



Bhutan_Thimphu
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EV READI NESS ASSESSMENT



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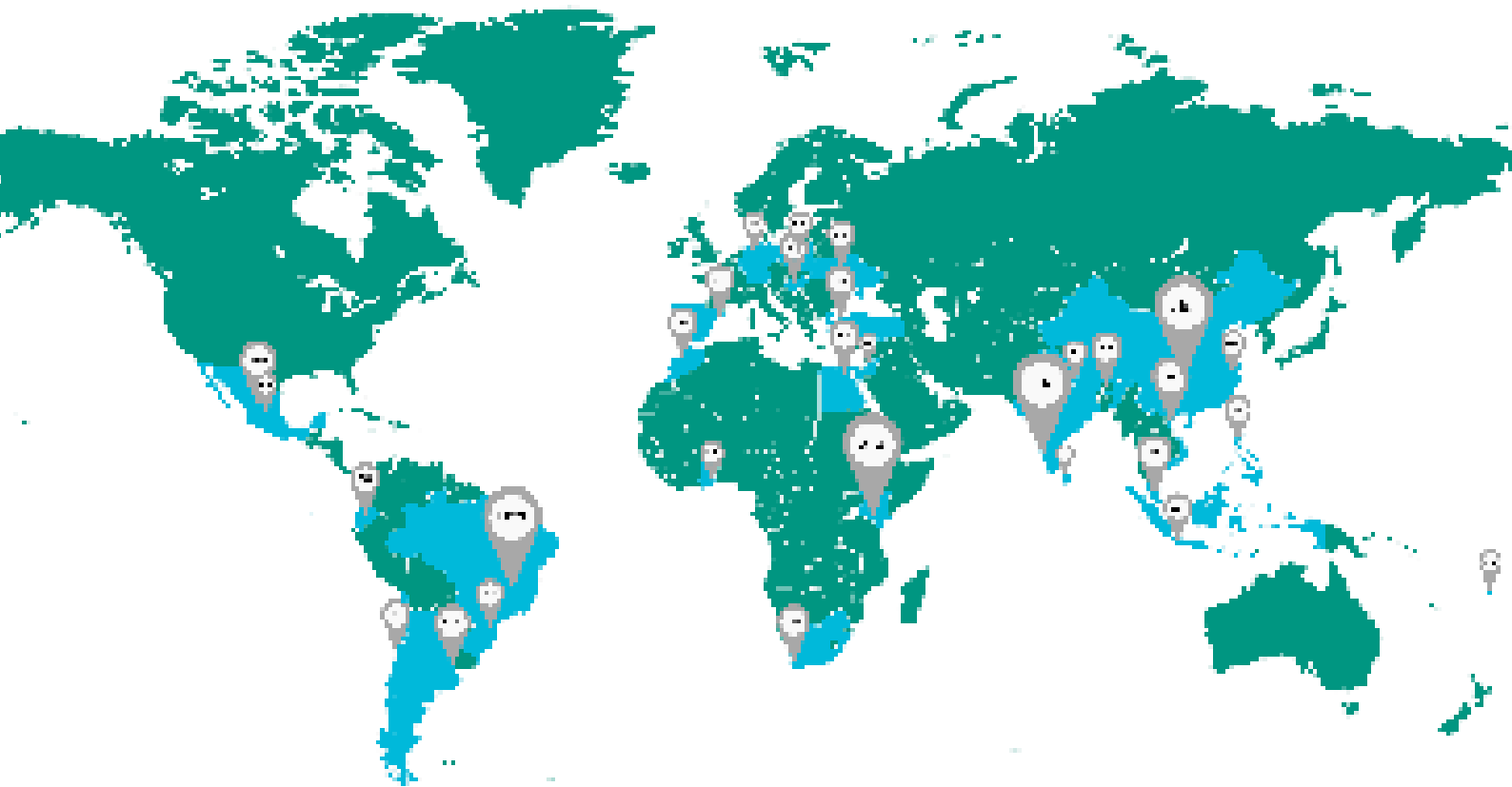
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KEY FACTS & FIGURES

THIMPHU

GDP 2,879 USD

CITY

Thimphu is the capital of Bhutan which is located in a mountainous region within an area space of 1,794.87 km² (National Statistics Bureau, 2017), at an altitude of 2,320m.

A population of 116,012 lives in Thimphu Dzongkhag in 2015 with an estimated population density of 64.6 per km² (National Statistics Bureau, 2017) and future projection foresee the city to grow.

