Ministry of Science and ICT

CTCN
CLIMATE TECHNOLOGY CENTRE & NETWORK

2019 Climate Change Technology Technical Assistance

-Stakeholder Workshop -

Development of low-emission mobility Policies Action Plan

Bring Light, Bring Life!

ENVELOPS

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1. Project Background

Cambodia, traffic volume has rapidly increased based on economic growth, which accounts for high portion of the GHG emission. For low-emission policy roadmap and E-Mobility expansion, external technical assistance is required.

Increase in transportation GHG emission and intensified air pollution with economic growth

- Since 2010, Cambodia yearly economic growth was about **7%**, but number of cars increased by **15.6%** (2008-2018)
- Out of Cambodia's 2016 CO_2 Emission 9.3M ton, **5M ton (54%)** was from Transportation sector. Road traffic accounts for 86% (IEA(2018))

Lack of capacity and resources for Low-emission mobility implementation

- Cambodia's GHG emission reduction target from transportation section based on Paris Agreement's INDC, suggested 390,000-ton CO_{2eq} 2030 BAU
- Low-emission mobility & E-Mobility expansion is in progress, but presents difficulties due to lack of financing and political competence.

Low-emission policy implementation plan and Financing plan for E-Mobility Project is required

Benefit

- **Cambodia low-emission economic development and contribute to GHG reduction**
- **Environment & Social Impact (Air pollution reduction, Gender equality etc.)**
- **Export opportunity for domestic E-mobility technology / policy**

2. General Information of Envelops

Envelops is a Renewable energy project development company providing overall services throughout the entire lifecycle of business (Project development, technology and finance expertise).

COMPANY	ENVELOPS Co., Ltd.
ESTABLISHED	April 2018
CEO	Yoon, Sung
BUSINESS	Renewable energy Project development, Project Financing, Power Plant O&M
ADDRESS	506 Techno Complex Research Center, 145 Anam-ro, Seongbuk-gu, Seoul, Republic of Korea

HISTORY

Mar 2018	Selected for Social Entrepreneurs support program
Apr 2018	Established Envelops Co., Ltd
Jul 2018	Winner of Global Impact Challenge (US Singularity University Accelerating Program)
Jul 2018	Awarded KOICA GCF Project development program
Aug 2018	Awarded KITECH Indonesia Biomass power plant localization project
Oct 2018	**Awarded Ministry of Science & ICT Program: Ethiopia Climate Change TA project (CTCN)**
Jan 2019	Awarded KEITI GCF project development support
Mar 2019	JP Morgan Social Bridging Project
Apr 2019	Awarded KEA Feasibility study support program
May 2019	Selected for LG Social Fellow 9th Edition
May 2019	Selected KOEN Global Start-up support program
Nov 2019	Awarded CTCN TA Project for Cambodia E-Mobility
Feb 2020	Awarded KOICA CTS (Creative Technology Solution)
Aug 2020	**Korea first GCF project approval – Fiji 4MW APV**

3. Project Strategy for implementation

For Introduction of low-emission mobility technology to Cambodia

(1) Establishing **Policy Roadmap and Action Plan**

(2) **International climate finance proposal** development for E-mobility project

Part I	**Establish policy roadmap and action plan for the introduction of E-mobility technology**
Part II	**Prepare International climate finance (GCF, GEC) for E-mobility Project**

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1. Business As Usual Scenario

- **Average travel speed = 25km/h**
- **Average daily vehicle kilometers**
  - General vehicles = 27km/day
  - Operation vehicles = 100km/day
  - Motorcycles = 19km (E-motorcycles = 23km)
- **Vehicle population growth estimation method = Gompertz function**

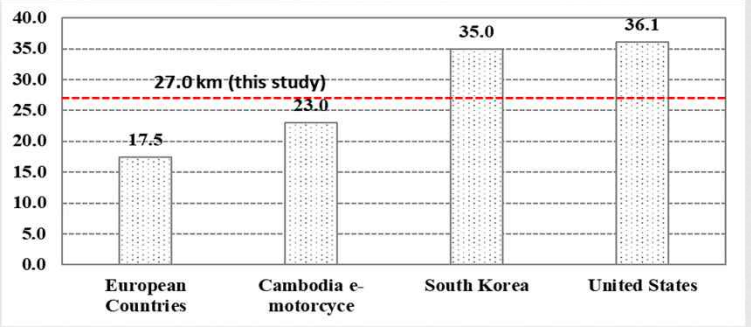
$$f(t) = \alpha e^{-be^{-ct}}$$

where: a is an asymptote; b sets the displacement along the x-axis; c sets the growth rate; e is Euler's Number

