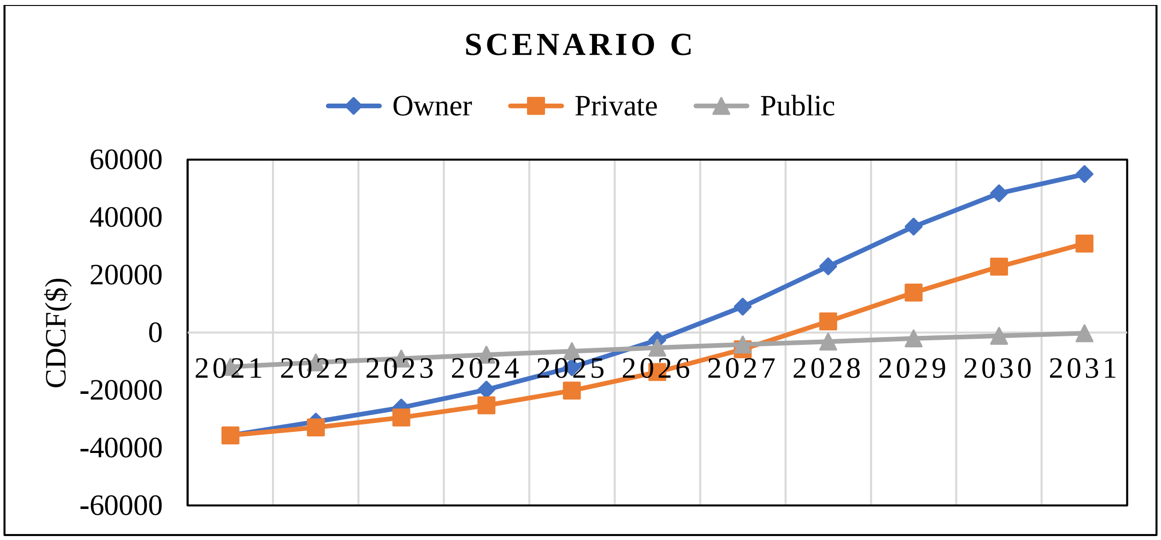


Figure 4. 7: Cumulative Discounted Cash Flow (Scenario C)

Owner – operator will have negative cumulative discounted cash flow up to 2026. This is because of negative free cash flow. This shows increasing operating cost than revenue increment. From 2027 the rate will be in increasing rate till the service life. This shows discounted payback period of 6 year for owner – operator. The cumulative cash flow in end year will be $ 53,614 which shows positive NPV for this partner.

Private sector will also have almost similar pattern of cash flow as of owner – operator with one more year i.e. 7 year of discounted payback period as the revenue from advertisement will be captured by the later one. The end year cumulative cash flow of $ 29,229 which is NPV for private sector.

Public sector has increasing cumulative cash flow. The initial investment is -$ 11,887. The cash inflows is from loan repayments from owner operator which is $ 1,539 annually. In the last year, the total cash flow is -$ 228, which shows project's NPV negative.

Further cases were developed in scenario C, which is based on decrease cost of CAPEX in future.

Case I: At 10% decrease cost

Case II: At 20% decrease cost

Case III: At 30% decrease cost

Case IV: At 40% decrease cost

Case V: At 50% decrease cost

This shows different financial scenario at decreased cost which is shown below.

- Project Cumulative DCF

The cumulative discounted cash flow at 10% cost reduction on CAPEX will be high than more reduction on CAPEX in negative zone

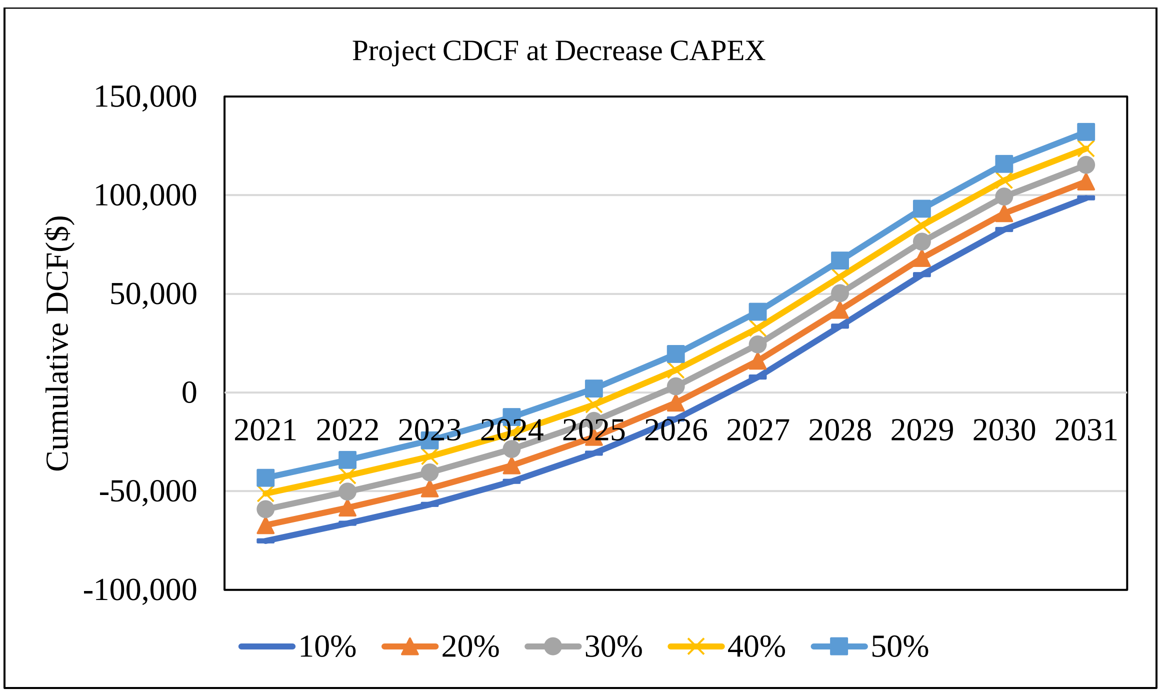


Figure 4. 8: Cumulative DCF at decrease CAPEX

As the CAPEX is decrease, the CDCF will have positive impact as the revenue will be higher at decrease CAPEX. The 50% reduction on CAPEX will have less DPP than other. This shows that, decreasing cost of charging equipment will be beneficial for sustainability of the project.

- Project NPV

  The NPV is based on project's DCF. More the positive DCF, higher will be the NPV. The NPV of the project will be higher as the CAPEX cost is reduced. This is because the initial cash outflow will be less at decreased CAPEX cost

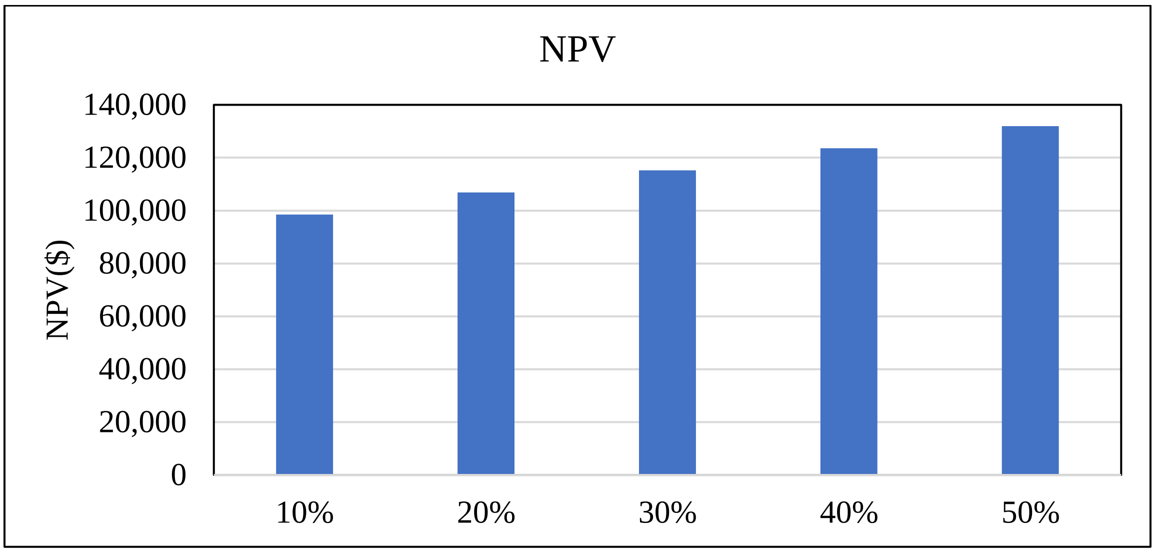


Figure 4. 9: Project NPV at decrease CAPEX

NPV at 10% decrease in CAPEX is \$ 98,523 and at 50% is \$ 131,959. The rate of NPV will be in increasing order as the cost of CAPEX decreases. The total DCFs consist of cash flow from owner-operator, private sector and public sector. Free cash flow comes from three partners.

- Project IRR

The IRR is based on project's discounted cash flow. The rate of return of the project will be higher if revenue generation is higher or the CAPEX is reduced.