Bhutan's economy is based on hydropower, agriculture, and forestry. The country's GDP per Capita is US\$ 2,879.07 and has a GDP growth rate of 7.99% (2016) (National Statistics Bureau, 2017a).

CO₂ EMIS SIONS

Bhutan's CO₂ emission per capita is 1.3 metric tons (World Bank, 2018) and total GHG emission is 3,297 kt of CO₂ equivalent in 2012 (World Bank, 2018a). As per the second national greenhouse gas (GHG) inventory, Bhutan is a net sink of GHG. This is due to the huge forest cover the country has, currently 70.46%, and a constitutional mandate to maintain the forest cover above 60%. The sequestration by forest is estimated at 6.3 million tons of CO₂ and emissions in 2013 amounted to an estimated 2.2 million tons of CO₂ equivalent. The emissions from Bhutan's agriculture sector have more or less remained constant, but emissions from sectors such as industrial processes and transport are increasing. During the period 2000 - 2013, emissions from the energy sector, industrial processes and waste management increased by 191.6 percent, 154.3 percent and 247.54 percent respectively (Royal Government of Bhutan, 2015). Bhutan's Intended Nationally Determined Contribution (INDC) included a target to remain carbon neutral by ensuring that GHG emission will not exceed the net sink capacity of its forest (Climate Action Tracker, 2017).

**TARGET:
REMAIN CARBON
NEUTRAL**



E-VEHICLES IN THIMPHU

Bhutan plans to make Thimphu - a clean Green Electric city (Tshering, 2014), along with the aim to achieve zero emissions in the transportation sector. The Royal Government of Bhutan (RGoB) initiated the introduction of Electric Vehicle (EV) but the market for EVs is still nascent. This paper gives an overview of e-mobility in the kingdom of Bhutan and in the capital city of Thimphu - on its status, measures considered, and political and technical support/barriers on its implementation.

With increases in economic growth in Bhutan, the vehicular growth is also significantly increasing. Currently, Bhutan has no railways and mode share are buses, taxis and private cars. Vehicle density is high in urban areas of Bhutan, including Thimphu. The city's public transport services (buses) are inadequate so that use of taxis and private modes of transport (private cars and two wheelers) are increasing. In Thimphu, city buses carry approximately 6,000 passengers per day, while taxis carry approximately 36,000 passengers per day. A "shared ride, fixed individual fare" based taxi is also in use during peak periods. The rate of motorisation in Bhutan grew about 12% per year during 2008–2012 with an average of about 6,300 newly registered vehicles each year. In 2014, the total number of vehicles registered in Bhutan was 68,744, of which around 38.4% of vehicle registration was in Thimphu Dzongkhag (Zhu, Patella, Steinmetz, & Peamsilpakulchorn, 2016). This increased emission and congestion, and declined air quality.

MODE SHARE
IN BHUTAN

DESCRIPTION & MEASURES

Electric Vehicles initiative in Bhutan:

EVs were introduced in Bhutan's market (mainly in Thimphu) in 2014 with the support from the government. As of March 2016, 52 Nissan Leaf EVs had been introduced in Bhutan, including 13 for government officials and 39 for general users, most of which are in Thimphu (Gross National Happiness Commission, 2016). The number of EVs import is growing. Considering the characteristics of private vehicle owners, EVs are likely to be bought by higher-income households (World Bank 2016). Quick charging stations on the road are available between Paro and Thimphu (the two main cities of Bhutan) (Tijhuis, n.d.)

Bhutan's government also have plans to convert some of the public sector vehicle-fleet and public transport to EVs (Tshering, 2014) (yet to be implemented):

- 1. Government fleet:** Cabinet fleet, Ministry and Agency fleet, Protocol Service cars, Police car
- 2. Public Transport and Private fleets:** Public Transport in Thimphu (City buses), taxis and school buses
- 3. Tourism sector:** Electric vans for transporting tourist, opportunities for low carbon tourism

CURRENT POLICY PROCESS

RGoB

The Royal Government of Bhutan (RGoB) initiated the introduction of Electric Vehicle (EV). The initiative is being developed in line with the country's commitment to address environmental issues and reduce fossil fuel dependency, as described in Bhutan's 11th Five-Year Plan (Zhu, Patella, Steinmetz, & Peamsilpakulchorn, 2016).