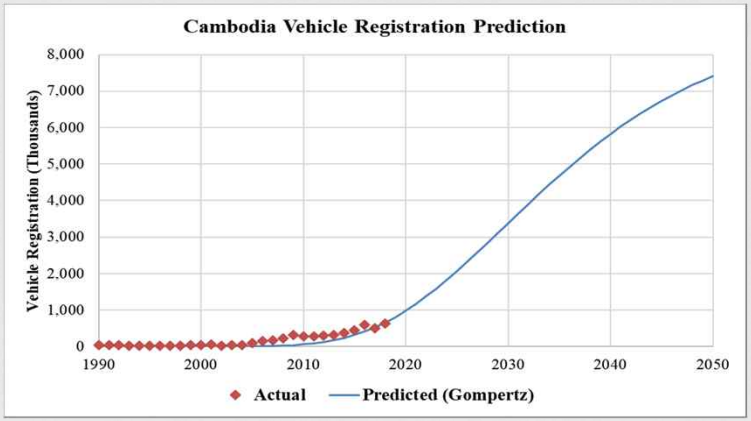
- **Emission rates based on Korean average speed model**

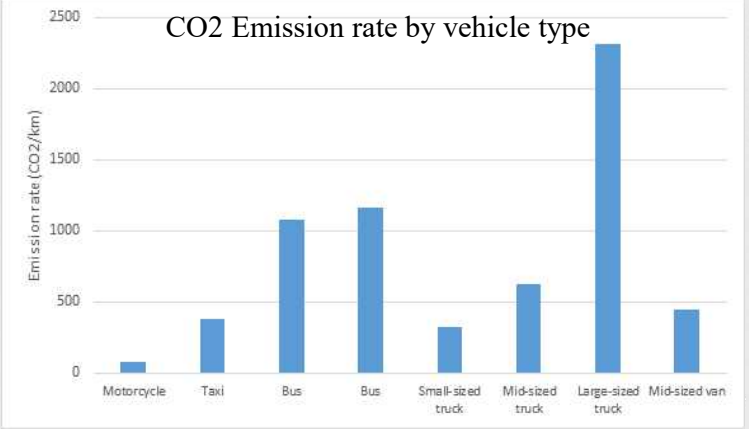
$$E = \alpha V^{\beta} \text{ (or } E = \alpha V^2 + \beta V + \gamma\text{)}$$

where, E is emission rate in g/km. V is vehicle speed in km/h, and α, β, γ are model parameters.