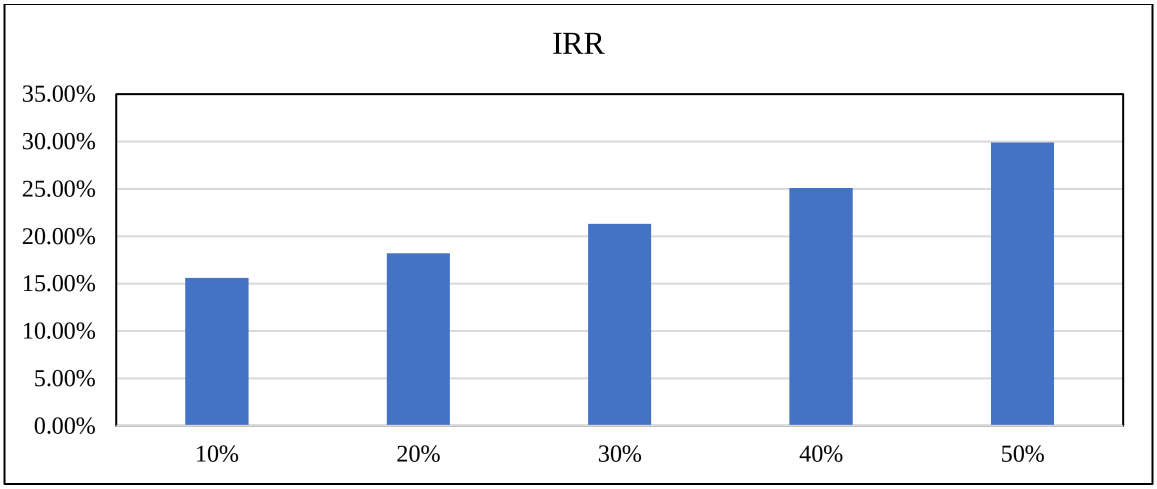


Figure 4. 10: Project IRR at decrease CAPEX

IRR will be 15.60% at 10% decrease in cost of CAPEX. It will be 21.30% at 30% and 29.90% at 50% cost reduction. Higher the IRR, more private sector will be attracted in this project in future.

- Project DPP

  DPP shows the year number where cash inflows equal the cash outflows. Less DPP will be better for a project.

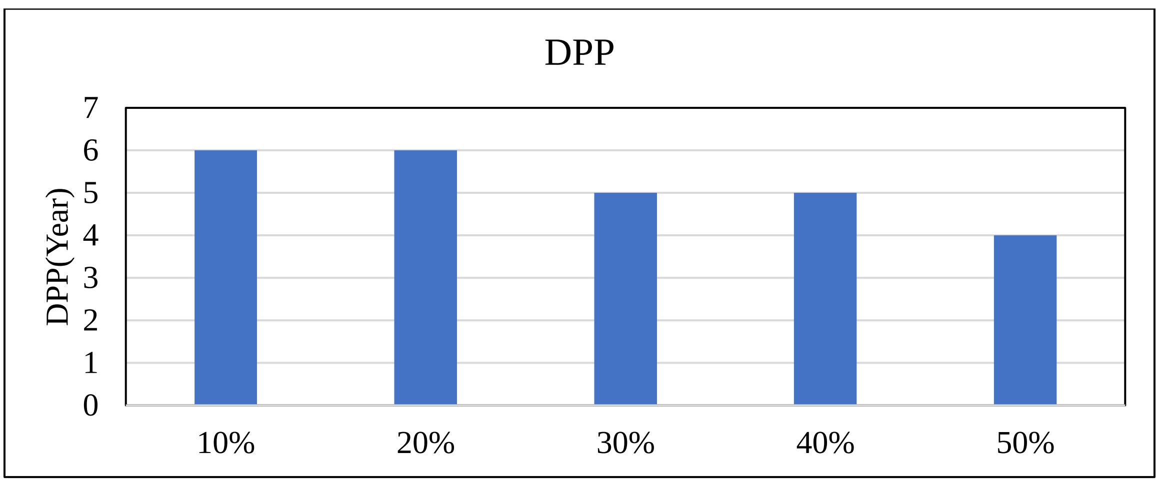


Figure 4. 11: Project DPP at decrease CAPEX cost

Maximum DPP of the project is at 10% cost decrease in CAPEX, which is 6 year. It will be similar for 20% cost reduction. The cash inflow and cash outflow will be equal in 5 year at 30% and 40% decrease in cost. The minimum DPP will occur when the CAPEX cost is decreased at 50 %, which is 4 year.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

5.1 Conclusions

Replacement of fossil fuel vehicle by EVs is a challenging job for developing countries like Nepal. There are many constraint and limitations of fossil fuel vehicle which make electric vehicle superior over it such as maintenance cost, environmental issues, operating cost etc. In this research, we have analyzed the different scenario for studying the possibility of replacement of fossil fuel vehicle by electric vehicle along with future trend of EV growth and role of government. Following conclusions have been made from this research work;

- There are limited number of EVs existing in current scenario. As per government policy, full replacement of LDVs by EVs is to be achieved by 2031 AD. So, we need average annual growth of 38% for achieving the governmental goal.
- Some conclusions were made as per scenario developed:
  I. For scenario A i.e. for base case scenario, without any government subsidy and indirect revenue sources, all financial parameter came out infeasible. NPV stand at -$63,590 both IRR and discounted payback period were not available. So, this scenario showed the project is financially infeasible.
  II. For scenario B i.e. project with government subsidy but without any indirect revenue sources. Under this scenario, there are three different cases for three partners. For owner operator, all three financial parameters were infeasible. Similarly, for private sector operator, NPV is -$34,786, IRR and discounted payback period were unavailable. For public sector partner, all parameters are also infeasible.
  III. For scenario C i.e. having both government subsidy of 25% and indirect revenue sources. There are also three cases for this scenario. First one is for owner operator, where NPV is $ 53,614 IRR is 17.7% and discounted payback is 6 year. Similarly, for private sector partner, NPV stand at $ 29,229, IRR comes out 10% and payback period is of 7 year. From public sector partner side, the project seems neutral. Five more different cases were analyzed under scenario C by reducing CAPEX from 10% to 50%. There will be improvement

on different financial parameters at reduced cost of CAPEX. Therefore, Scenario C is found to be best scenario among three scenarios.

- Since project seems financially infeasible without government subsidy and the main objective of private sector in business is profit oriented. To attract the private sectors in EV field, government should make provision of good subsidy policy. In other hand, government can take sole responsibility to develop this project. Also, public private partnership (PPP) model can be implemented which ensures improved service delivery, cost-effectiveness, reduce risk for government and long-term investment opportunity, security from government and secured revenue generation for private sector.

5.2 Recommendations

As global market of EV sector is growing day by day and most of the developed countries are keeping the development of EV in major priority for the sustainable development. Government of Nepal has also brought different policies for the growth of EVs such as exemption on excise duty, reduced tax rate, EV loan at reduced interest rate, reliability of electricity supply etc. Different infrastructure needs to be developed for development of electric vehicle. To increase the growth of electric vehicle concern authority must give focus on deployment of public charging station also. The basic guideline must be developed for the establishment of public charging station. Also, government tariff policy should be beneficial from both consumer and service provide side.

Since it is a new sector in transportation and electricity field, concern authority must focus on production of skilled manpower for the establishing, operating and maintaining of the EV charging station through trainings and other possible skill development programs.

Location of charging station is also an important factor to be considered to reduce the range anxiety problem. For this optimum location of charging station should be selected.

Government can also make necessary research to develop the integrated model which involves hydropower developer along with other private sectors. Also, provision of aid can be helpful in research work of EV sector which may reduce trade deficit in import of petroleum oil. The Future surplus electric energy can be balance by creating the demand in EV sector.

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APPENDICES

Appendix-A: Tool Inputs

Tool Inputs contains input for market, owner-operator, private sector, and public sector.

A.1 Market Inputs

EV Charging Financial Analysis Input Field	Values	Source
Market Assumptions		
EV fuel economy [miles per kilowatt-hour]	3.5	Atlas estimate used to calculate public benefits.
Conventional vehicle replacement fuel economy [mpg]	N/A	Not applicable for this analysis.
Energy security benefit [$per gasoline gallon displaced]	N/A	Not applicable for this analysis.
Electrical grid benefit [$per megawatt-hour]	N/A	Not applicable for this analysis.
Electrical grid emissions rate [carbon dioxide equivalent pounds per megawatt-hour]	N/A	Not applicable for this analysis.
Climate benefit [$per ton of greenhouse gas emissions abated]	N/A	Not applicable for this analysis.
Use traffic-derived values [1] or direct inputs [2]	N	Disable this method for estimating utilization rate.
Direct Utilization Values		
Expected annual utilization growth rate [%]	38%	Calculate from DoTM vehicle data.
[Station Type 1] Initial average	4320	From Analysis
utilization [# of charging sessions per station per year]		

A.2 Owner – Operator

EV Charging Financial Analysis Input Field	Values	Source
Expected equipment lifespan [years]	10	Taken for selected product
Charging Station Capital Cost		
Charging station equipment cost per type 1 station [$]	$25,000 to 30,000	Taken from Alibaba
Construction and equipment installation cost per type 1 stat\ion [$]	$15,000 to 20,000	From Kathmandu District rate.
Energy storage cost per type 1 site [$]	N/A	Not applicable for this analysis.
Photovoltaic energy system cost per type 1 site [$]	N/A	Not applicable for this analysis.
Electric utility upgrades and grid interconnection cost per type 1 site [$]	N/A	Not applicable for this analysis.
Lease and property transaction costs per type 1 site (one-time fee) [$]	N/A	Not applicable for this analysis.
Host site identification and screening and design per type 1 site [$]	N/A	Not applicable for this analysis.
Total number of type 1 stations [#]	1	Sample
Total number of type 1 sites [#]	1	Assume only one site for this analysis.
Charging Station Utilization		
Maximum number of charging Sessions pet type 1 station [sessions/year/station]	34,674	Based on initial utilization of 38%%.
Energy Usage		
Average charging energy per type 1 session [kWh/session]	20 to 30	From Analysis
Maximum power draw (type 1 station) [kW/session]	142	Maximum from Selected Charging station
Average time of charging session (type 1 station) [minutes]	32 to 142	From Analysis

A.2 continued

EV Charging Financial Analysis Input Field	Values	Source
Charging Station Revenue [Operating Revenue-Direct]		
Per-energy user fee (type 1 station) [$/kWh]	$0.056 to $0.08	ERC
Per-charge event user fee (type 1 station) [$/session]	$1.56 to $30	From Analysis
	Electricity	
Electricity retail price in first year (type 1 station) [$/kWh]	$0.056	ERC
Monthly electricity fixed charges (type 1 site) [$]	$386.55	ERC
Annual compounded growth rate in electricity price (type 1 station) [%]	1%	For industrial sector.
Share of onsite energy generation (type 1 station) [%]	N/A	Not applicable for this analysis.
Demand charge (type 1 station) [$/kW/month]	-	Assume no demand charge for Level 2 charging stations.
Demand charge threshold (type 1 station) [kWh/month]	-	Assume no demand charge for Level 2 charging stations.
Maximum load at site excluding charging stations (type 1 station) [kW]	0	Atlas assumption.
Maintenance Cost		
Annual maintenance cost (type 1 station) [$]	5%	Atlas assumption
Communication Cost		
Annual communications cost (average per type 1 site/year) [$]	$1200	(Shah, 2019)
Warranty Cost		
Annual warranty cost (type 1 station) [$]	0	Not applicable for this analysis.