Bhutan's INDC further elaborates on its ambitious plan to promote low carbon transport system (Royal Government of Bhutan, 2015), which include promoting non-motorised transport and non-fossil fuel powered transport such as electric and fuel cell vehicles.

E-MOBILITY





POLICY

ENVIRONMENT

Legal and policy Framework supporting EVs in Bhutan (Tshering, 2014):

- Bhutan's constitution provides overall mandates for environmental conservation, which includes reduction of pollution and emission;
- National Environmental Protection Act (NEPA) of Bhutan 2007 provides a legal basis for financial incentives for reducing pollution and emission and penalties for pollution;
- Waste Act provides a legal basis for tax incentives for manufacturing environmental friendly technology, and increase in customs and other duties for imports of products which generates large volumes of waste;
- Economic Development Policy (EDP) of Bhutan 2010 provides policy frameworks for incentives for environmentally friendly economic activities and tax;
- Bhutan's declaration to remain "Net Sink of Green House Gases" at the Conference of Parties

70% REDUCTION IN FOSSIL FUEL IMPORTS BY 2020

National target: Bhutan targets 70 percent reduction in fossil fuel imports by 2020 (Sundas, 2015). Bhutan aims to achieve zero emissions in the transportation sector and make Thimphu a clean green city. For this, it is necessary to improve the availability and quality of urban transport services in Bhutan. To accommodate the growing urban populations and increasing levels of motor vehicle ownership, the main urban centers of Bhutan (Thimphu and Phuentsholing) is focusing on expanding the availability and quality of urban infrastructure and services, including transport services (Zhu, Patella, Steinmetz, & Peamsilpakulchorn, 2016).

Electricity generation: Reducing dependency on fossil fuel is one of the main goals of Bhutan's 11th Five-Year Plan. The use of hydro-based electricity in the transportation sector is considered one of the policy options to achieve this goal (Zhu, Patella, Steinmetz, & Peamsilpakulchorn, 2016).

Financial incentives: The analysis on EVs in Bhutan assumed that the government will use cost subsidies in addition to the currently provided tax incentives as additional fiscal incentives to influence the price of EVs (Zhu, Patella, Steinmetz, & Peamsilpakulchorn, 2016).

Charging facilities: The first draft plan developed by Bhutan Power Corporation (BPC) shows the location of 46 fast chargers along Bhutan's major route network.

The city of Thimphu plans for charging stations in 12 neighborhoods. For fast charging, they planned "neighborhood nodes," as described in the Thimphu Structure Plan 2004, which are in a suitable (central) location and are planned around a concentration of local facilities, such as shops, police stations, banks, and schools (Zhu, Patella, Steinmetz, & Peamsilpakulchorn, 2016).

POTENTIAL CONTRIBUTION

SDG 7 AFFORDABLE CLEAN ENERGY

CO₂ EMISSION REDUCTION

The **Bhutan Electric Vehicles initiative** has following objectives (Tshering, 2014):

- To achieve Zero Emission in the transport sector
- To make the capital city, Thimphu, a clean Green Electric City
- To reduce import of fossil fuels and thereby reduce vehicular emissions
- To sustain and reduce current account deficit due to fossil fuel import
- To protect the environment through reduction in CO₂ emissions and contribute towards global efforts to fight climate change
- To provide access to clean mobility for the poor and vulnerable sections of the society

ACCESS

With an EV policy, Bhutan aims to improve the public transport system as well as serve lower-income users who have no other choice than to use public transport. Improved public transport that is designed to connect travelers from their homes to work and community services would be expected to result in a switch from car use to public transport by providing substantial welfare benefits (such as, time savings and affordable) along with significant environmental benefits (Zhu, Patella, Steinmetz, & Pemsilpakulchorn, 2016).



MOBILITY

From the study carried out by the Zhu et al. (2016) on the Bhutan Electric Vehicle Initiative, annual GHG reduction benefits in 2027 are estimated to be 1.39 percent, 4.5 percent, and 33.6 percent of annual transport emissions in 2000 in the low, high, and super high uptake scenarios¹, respectively. With regard to total accumulated savings during 2015–2027, the estimates

¹ Low uptake scenario: EV replacement rates of 1 percent and 2 percent. High uptake scenario: EV replacement rate for government and private vehicles of 3 percent. Super high scenario: EV replacement rate for government and private vehicles of 5 percent and introduce about 1,000 EVs per year including all new taxi is assumed to be an EV (World Bank 2016).