<Average Daily Vehicle Kilometers Traveled by Countries>

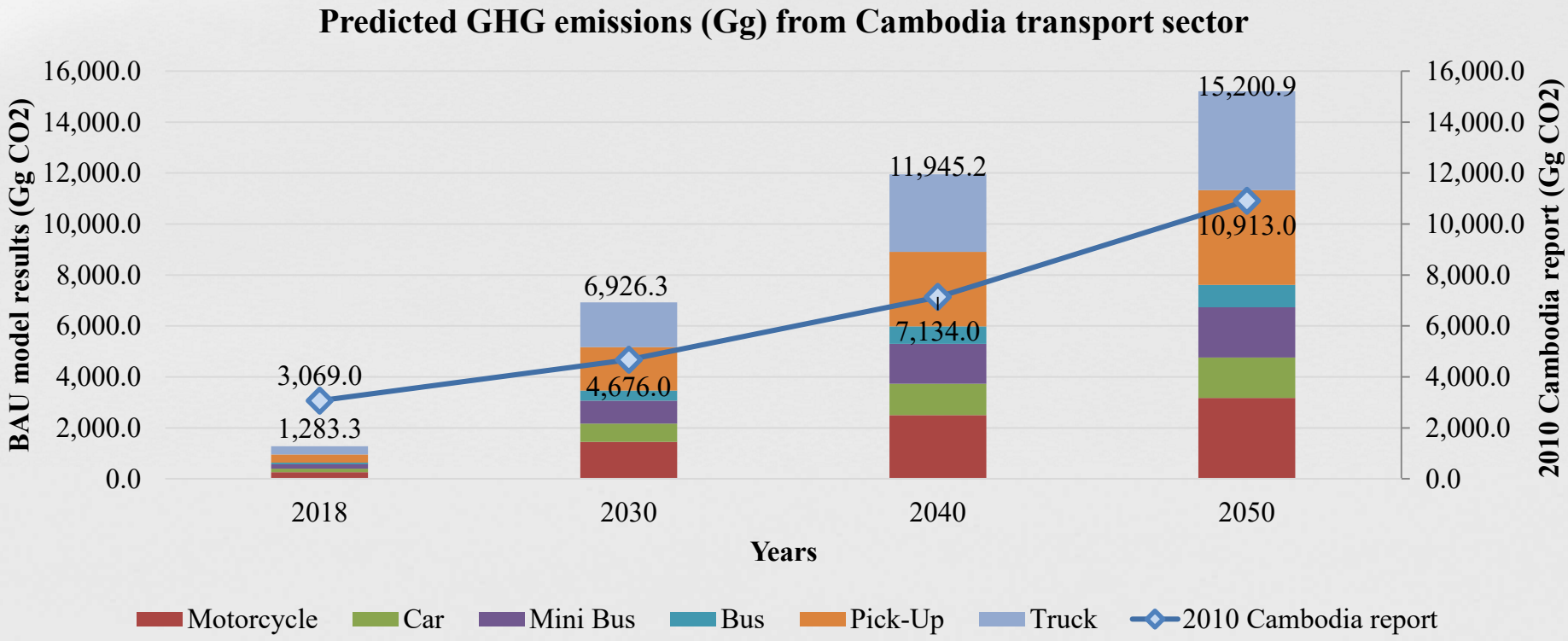




ENVELOPS

1. Business As Usual Scenario

BAU analysis estimated greenhouse gas (GHG) from Cambodia transportation sector, for current and future years. Under the BAU scenario, GHG from Cambodia transportation sector is expected to continuously increase by the annual growth rate of 33.9%, with the expected increase in Cambodia population and thereby vehicle ownership.



2. Alternative Scenario #1 (Assumptions)

❖ Motorcycle penetration rate

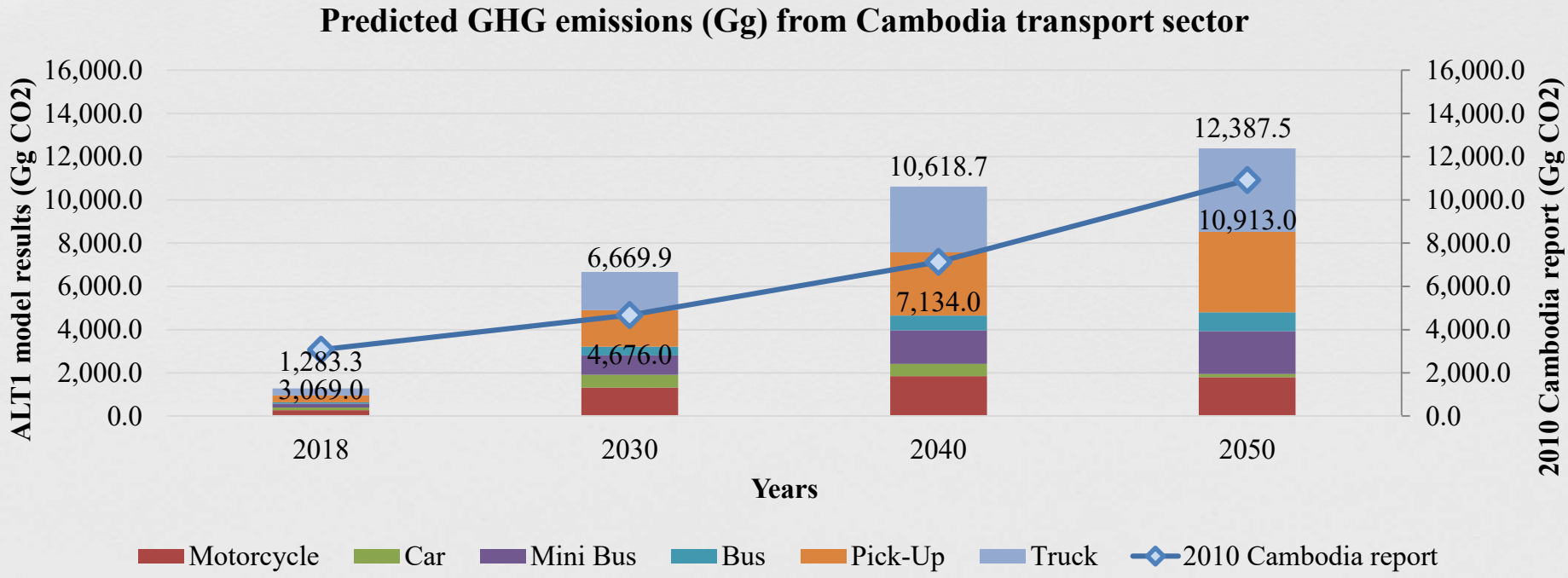
- Year 2018: 0.0%
- Year 2030: 10.0%, which equals to 271,320 e-motorcycles accumulated.
- Year 2040: 30.0%, which equals to 1,403,782 e-motorcycles accumulated.
- Year 2050: 50.0%, which equals to 2,977,304 e-motorcycles accumulated.