A.2 Continued

EV Charging Financial Analysis Input Field	Values	Source
Host site lease or access cost		
Host site lease or access cost (average per type 1 site/year) [$]	$0	As per current scenario in Nepal
Additional Revenue Assumptions		
Number of subscribers in first year [subscribers/year]	-	Atlas assumption. Use in model only if appropriate.
Annual growth rate in number of subscribers [%]	-	Atlas assumption. Use in model only if appropriate.
Subscription fee [$/subscriber/year]	-	Atlas assumption. Use in model only if appropriate.
Annual advertising revenue (In-station advertising) [$]	$5843	(Pixeltouch, 2021)
Owner-operator share of energy security benefit [%]	0%	Atlas to research.
Owner-operator share of electrical grid benefit [%]	0%	Atlas to research.
Owner-operator share of climate benefit [%]	0%	Atlas to research.
Additional Cost Assumptions		
Sales, General, and Administrative [%of Revenue]	5%	Atlas assumption.
Initial Capitalization Assumptions		
Percent Equity Funded [%]	75%	(Rajkumar, 2021)
Assumed EBITDA exit multiple	0	Atlas assumption.
Owner-Operator Cost of Equity		
Risk Free Rate	3.24%	(Nepal Rastra Bank, 2019)
Market Risk Premium	11.54%	(Amatya, 2018)
Maximum Debt Term [years]	10	For Selected Sample
Owner-Operator Cost of Debt (Long Term) [%]	5%	(Nepal Rastra Bank, 2021)

A.2 Continued

EV Charging Financial Analysis Input Field	Values	Source
Income Statement Assumptions		
Interest Income [$]	0	Atlas assumption.
Other Income, Net [$]	0	Atlas assumption.
Other Special Charges [$]	0	Atlas assumption.
Interest Expense Rate [%] (Revolving Line of Credit)	0%	Atlas assumption.
Income Tax Rate [%]	12.5 %	(Inland Revenue Department, 2020)
Projected Shares Outstanding (Millions)	1	Atlas assumption.
Current Assets		
Accounts Receivable [% of Revenue]	0%	Atlas assumption.
Other Receivable [% of Revenue]	0%	Atlas assumption.
Prepaid Expenses [% of Revenue]	0%	Atlas assumption.
Non-current assets		
Intangibles (Goodwill)	0%	Atlas assumption.
Other Non-Current Assets	0%	Atlas assumption.
Current liabilities		
Accounts Payable [% of Revenue]	0%	Atlas assumption.
Revolving Line of Credit [% of Revenue]	0%	Atlas assumption.

A.3 Private Sector Inputs

EV Charging Financial Analysis Input Field	Values	Source
Private Sector Partner-Inputs		
Private Sector Weighted Average Cost of Capital (WACC)	12 %	(USAID, 2020)
Private Sector Cost of Goods Sold [% of Revenue]	80%	Atlas assumption.
Private Sector Marginal Tax Rate	12.5 %	(Inland Revenue Department, 2020)
Revenues		
Private sector captures host site lease/access fees?	N	Atlas assumption. Use if applicable
Average expected revenue per customer per minute [$]	$0.20	From Site Visit
Type 1 stations capture customer traffic revenue	Y	Atlas assumption. Use if applicable
Maximum retail revenue per customer per session (type 1 station) [$]	$8	From site visit
Capture the electrical grid benefits	N	Atlas assumption.
Costs		
Annual customer revenue sharing agreement (from sales) [% of revenue]	10%	Atlas assumption.
Per station subsidy (type 1 station) [$]	-	
Annual flat fee (paid to owner-operator) [$]	-	If applicable.

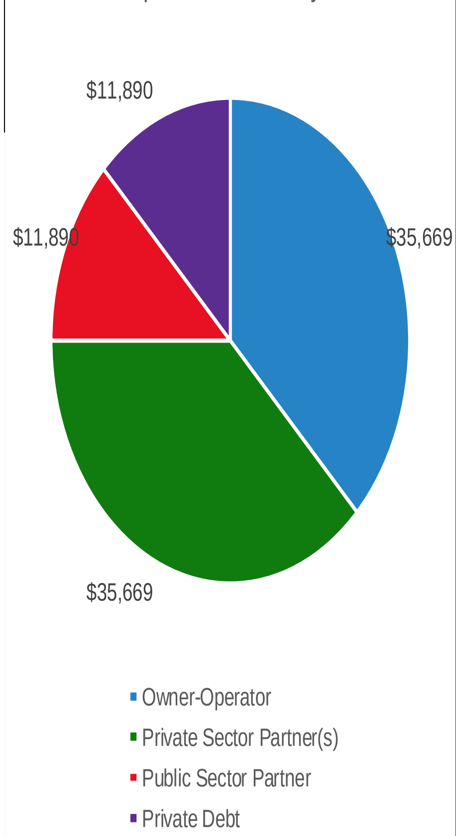
A.4 Public Sector Input

EV Charging Financial Analysis Input Field	Values	Source
Public Sector Cost of Capital [%]	5%	(Nepal Rastra Bank, 2021)
Public sector funded portion of debt [%of debt needed]	100%	(Nepal Rastra Bank, 2021)
Term [years]	10	Atlas assumption.
Rate (APR) [%]	5%	Atlas assumption.
Public sector funded portion of equity investment [% of equity needed]	0%	Atlas assumption.
Public sector equity has capped annual returns?	N	Atlas assumption.
Annual equity return cap [%]	0%	Atlas assumption.
Non-shareholder contribution to capital (grants, etc.) [% of equity needed]	0%	Atlas assumption.
Other annual non-revolving support (grants, etc.) [$]	$0	

Appendix-B: Output Dashboard

Financial Performance Summary

Project NPV (Payback)	+$93,235 (6)
Owner-Operator NPV (Payback)	+$54,927 (6)
Private Sector Partner NPV (Paybacl	+$30,845 (7)
Public Sector Partner NPV (Payback)	-$228

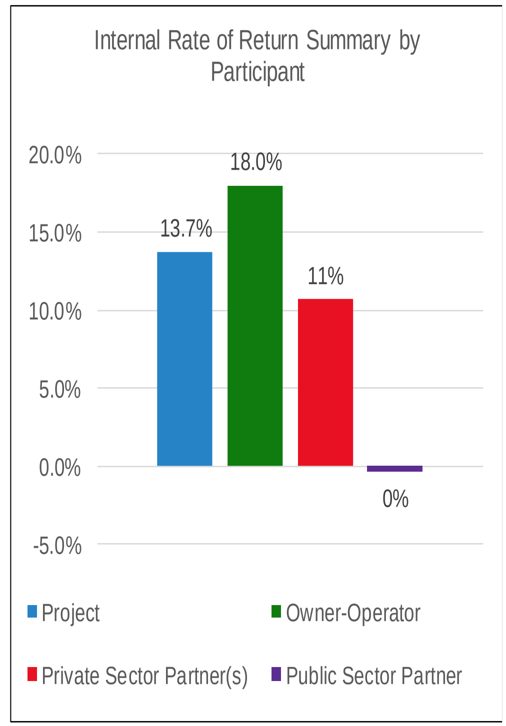


Financial Performance Details

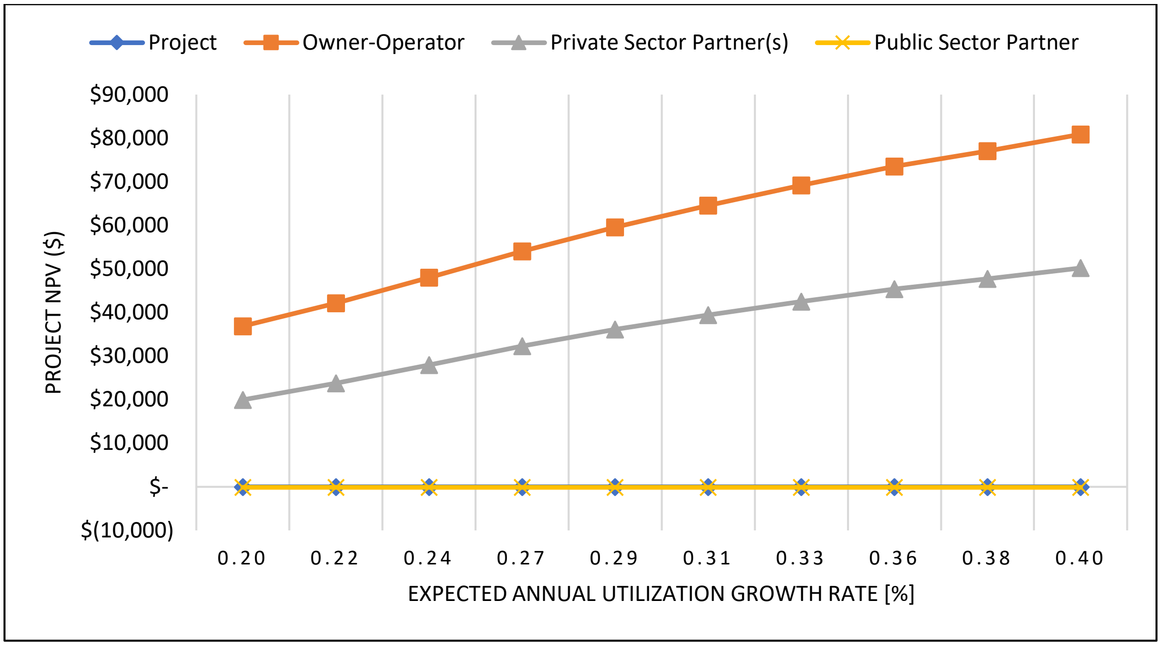
Project	
Capital Investment	$47,558
Net Present Value	+$93,235
Internal Rate of Return (IRR)	13.7%
Discounted Payback (Years)	6.00
Owner-Operator	
Capital Investment	
Equity	$35,669
Private Debt	$0
Public Subsidized Debt	$11,890
Net Present Value	+$54,927
Internal Rate of Return (IRR)	18.0%
Discounted Payback (Years)	6.00
Private Sector Partner(s)	
Funds to owner-operator initially	$0
Funds to owner-operator annually	$3,542 - $28,433
Capital Investment	$35,669
Other Contributions	$164,841
Net Present Value	+$30,845
Internal Rate of Return (IRR)	11%
Discounted Payback (Years)	7.00
Public Sector Partner	
Capital Investment	$11,890
Other Contributions	$0
Net Present Value	-$228
Internal Rate of Return (IRR)	0%
Discounted Payback (Years)	N/A