CO₂ EMISSION



REDUCTION

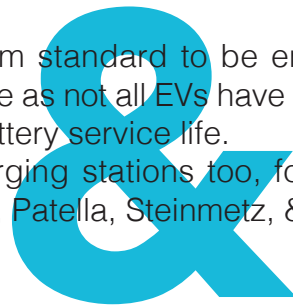
for the three scenarios are 17,276 tons of carbon dioxide equivalent (tCO_{2e}), 55,774 tCO_{2e}, and 416,897 tCO_{2e} in the low, high, and super high uptake scenarios, respectively. Considering a social value of US\$30 (Nu 1,800)² per ton of carbon emissions in 2015, the total accumulated social value of avoided carbon emissions during 2015–2027 is estimated to be Nu 31 million (US\$0.52 million), Nu 100 million (US\$1.67 million), and Nu 750 million (US\$12.5 million) in the low, high, and super high EV uptake scenarios, respectively.

² Exchange rate of 60 Nu (Bhutanese ngultrum) = 1 U.S. dollar (US\$)

SAFETY

Bhutan is looking for a basic minimum standard to be enforced to protect consumer from EV products that may not be safe or reliable as not all EVs have the same quality across manufacturers, mainly on battery performance and battery service life.

Safety measures are planned at charging stations too, for which the infrastructure operator is responsible for equipment safety (Zhu, Patella, Steinmetz, & Peamsilpakulchorn, 2016).



SECURITY

Till date no systematic data are collected on air quality due to lack of measuring devices, and it is difficult to assess the level of impact of the EV initiative on the overall air pollution problem in the initial study (Zhu, Patella, Steinmetz, & Peamsilpakulchorn, 2016).

■ AIR QUALITY DATA IS MISSING

AIR

QUALITY

National level

Ministry of Finance

International

International Finance Corporation (IFC), the World Bank Group. Within IFC's total climate-smart investment opportunity of \$42 billion in Bhutan from 2018-2030, \$615 million will be to develop Bhutan's low-carbon transport infrastructure and \$322 million in electric vehicles to green Bhutan's fleet in accordance with the government's goal to reduce fossil fuel imports (IFC, n.d.).

POTENTIAL

FINANCE

PARTNERS



TECHNOLOGY REQUIREMENTS

TECHNICAL BARRIERS TO THE PROJECT

FINANCIAL

- EV initiative challenges in Bhutan (Tshering, 2014):
- Funding for Infrastructure and Government Fleets
- Low cost financing to overcome higher upfront costs of EV ownership

TECHNICAL

- Limited knowledge/experiences on EVs
- Consumer confidence due to technological challenges like driving range per charge
- Identifying and installing appropriate charging schemes and harmonization of different models
- Maintenance and servicing expertise
- Durability and reliability in a rugged terrain
- Battery Life and Disposal/Management/Recycle



ELECTRICITY MIX & RELIABILITY OF THE GRID

BHUTAN HAS AN ABUNDANT SUPPLY OF CLEAN ELECTRICITY

Bhutan has an abundant supply of clean electricity from hydropower. Hydropower sector contributes to 12.5 percent of GDP and revenue from hydropower exports contributes to 3.7 percent of GDP in 2013. The share is expected to grow as more hydropower projects are completed and start generating electricity (World Bank 2016). Combined with enough supply of hydropower that is increasingly turned into electricity, the outlook looks promising for the growth of EV use (Tijhuis, n.d.).

POLICY

GOVERNANCE

Support from the local, state and national policy levels

The Royal Government of Bhutan (RGoB) for the initiation to promote the use of EVs

Gross National Happiness Commission carried out an initial study on EVs with the World Bank

Thimphu city municipality

KEY STAKEHOLDERS

- 1 ■ Gross National Happiness Commission (GNHC) - for policy development, creating a suitable environment for the implementation and address service pricing in charging station
- 2 ■ Road Safety and Transport Authority (RSTA) under the Ministry of Information and Communications (MoIC) - for transport planning
- 3 ■ Bhutan Power Corporation (BPC) - for handling grid connection and electricity supply
- 4 ■ Thimphu Municipality - for managing land and planning for charging points
- 5 ■ Private companies - for establishing charging stations for EVs through tenders and partnerships
- 6 ■ EV dealers, parts and maintenance businesses
- 7 ■ Financial institutions (banks) - for providing loans to EV consumers
- 8 ■ Citizens

In Bhutan, the government fleet, taxi drivers, and private car owners have been identified as potential target groups for the first phase of EV adoption (Zhu, Patella, Steinmetz, & Peamsilpakulchorn, 2016).