❖ E-motorcycle emission rate and daily travel distance

- 8.6 CO2 g/km
- 23 km/day

2. Alternative Scenario #1

In alternative scenario #1, the diffusion of electric motorcycles is considered as a way to reduce GHG from Cambodia transportation sector. The result shows that replacing conventional gasoline-powered motorcycles with electric motorcycles is effective in reducing GHG, by reducing GHG by 2,813.41 $GgCO_2$ compared with BAU scenario (by 18.5%) in 2050. To achieve this goal, it requires a total of around 3 million e-motorcycles by 2050, which costs a total of 2 billion US dollars.



3. Alternative Scenario #2 (Assumptions)

❖ E-car

- Year 2018: 0.0%
- Year 2030: 1.0%, which equals to 2,646 e-cars accumulated.
- Year 2040: 3.0%, which equals to 13,690 e-cars accumulated.
- Year 2050: 5.0%, which equals to 29,036 e-cars accumulated.

❖ E-minibus (around 15-20 passengers)

- Year 2018: 0.0%
- Year 2030: 5.0%, which equals to 3,806 e-minibus accumulated.
- Year 2040: 10.0%, which equals to 13,129 e-minibus accumulated.
- Year 2050: 20.0%, which equals to 33,415 e-minibus accumulated.

❖ E-bus (around 45 passengers)

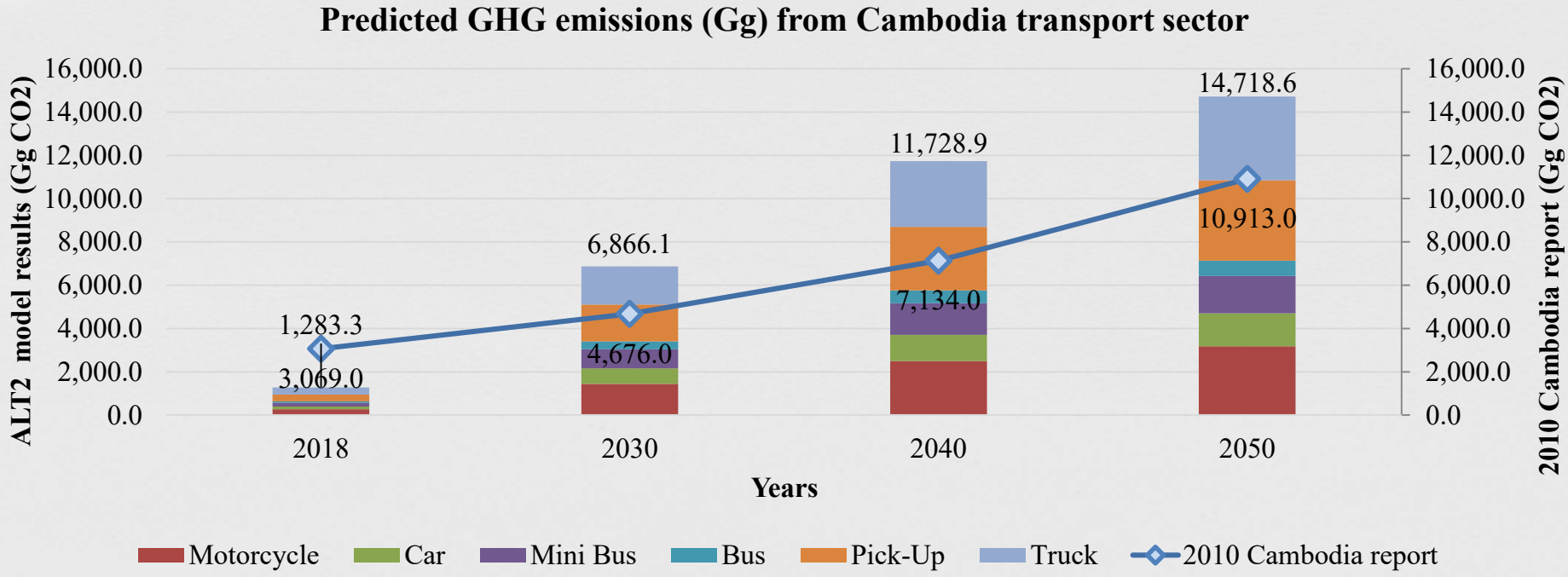
- Year 2018: 0.0%
- Year 2030: 10.0%, which equals to 1,292 e-bus accumulated.
- Year 2040: 20.0%, which equals to 4,457 e-bus accumulated.
- Year 2050: 30.0%, which equals to 8,507 e-bus accumulated.