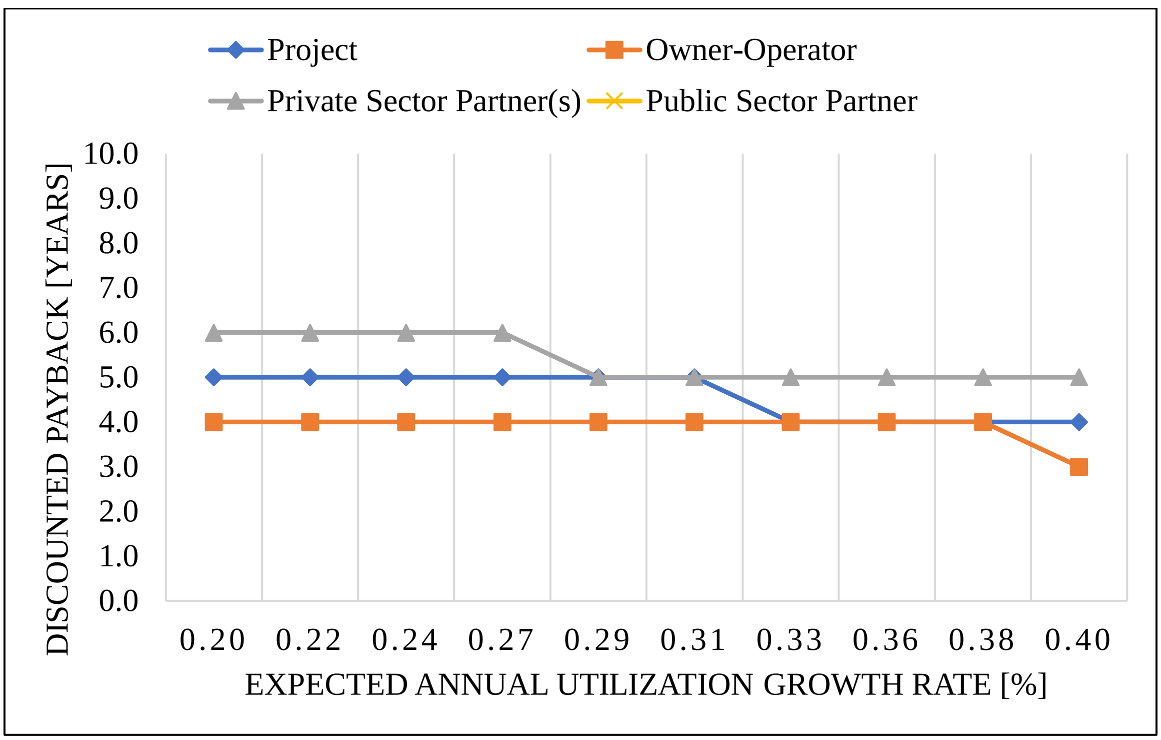
Charging Infrastructure Statistics

Total New Sites	1
Total New Stations	1
Number of Charging Sessions Provided	201,025
Energy Provided (kWh)	5,829,725
Total Energy Security Benefits	$0
Total Electrical Grid Benefits	Captured
Total Climate Benefits	$0
Greenhouse Gas Emissions Abated (CO2e tons	181,331

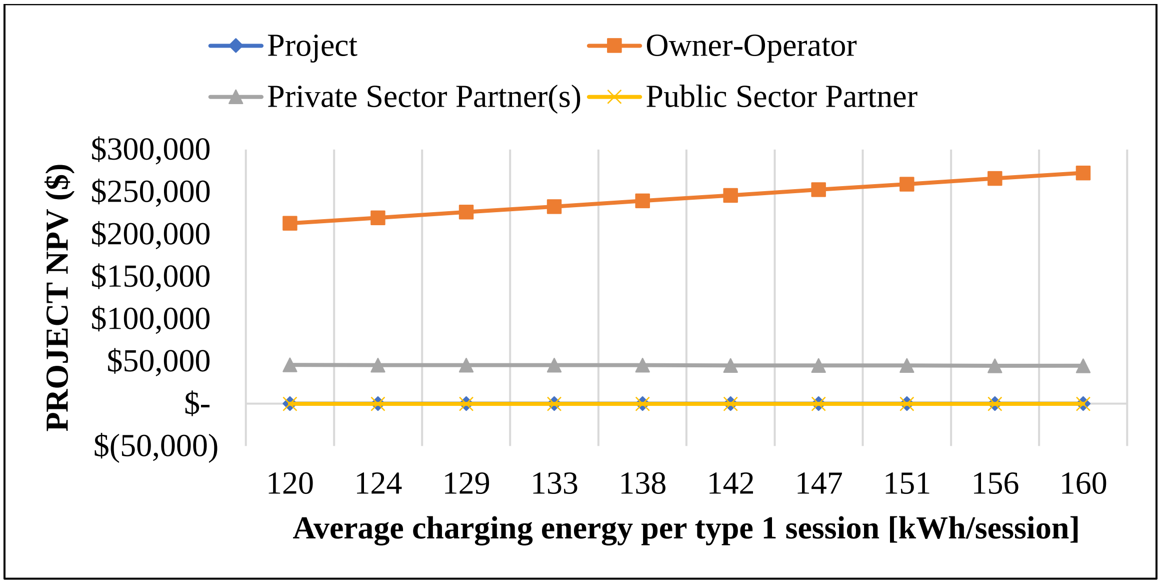


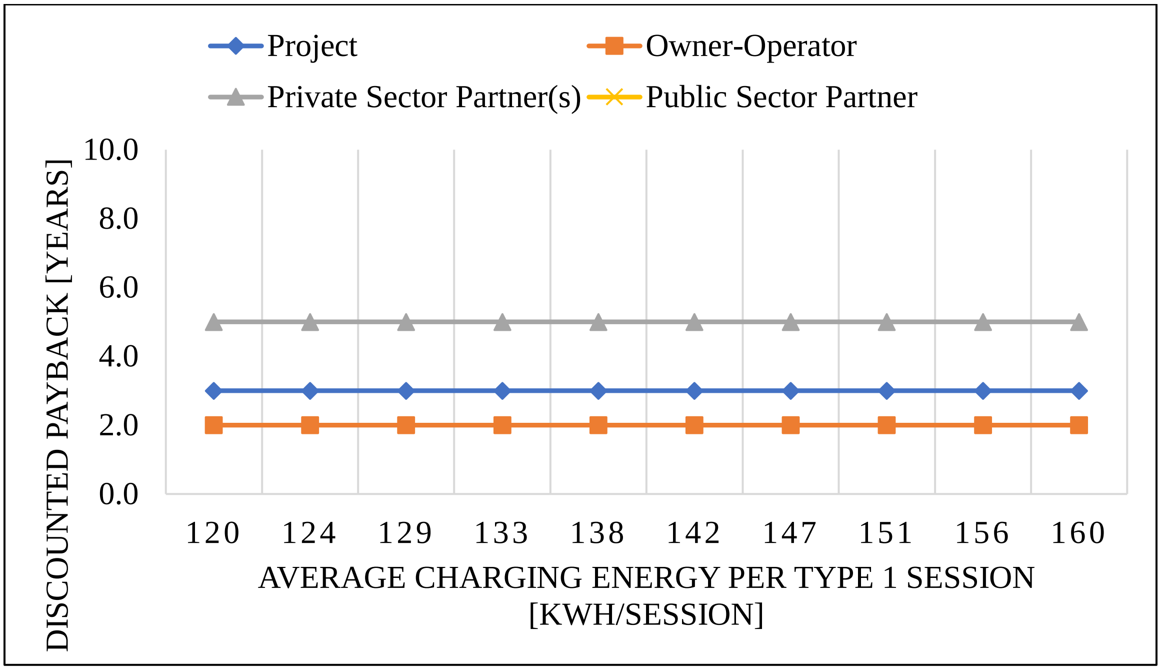
Appendix C: Expected annual utillization growth rate (%)