STEPS TOWARDS IMPLEMENTATION

FEASIBILITY OF THE IMPLEMENTATION

Metropolitan areas have typical characteristics of higher incomes, shorter travel times, and more incentives to improve air quality or reduce CO₂ emissions, making them more suitable for EV programs. Thimphu has these characteristics, which, along with its mild climate, make it a good pilot area for testing the new EVs and building a foundation for a cost-effective countrywide roll-out (Zhu, Patella, Steinmetz, & Peamsilpakulchorn, 2016).

EV initiative plan and roadmap in Bhutan (Tshering, 2014):

The EV initiative plan of Royal Government of Bhutan (RGoB) that intends to formulate and implement

National Action Plan for Zero Emission country is as follows:

- Thimphu, the capital city, to be “clean electric city”
- Adopt Sustainable Urban Transport System
- Reduction of fossil fuel imports substantially by 2020
- Enhance market share of EV substantially in 5 years
- Explore establishing local conversion, assemble and manufacturing of EVs

EV initiative roadmap

- To launch different EVs
- To develop a network of nationwide quick charging infrastructure
- To promote EV fleet programs for government, public and private sector
- Study the feasibility of introducing electric trains
- To implement tax incentives, subsidies and carbon scheme to promote EVs

LIKELY TIMEFRAME FOR TAKE-UP AND IMPLEMENTATION

READI NESS

Summary of the key issues of assessment

Higher upfront cost of EVs (high vehicle tax rates) and affordability issue

Public urban transport not well developed

Fiscal and technical capacities

Charging stations (Infrastructure: firstly concentrate in a densely populated area and then additional public fast charging can be planned for more rural areas. Operation: look for an operator of the charging infrastructure as it is beyond existing mandate for BPC)

EV PUBLIC AWARE- NESS & STAKEHOLDER INVOLVEMENT

MILEAGE ISSUES

NASCENT MARKET FOR EVS

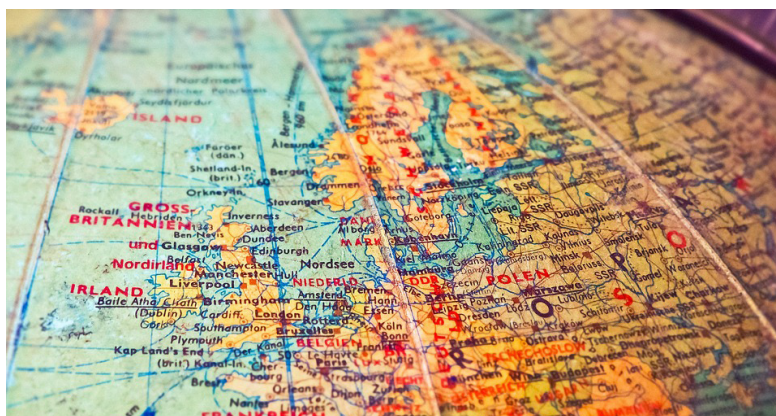
To assess the potential for EVs uptake, a first factor to look at is whether travel demand in the Bhutanese context can be served by EV driving characteristics. Some key advantages of the Thimphu city for EV uptake include its relatively small geographical size and mild climate. These factors accommodate the trip types that largely goes along with the current offering of EVs. However, considering hilly terrain and limited technical capacity, Thimphu is not yet ready for electric buses (Zhu, Patella, Steinmetz, & Peamsilpakulchorn, 2016).

POLITICAL & INSTITUTIONAL & FINANCIAL READINESS

Political, institutional and financial readiness

The EV market in the neighbouring countries (China and India) influence the market in Bhutan

Require public and private investments for the purchase of EVs and charging infrastructure. From the study (Zhu et al., 2016), it is estimated that during 2015–2020 the



total investment requirement will range from Nu 728 million (US\$12.13 million) in the low EV uptake scenario to Nu 7,793 million (US\$129.88 million) in the super high uptake scenario (approximately 0.73–7.84 percent of 2012 gross domestic product [GDP]).

Small-scale electric public transport can be introduced as a feeder mode to the city bus service (a large-scale deployment of electric buses require very high capital expenditure)

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