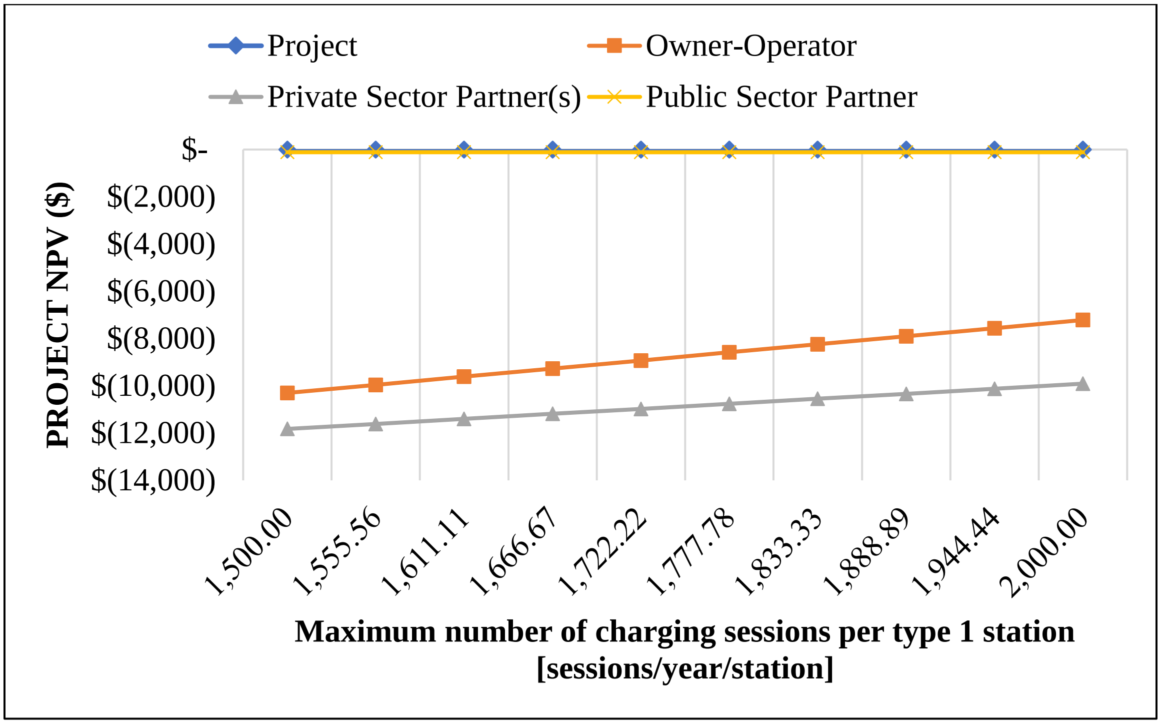


Appendix D: Average charging energy per type 1 session (kWh/session)

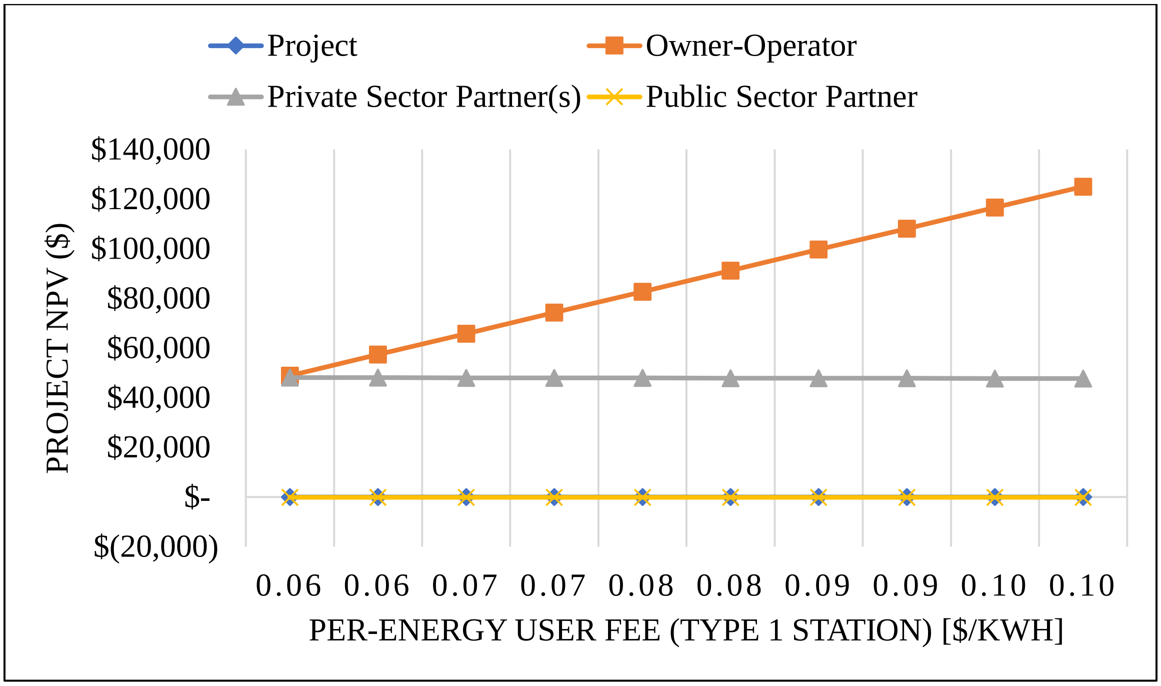


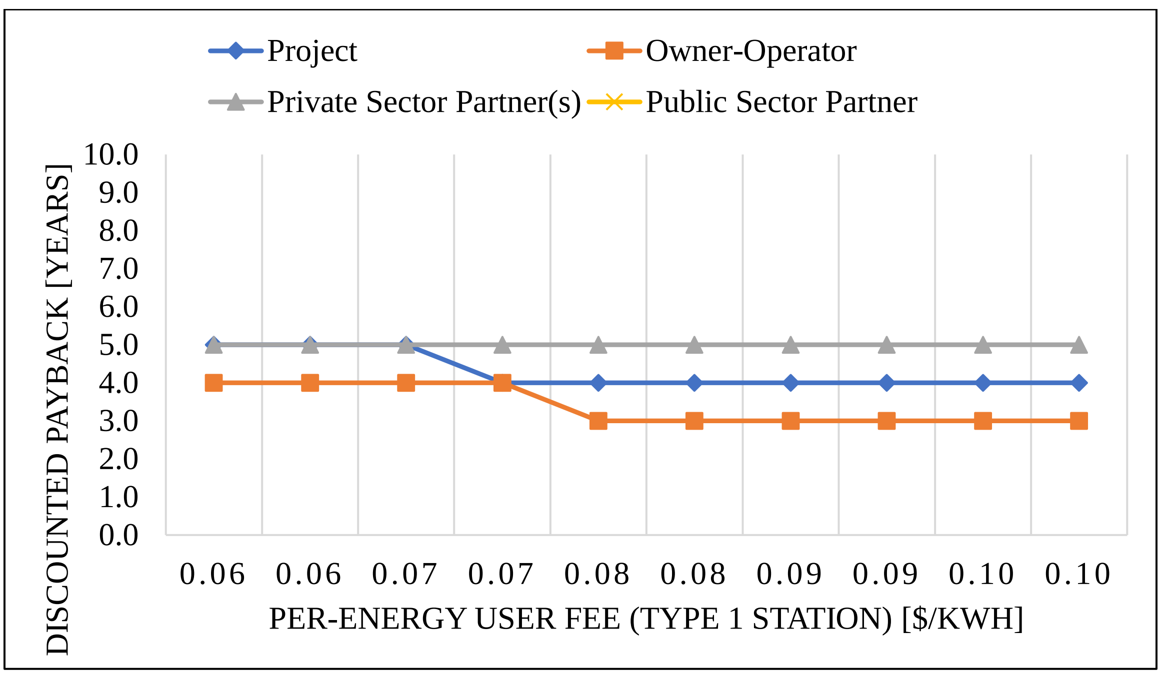


Appendix E: Maximum number of charging session per type 1 staion(sessions/year/station)



Appendix F: Per-energy user fee (type 1 station) ($/kWh)





Appendix G: Consolidated Statements of Income ($)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Revenues										
Operating Revenue	$ 9,396.00	$ 12,967.35	$ 17,895.90	$ 24,697.13	$ 34,082.25	$ 47,034.38	$ 64,908.53	$ 75,415.95	$ 75,415.95	$ 75,415.95
Other Revenue	$ 9,384.40	$ 10,730.84	$ 12,588.96	$ 15,153.10	$ 18,691.40	$ 23,574.50	$ 30,313.26	$ 34,274.68	$ 34,274.68	$ 34,274.68
Total Revenues	$ 18,780.40	$ 23,698.19	$ 30,484.86	$ 39,850.23	$ 52,773.65	$ 70,608.88	$ 95,221.79	$ 109,690.63	$ 109,690.63	$ 109,690.63
Expenses										
Operating Expenses										
Cost of Sales	$ 12,147.37	$ 14,466.68	$ 17,699.39	$ 22,205.04	$ 28,484.65	$ 37,237.60	$ 49,437.62	$ 56,929.04	$ 57,435.74	$ 57,947.50
Total Operating Expenses	$ 12,147.37	$ 14,466.68	$ 17,699.39	$ 22,205.04	$ 28,484.65	$ 37,237.60	$ 49,437.62	$ 56,929.04	$ 57,435.74	$ 57,947.50
Other Expenses										
SG&A (Overhead)	$ 939.02	$ 1,184.91	$ 1,524.24	$ 1,992.51	$ 2,638.68	$ 3,530.44	$ 4,761.09	$ 5,484.53	$ 5,484.53	$ 5,484.53
Depreciation	$ 4,568.02	$ 4,568.02	$ 4,568.02	$ 4,568.02	$ 4,568.02	$ 4,568.02	$ 4,568.02	$ 4,568.02	$ 4,568.02	$ 4,568.02

Total Other Expenses	$ 5,507.04	$ 5,752.93	$ 6,092.27	$ 6,560.53	$ 7,206.70	$ 8,098.47	$ 9,329.11	$ 10,052.55	$ 10,052.55	$ 10,052.55
Total Expenses	$ 17,654.41	$ 20,219.61	$ 23,791.66	$ 28,765.57	$ 35,691.36	$ 45,336.07	$ 58,766.73	$ 66,981.59	$ 67,488.29	$ 68,000.06
Operating Income (EBIT)	$ 1,125.99	$ 3,478.58	$ 6,693.20	$ 11,084.65	$ 17,082.29	$ 25,272.81	$ 36,455.06	$ 42,709.04	$ 42,202.34	$ 41,690.57
Interest Income	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Other Income, Net	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Other Special Charges	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Adjusted Operating Income (EBIT)	$ 1,125.99	$ 3,478.58	$ 6,693.20	$ 11,084.65	$ 17,082.29	$ 25,272.81	$ 36,455.06	$ 42,709.04	$ 42,202.34	$ 41,690.57
Interest Expense	$ (594.48)	$ (547.21)	$ (497.59)	$ (445.48)	$ (390.77)	$ (333.32)	$ (272.99)	$ (209.66)	$ (143.15)	$ (73.32)
Income Before Taxes (EBT)	$ 531.51	$ 2,931.36	$ 6,195.61	$ 10,639.17	$ 16,691.53	$ 24,939.49	$ 36,182.06	$ 42,499.38	$ 42,059.19	$ 41,617.25
Income Taxes	$ (66.44)	$ (366.42)	$ (774.45)	$ (1,329.90)	$ (2,086.44)	$ (3,117.44)	$ (4,522.76)	$ (5,312.42)	$ (5,257.40)	$ (5,202.16)
Net Income	$ 465.07	$ 2,564.94	$ 5,421.16	$ 9,309.27	$ 14,605.09	$ 21,822.05	$ 31,659.31	$ 37,186.96	$ 36,801.79	$ 36,415.10

Appendix H: Consolidated Balance Sheet

Assets	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Current assets											
Cash and Equivalents	$ 1,878.04	$ 7,280.48	$ 13,765.16	$ 23,187.24	$ 36,625.84	$ 55,554.60	$ 81,986.71	$ 118,670.18	$ 160,107.89	$ 200,081.10	$ 239,597.78
Accounts Receivable		$ 939.02	$ 1,184.91	$ 1,524.24	$ 1,992.51	$ 2,638.68	$ 3,530.44	$ 4,761.09	$ 5,484.53	$ 5,484.53	$ 5,484.53
Other Receivable		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Prepaid Expenses		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total current assets	$ 1,878.04	$ 8,219.50	$ 14,950.07	$ 24,711.49	$ 38,618.35	$ 58,193.29	$ 85,517.15	$ 123,431.27	$ 165,592.42	$ 205,565.63	$ 245,082.31
Non-Current Assets											

Gross Fixed Assets (Plant, Prop. & Equip.)	$ 45,680.22	$ 45,680.22	$ 45,680.22	$ 45,680.22	$ 45,680.22	$ 45,680.22	$ 45,680.22	$ 45,680.22	$ 45,680.22	$ 45,680.22	$ 45,680.22
Accumulated Depreciation & Depletion		$ (4,568.02)	$ (9,136.04)	$ (13,704.07)	$ (18,272.09)	$ (22,840.11)	$ (27,408.13)	$ (31,976.15)	$ (36,544.18)	$ (41,112.20)	$ (45,680.22)
Intangibles (Goodwill)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Other Non-Current Assets		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Non-Current Assets	$ 45,680.22	$ 41,112.20	$ 36,544.18	$ 31,976.15	$ 27,408.13	$ 22,840.11	$ 18,272.09	$ 13,704.07	$ 9,136.04	$ 4,568.02	$ 0.00
Total assets	$ 47,558.26	$ 49,331.70	$ 51,494.24	$ 56,687.64	$ 66,026.48	$ 81,033.40	$ 103,789.24	$ 137,135.34	$ 174,728.46	$ 210,133.65	$ 245,082.31
Liabilities and stockholders' equity											

Current liabilities:											
Accounts Payable		$ 2,253.65	$ 2,843.78	$ 3,658.18	$ 4,782.03	$ 6,332.84	$ 8,473.07	$ 11,426.61	$ 13,162.88	$ 13,162.88	$ 13,162.88
Revolving Line of Credit		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Current Portion of Long Term Debt	$ 945.27	$ 992.54	$ 1,042.17	$ 1,094.27	$ 1,148.99	$ 1,206.44	$ 1,266.76	$ 1,330.10	$ 1,396.60	$ 1,466.43	$ -
Total current liabilities	$ 945.27	$ 3,246.19	$ 3,885.95	$ 4,752.46	$ 5,931.01	$ 7,539.27	$ 9,739.82	$ 12,756.71	$ 14,559.48	$ 14,629.31	$ 13,162.88
Non-Current Liabilities											
Long Term Debt, Net Current Portion	$ 10,944.29	$ 9,951.75	$ 8,909.59	$ 7,815.31	$ 6,666.32	$ 5,459.89	$ 4,193.13	$ 2,863.03	$ 1,466.43	$ 0.00	$ 0.00
Total Non-Current Liabilities	$ 10,944.29	$ 9,951.75	$ 8,909.59	$ 7,815.31	$ 6,666.32	$ 5,459.89	$ 4,193.13	$ 2,863.03	$ 1,466.43	$ 0.00	$ 0.00

Total Liabilities	$ 11,889.57	$ 13,197.94	$ 12,795.53	$ 12,567.77	$ 12,597.34	$ 12,999.16	$ 13,932.95	$ 15,619.74	$ 16,025.91	$ 14,629.31	$ 13,162.88
Total stockholders' equity	$ 35,668.70	$ 36,133.76	$ 38,698.71	$ 44,119.87	$ 53,429.15	$ 68,034.23	$ 89,856.29	$ 121,515.59	$ 158,702.55	$ 195,504.34	$ 231,919.44
Total liabilities and stockholders' equity	$ 47,558.26	$ 49,331.70	$ 51,494.24	$ 56,687.64	$ 66,026.48	$ 81,033.40	$ 103,789.24	$ 137,135.34	$ 174,728.46	$ 210,133.65	$ 245,082.31

Appendix I: Consolidated Statement of Cash Flows ($)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Cash Flow from Operations										
Net Income (Loss)	$ 465.07	$ 2,564.94	$ 5,421.16	$ 9,309.27	$ 14,605.09	$ 21,822.05	$ 31,659.31	$ 37,186.96	$ 36,801.79	$ 36,415.10
Depreciation	$ 4,568.02	$ 4,568.02	$ 4,568.02	$ 4,568.02	$ 4,568.02	$ 4,568.02	$ 4,568.02	$ 4,568.02	$ 4,568.02	$ 4,568.02
(Increase) Decrease in Accounts Receivable	$ (939.02)	$ (245.89)	$ (339.33)	$ (468.27)	$ (646.17)	$ (891.76)	$ (1,230.65)	$ (723.44)	$ -	$ -
(Increase) Decrease in Other Receivable	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
(Increase) Decrease in Prepaid Expenses	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
(Increase) Decrease in Intangibles	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
(Increase) Decrease in Other Non-Current Assets	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
(Decrease) Increase in Accounts Payable	$ 2,253.65	$ 590.13	$ 814.40	$ 1,123.84	$ 1,550.81	$ 2,140.23	$ 2,953.55	$ 1,736.26	$ -	$ -
Total	$ 6,347.72	$ 7,477.21	$ 10,464.25	$ 14,532.87	$ 20,077.75	$ 27,638.54	$ 37,950.23	$ 42,767.80	$ 41,369.81	$ 40,983.12
Cash Flow from Investing										
CAPEX	$ (0.00)	$ 0.00	$ (0.00)	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ (0.00)	$ (0.00)	$ 0.00

Total	$ (0.00)	$ 0.00	$ (0.00)	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ (0.00)	$ (0.00)	$ 0.00
Cash Flow from Financing										
Revolving Line of Credit	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Long Term Debt	$ (945.27)	$ (992.54)	$ (1,042.17)	$ (1,094.27)	$ (1,148.99)	$ (1,206.44)	$ (1,266.76)	$ (1,330.10)	$ (1,396.60)	$ (1,466.43)
Total	$ (945.27)	$ (992.54)	$ (1,042.17)	$ (1,094.27)	$ (1,148.99)	$ (1,206.44)	$ (1,266.76)	$ (1,330.10)	$ (1,396.60)	$ (1,466.43)
Net Change in Cash	$ 5,402.44	$ 6,484.67	$ 9,422.09	$ 13,438.60	$ 18,928.76	$ 26,432.11	$ 36,683.47	$ 41,437.70	$ 39,973.21	$ 39,516.69
Cash at Beginning of Year	$ 1,878.04	$ 7,280.48	$ 13,765.16	$ 23,187.24	$ 36,625.84	$ 55,554.60	$ 81,986.71	$ 118,670.18	$ 160,107.89	$ 200,081.10
Cash at End of Year	$ 7,280.48	$ 13,765.16	$ 23,187.24	$ 36,625.84	$ 55,554.60	$ 81,986.71	$ 118,670.18	$ 160,107.89	$ 200,081.10	$ 239,597.78
Cash Per Balance Sheet	$ 7,280.48	$ 13,765.16	$ 23,187.24	$ 36,625.84	$ 55,554.60	$ 81,986.71	$ 118,670.18	$ 160,107.89	$ 200,081.10	$ 239,597.78
Unreconciled Difference	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

Appendix J : Vehicle Registration

भौतिक पूर्वाधार तथा यातायात मन्त्रालय

यातायात व्यवस्था विभाग

आ.व. २०७५/७६* सम्ममा दर्ता भएका सवारीको विवरण

आ.व.	बस	मिनिबस/ मिनि ट्रक	क्रेन/डोजर एस्काभेटर/ट्रक	कार/जिप भ्यान	पिक अप	माइक्रो	टेम्पो	मोटरसाइकल	ट्रैक्टर पावरटेलर	ई- रिक्सा	अन्य	आ.व.को जम्मा	आ.व सम्मको कुल जम्मा
046/47	3978	2064	6532	21350	0	0	2359	34576	5417	0	102	76378	**76378**
047/48	458	437	834	2353	0	0	856	5697	965	0	1549	13149	**89527**
048/49	531	455	1524	2637	0	0	1207	9336	1342	0	435	17467	**106994**
049/50	606	185	1491	2266	0	0	62	8513	751	0	381	14255	**121249**
050/51	1168	121	1740	3049	0	0	213	10550	1396	0	372	18609	**139858**
051/52	850	83	1629	3043	0	0	241	11401	1814	0	353	19414	**159272**
052/53	486	82	1151	3974	0	0	117	12357	2183	0	58	20408	**179680**
053/54	608	175	907	4521	0	0	185	15739	1278	0	352	23765	**203445**
054/55	899	130	1291	4139	0	0	344	12306	1265	0	51	20425	**223870**
055/56	872	19	978	2507	0	0	388	17090	2248	0	37	24139	**248009**
056/57	494	122	829	3647	0	0	789	19755	2542	0	102	28280	**276289**
057/58	1203	250	1271	5152	0	0	232	29291	3519	0	77	40995	**317284**
058/59	868	475	1798	4379	0	0	248	36117	3189	0	86	47160	**364444**
059/60	432	298	1212	2906	581	232	17	29404	2485	0	43	37610	**402054**
060/61	732	237	1477	7079	478	884	16	26547	2191	0	58	39699	**441753**
061/62	753	285	1592	4781	0	584	48	31273	1374	0	21	40711	**482464**
062/63	1528	663	2263	5114	36	66	60	44610	635	0		54975	**537439**
063/64	1564	806	3278	5156	736	138	12	72568	2942	0	1535	88735	**626174**
064/65	1419	1179	3594	4741	1588	31	18	68667	3297	0	206	84740	**710914**
065/66	1843	593	3643	6857	1287	128	20	83334	4663	0	202	102570	**813484**
066/067	1888	780	4524	12268	1975	145	9	168707	11460	0	31	201787	**1015271**
067/068	1610	1370	1969	8510	3087	115	2	138907	7937	0	133	163640	**1178911**
068/069	2085	1170	1333	8711	2981	155	10	145135	8413	0	91	170084	**1348995**
069/070	3263	1328	3332	9595	5422	158	57	175381	9795	0	152	208483	**1557478**
2070/71	2776	1412	2789	11372	5668	178	17	163945	10070	0	116	198343	**1755821**
2071/72	3737	2270	4236	13560	6057	932	1541	196383	10524	0	343	239583	**1995404**
2072/73	4353	4625	8328	28361	5060	1137	2613	267439	9786	11894	169	343765	**2339169**
2073/74	5342	2008	12712	21292	10675	841	17782	354071	17085	2247	204	444259	**2783428**
2074/75	2972	1973	12154	24338	10342	1934	16209	341623	13396	12325	348	437614	**3221042**
2075/76*	2354	1751	9958	17953	6987	1431	9785	249581	9765	8654	258	318477	**3539519**
जम्मा	**49318**	**25595**	**90411**	**237658**	**55973**	**7658**	**45672**	**2530722**	**143962**	**26466**	**7607**	**3539518.68**	

Appendix K: Electricity Tariff Rate

२.२. माथिल्लो भोल्टेज स्तर

क्र.सं.	उपभोक्ता वर्ग	डिमाण्ड शुल्क (रू. प्रति के.भि.ए. प्रति महिना)	इनर्जी शुल्क (रू.प्रति कि.वा.घण्टा)
अ.	**माथिल्लो भोल्टेज**		
१	औद्योगिक (१३२ के.भी.)	२३०	८.२०
२	औद्योगिक (६६ के.भी.)	२४०	८.३०
आ.	**मझौला भोल्टेज (३३ के.भी.)**		
१	औद्योगिक	२५५	८.४०
२	व्यापारिक	३१५	१०.८०
३	गैह्र व्यापारिक	२४०	११.४०
४	सिंचाई	०	४.८०
५	खानेपानी		
	क. सामुदायिक खानेपानी	०	४.६०
	ख. अन्य खानेपानी	१६०	६.६०
६	**यातायात**		
	क. चार्जिङ्ग स्टेसन	२३०	५.६०
	ख. अन्य यातायात	२५५	८.६०
७	गैह्र ग्राहस्थ	३५०	१२.५५
८	मनोरञ्जन व्यवसाय	३५०	१३.५०
इ.	**मझौला भोल्टेज (११ के.भी.)**		
१	औद्योगिक	२५५	८.६०
२	व्यापारिक	३१५	११.१०
३	गैह्र व्यापारिक	२४०	११.५०
४	सिंचाई	०	४.९०
५	खानेपानी		
	क. सामुदायिक खानेपानी	०	४.८०
	ख. अन्य खानेपानी	१५०	६.८०
६	**यातायात**		
	क. चार्जिङ्ग स्टेसन	२३०	५.६०
	ख. अन्य यातायात	२५५	८.८०
७	धार्मिक स्थल	२२०	९.९०
८	अस्थायी कनेक्सन	३३०	१२.००
९	गैह्र ग्राहस्थ	३५०	१२.९०
१०	मनोरञ्जन व्यवसाय	३५०	१३.९०

Appendix L: Owner-Operator Discounted Cash Flow Model (Scenario A)

Owner-Operator Discounted Cash Flow Model ($)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Revenue		7,016	9,682	13,362	18,441	25,448	35,119	48,465	56,311	56,311	56,311
Operating Costs		(12,498)	(14,951)	(18,368)	(23,127)	(29,757)	(38,994)	(51,861)	(59,745)	(60,251)	(60,763)
EBITDA		(5,482)	(5,269)	(5,005)	(4,687)	(4,309)	(3,875)	(3,396)	(3,434)	(3,941)	(4,452)
Dep & Amortization		(4,568)	(4,568)	(4,568)	(4,568)	(4,568)	(4,568)	(4,568)	(4,568)	(4,568)	(4,568)
Operating Income (EBIT)		(10,050)	(9,837)	(9,573)	(9,255)	(8,877)	(8,443)	(7,964)	(8,002)	(8,509)	(9,020)
Income Before Taxes (EBT)		(10,050)	(9,837)	(9,573)	(9,255)	(8,877)	(8,443)	(7,964)	(8,002)	(8,509)	(9,020)
Taxes		1,256	1,230	1,197	1,157	1,110	1,055	995	1,000	1,064	1,128
Cash Flow from Operations		(4,226)	(4,039)	(3,809)	(3,530)	(3,199)	(2,819)	(2,400)	(2,434)	(2,877)	(3,325)
Change in Non-cash Assets		(351)	(133)	(184)	(254)	(350)	(484)	(667)	(392)	-	
Change in Liabilities		842	320	442	609	841	1,161	1,602	941	-	
Free Cash Flow to Equity		(3,735)	(3,852)	(3,551)	(3,174)	(2,709)	(2,142)	(1,466)	(1,885)	(2,877)	(3,325)
Total Free Cash Flow to Owner-Operator Equity Holders	(46,382)	(3,735)	(3,852)	(3,551)	(3,174)	(2,709)	(2,142)	(1,466)	(1,885)	(2,877)	(10,082)
Discount Factor (15%)	100%	87%	76%	66%	58%	50%	44%	38%	33%	29%	25%
Discounted Cash Flows	(46,381.79)	(3,254)	(2,924)	(2,348)	(1,829)	(1,360)	(937)	(559)	(626)	(832)	(2,540)
Cumulative Discounted Cash Flows	(46,382)	(49,636)	(52,560)	(54,908)	(56,737)	(58,097)	(59,034)	(59,592)	(60,218)	(61,050)	(63,590)
Net Present Value for Owner-Operator Equity Holders	(63,590)										
Internal Rate of Return for Owner-Operator Equity Holders	N/A										
Discounted Payback	N/A										

Appendix M: Owner-Operator Discounted Cash Flow Model (Scenario B)

Owner-Operator Discounted Cash Flow Model ($)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Revenue		7,016	9,682	13,362	18,441	25,448	35,119	48,465	56,311	56,311	56,311
Operating Costs		(12,498)	(14,951)	(18,368)	(23,127)	(29,757)	(38,994)	(51,861)	(59,745)	(60,251)	(60,763)
EBITDA		(5,482	(5,269	(5,005	(4,687	(4,309	(3,875	(3,396	(3,434	(3,941	(4,452
Dep & Amortization		(4,568	(4,568	(4,568	(4,568	(4,568	(4,568	(4,568	(4,568	(4,568	(4,568
Operating Income (EBIT)		(10,050)	(9,837)	(9,573)	(9,255)	(8,877)	(8,443)	(7,964)	(8,002)	(8,509)	(9,020)
Interest Expense		(580)	(534)	(485)	(434)	(381)	(325)	(266)	(204)	(140)	(72)
Income Before Taxes (EBT)		(10,630)	(10,370)	(10,059)	(9,689)	(9,258)	(8,768)	(8,230)	(8,206)	(8,648)	(9,092)
Taxes		1,329	1,296	1,257	1,211	1,157	1,096	1,029	1,026	1,081	1,136
Cash Flow from Operations		(4,733	(4,506	(4,233	(3,910	(3,533	(3,104	(2,633	(2,613	(2,999	(3,387)
Change in Non-cash Assets		(351)	(133)	(184)	(254)	(350)	(484)	(667)	(392)	-	
Change in Liabilities		(80)	(648)	(575)	(458)	(280)	(16)	366	(356)	(1,362)	(1,430)
Free Cash Flow to Equity		(5,164)	(5,287)	(4,992)	(4,622)	(4,163)	(3,603)	(2,935)	(3,361)	(4,361)	(4,818)
Total Free Cash Flow to Owner-Operator Equity Holders	(34,786)	(5,164)	(5,287)	(4,992)	(4,622)	(4,163)	(3,603)	(2,935)	(3,361)	(4,361)	(11,575)
Discount Factor (15%)	100%	87%	76%	66%	58%	50%	44%	38%	33%	29%	25%
Discounted Cash Flows	(34,786.34)	(4,499)	(4,013)	(3,301)	(2,663)	(2,090)	(1,576)	(1,118)	(1,116)	(1,261)	(2,916)
Cumulative Discounted Cash Flows	(34,786)	(39,286)	(43,299)	(46,600)	(49,263)	(51,352)	(52,928)	(54,046)	(55,162)	(56,423)	(59,340)
Net Present Value for Owner-Operator Equity Holders	(59,340)										
Internal Rate of Return for Owner-Operator Equity Holders	N/A										
Discounted Payback	N/A										

Appendix N: Private Sector Discounted Cash Flow Model (Scenario B)

Private Sector Discounted Cash Flow Model ($)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Revenue		-	-	-	-	-	-	-	-	-	-
Operating Costs		-	-	-	-	-	-	-	-	-	-
EBITDA		-	-	-	-	-	-	-	-	-	-
Dep & Amortization											
Operating Income (EBIT)		-	-	-	-	-	-	-	-	-	-
Interest Expense											
Income Before Taxes (EBT)		-	-	-	-	-	-	-	-	-	-
Taxes		-	-	-	-	-	-	-	-	-	-
Cash Flow from Operations		-	-	-	-	-	-	-	-	-	-
Change in Non-cash Assets											
Change in Liabilities											
Free Cash Flow		-	-	-	-	-	-	-	-	-	-
Terminal Value											-
Total Free Cash Flow	(34,786)	-	-	-	-	-	-	-	-	-	-
Discount Factor (WACC), 12%	100%	89%	80%	71%	64%	57%	51%	45%	40%	36%	32%
Discounted Cash Flows	(34,786)	-	-	-	-	-	-	-	-	-	-
Cumulative Discounted Cash Flows	(34,786)	(34,786)	(34,786)	(34,786)	(34,786)	(34,786)	(34,786)	(34,786)	(34,786)	(34,786)	(34,786)
Net Present Value	(34,786)										
Internal Rate of Return	N/A										
Discounted Payback	N/A										

Appendix N: Public Sector Discounted Cash Flow Model (Scenario B)

Public Sector Discounted Cash Flow Model ($)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Cash Outflows											
Loan disbursement	(11,595)										
Equity investment	-										
Non-shareholder contributions to capital (grants)	-	-	-	-	-	-	-	-	-	-	-
Cash Inflows											
Loan repayments		1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502
Cash Flow from Equity (Public Sector Portion)		-	-	-	-	-	-	-	-	-	-
Sales tax revenue		-	-	-	-	-	-	-	-	-	-
Energy security benefit revenue		-	-	-	-	-	-	-	-	-	-
Electrical grid benefit revenue		-	-	-	-	-	-	-	-	-	-
Climate benefit revenue		-	-	-	-	-	-	-	-	-	-
Free Cash Flow	(11,595)	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502
Loan terminal value											-
Equity sale terminal value											-
Total Free Cash Flow	(11,595)	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502
Discount Factor (WACC),5%	100%	95%	90%	85%	81%	77%	73%	69%	66%	62%	59%
Discounted Cash Flows	(11,595)	1,425	1,352	1,282	1,217	1,154	1,095	1,039	986	935	887
Cumulative Discounted Cash Flows	(11,595)	(10,171)	(8,819)	(7,537)	(6,320)	(5,165)	(4,070)	(3,031)	(2,045)	(1,109)	(222)
Net Present Value	(222)										
Internal Rate of Return	0%										
Discounted Payback	N/A										

Appendix O: Owner-Operator Discounted Cash Flow Model (Scenario C)

Owner-Operator Discounted Cash Flow Model ($)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Revenue		18,694	23,579	30,320	39,623	52,460	70,176	94,625	108,997	108,997	108,997
Operating Costs		(13,082)	(15,646)	(19,215)	(24,186)	(31,108)	(40,746)	(54,169)	(62,379)	(62,886)	(63,432)
EBITDA		5,612	7,933	11,105	15,437	21,353	29,430	40,456	46,618	46,112	46,259
Dep & Amortization		(4,568	(4,568	(4,568	(4,568	(4,568	(4,568	(4,568	(4,568	(4,568	(4,568)
Operating Income (EBIT)		1,044	3,365	6,537	10,869	16,785	24,862	35,888	42,050	41,544	41,691
Interest Expense		(594)	(547)	(497)	(445)	(391)	(333)	(273)	(210)	(143)	(73)
Income Before Taxes (EBT)		450	2,818	6,039	10,424	16,394	24,529	35,615	41,841	41,400	41,617
Taxes		(56)	(352)	(755)	(1,303	(2,049	(3,066	(4,452	(5,230	(5,175	(5,202)
Cash Flow from Operations		4,961	7,034	9,852	13,689	18,913	26,031	35,731	41,179	40,793	40,983
Change in Non-cash Assets		(935)	(244)	(337)	(465)	(642)	(886)	(1,222)	(719)	-	-
Change in Liabilities		1,298	(406)	(233)	22	392	920	1,667	395	(1,396	(1,466)
Free Cash Flow to Equity		5,325	6,384	9,282	13,246	18,662	26,065	36,176	40,855	39,397	39,517
Total Free Cash Flow to Owner-Operator Equity Holders	(35,662)	5,325	6,384	9,282	13,246	18,662	26,065	36,176	40,855	39,397	26,354
Discount Factor (15%)	100%	87%	76%	66%	58%	50%	44%	38%	33%	29%	25%
Discounted Cash Flows	(35,662.22)	4,639	4,845	6,138	7,632	9,368	11,399	13,783	13,562	11,394	6,640
Cumulative Discounted Cash Flows	(35,662)	(31,023)	(26,178)	(20,039)	(12,408)	(3,040)	8,359	22,142	35,704	47,098	54,927
Net Present Value for Owner-Operator Equity Holders	53,614										
Internal Rate of Return for Owner-Operator Equity Holders	18%										
Discounted Payback	6										

Appendix P: Private Sector Discounted Cash Flow Model (Scenario C)

Private Sector Discounted Cash Flow Model ($)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Revenue		34,560	47,696	65,824	90,840	125,360	173,000	238,744	277,392	277,392	277,392
Operating Costs		(31,104)	(42,926)	(59,242)	(81,756)	(112,824)	(155,700)	(214,870)	(249,653)	(249,653)	(249,653)
EBITDA		3,456	4,770	6,582	9,084	12,536	17,300	23,874	27,739	27,739	27,739
Operating Income (EBIT)		3,456	4,770	6,582	9,084	12,536	17,300	23,874	27,739	27,739	27,739
Income Before Taxes (EBT)		3,456	4,770	6,582	9,084	12,536	17,300	23,874	27,739	27,739	27,739
Taxes		(432)	(596)	(823)	(1,136)	(1,567)	(2,163)	(2,984)	(3,467)	(3,467)	(3,467)
Cash Flow from Operations		3,024	4,173	5,760	7,949	10,969	15,138	20,890	24,272	24,272	24,272
Free Cash Flow		3,024	4,173	5,760	7,949	10,969	15,138	20,890	24,272	24,272	24,272
Total Free Cash Flow	(35,662)	3,024	4,173	5,760	7,949	10,969	15,138	20,890	24,272	24,272	24,272
Discount Factor (WACC), 12%	100%	89%	80%	71%	64%	57%	51%	45%	40%	36%	32%
Discounted Cash Flows	(35,662)	2,700	3,327	4,100	5,051	6,224	7,669	9,450	9,803	8,753	7,815
Cumulative Discounted Cash Flows	(35,662)	(32,962)	(29,635)	(25,536)	(20,484)	(14,260)	(6,591)	2,859	12,662	21,414	29,229
Net Present Value	29,229										
Internal Rate of Return	10%										
Discounted Payback	7										

Appendix Q: Public Sector Discounted Cash Flow Model (Scenario C)

Public Sector Discounted Cash Flow Model ($)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Cash Outflows											
Loan disbursement	(11,887)										
Equity investment	-										
Non-shareholder contributions to capital (grants)	-	-	-	-	-	-	-	-	-	-	-
Cash Inflows											
Loan repayments		1,539	1,539	1,539	1,539	1,539	1,539	1,539	1,539	1,539	1,539
Cash Flow from Equity (Public Sector Portion)		-	-	-	-	-	-	-	-	-	-
Sales tax revenue		-	-	-	-	-	-	-	-	-	-
Energy security benefit revenue		-	-	-	-	-	-	-	-	-	-
Electrical grid benefit revenue		-	-	-	-	-	-	-	-	-	-
Climate benefit revenue		-	-	-	-	-	-	-	-	-	-
Free Cash Flow	(11,887)	1,539	1,539	1,539	1,539	1,539	1,539	1,539	1,539	1,539	1,539
Loan terminal value											-
Equity sale terminal value											-
Total Free Cash Flow	(11,887)	1,539	1,539	1,539	1,539	1,539	1,539	1,539	1,539	1,539	1,539
Discount Factor (WACC), 5%	100%	95%	90%	85%	81%	77%	73%	69%	66%	62%	59%
Discounted Cash Flows	(11,887)	1,461	1,386	1,315	1,247	1,184	1,123	1,065	1,011	959	910
Cumulative Discounted Cash Flows	(11,887)	(10,427)	(9,041)	(7,726)	(6,479)	(5,295)	(4,172)	(3,107)	(2,096)	(1,137)	(228)
Net Present Value	(228)										
Internal Rate of Return	0%										
Discounted Payback	N/A										

Appendix R: Site Visit for Data Collection

Appendix S: Originality Report

FT003-Dilli Sapkota

ORIGINALITY REPORT

19%

SIMILARITY INDEX

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