❖ Emission Rate

- E-car: 77.0 g/km (273.32 g/km for gasoline cars)
- E-minibus: 157.8 g/km (442.424 g/km for diesel minibuses)
- E-bus: 402.6 g/km (1,159.689 g/km for diesel buses)

3. Alternative Scenario #2

In alternative scenario #2, the diffusion of electric cars and buses is considered as an alternative way to reduce GHG from Cambodia transportation sector. The result shows that replacing conventional vehicles with electric cars is also effective in reducing GHG, by reducing GHG by 482.28 $GgCO_2$ compared with BAU scenario (by 3.2%) in 2050. However, comparing the cost/effectiveness (i.e., cost per CO_2 reduction) of alternative scenario #1 and #2, the result suggested that alternative scenario #1 (i.e., diffusion of e-motorcycles) appears to be a better option for Cambodia.



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1. Impact Analysis

Based on the BAU and two alternative scenarios, various impact analysis was carried out.

- **GHG Emission Reduction Impacts**
- **Lifecycle Cost Analysis**
- **Environmental and Health Impacts**
- **Socio-economic and Gender Impacts**

2. GHG Emission Reduction Impacts

The Government of Cambodia submitted the Intended Nationally Determined Contribution (INDC) to the UNFCCC in 2015, indicating the possible emission reduction of 390 GgCO2-eq by 2030 in the transport sector. This reduction target is comparable to the amount of the estimated reduction in 2030, 316.6 GgCO2-eq (combining Alternatives #1 and #2).

Year	BAU	Alternative #1		Alternative #2	
	CO2 (Gg)	CO2 (Gg)	vs. BAU	CO2 (Gg)	vs. BAU
2018	1,283.3	1,283.3	0.0%	1,283.3	0.0%
2030	6,926.3	6,669.9	-3.7%	6,866.1	-0.9%
2040	11,945.2	10,618.7	-11.1%	11,728.9	-1.8%
2050	15,200.9	12,387.5	-18.5%	14,718.6	-3.2%

3. Lifecycle Cost Analysis

The cost/benefit analysis was conducted to compare the effectiveness of the alternative scenarios. As a result, the alternative #1 (i.e., introducing e-motorcycles) appears to be more effective in reducing the transport GHG than the alternative #2 (i.e., introducing e-cars and e-buses). The costs per GHG reduction unit are 6.5 to 8.0 times lower, depending on target year, for alternative #1.

	Alternative #1			Alternative #2		
Year	Total CO_2 Reduction to BAU (Gg)	Total Purchase Cost (USD, $)	Cost per benefit ($/Gg)	Total CO_2 Reduction to BAU (Gg)	Total Purchase Cost (USD, $)	Cost per benefit ($/Gg)
2018	0	0	0	0	0	0
2030	256	379,848,683	1,481,555	60	668,854,676	11,122,350
2040	1,327	1,094,122,148	824,814	216	1,164,110,771	5,381,081
2050	2,813	610,141,881	216,869	482	835,512,616	1,732,418
Total	4,396	2,084,112,712	474,060	759	2,668,478,063	3,516,934

4. Environmental and Health Impacts

- Less consumption of fossil fuels leading to no air pollutant and GHG emission during EV driving, results in less damages to the public health.
- GHG Emission in battery production but less than in conventional Motorcycles in Life-cycle Assessment (LCA).
- Environmental and health impacts of lead acid battery pose significant threats.
- Noise
- Environmental Impacts of Lithium-Ion Battery Production is less than Lead Battery
- Measures to further mitigate environmental and CO2 Emission Impacts

5. Socio-economic and Gender Impacts

- Resource extraction for battery production may lead to unintended social impacts in the extraction sites and societies.
- Electric Motorcycles are more affordable / accessible to lower income group than electric vehicles.
- Electrification of public buses, however, may have more positive gender and poverty impacts in the long run
- Poverty reduction and gender empowerment impacts may be higher when electrifying Motorcycles than electric vehicles
- Promotion of electric Motorcycles in rural areas may generate more socio-economic benefits but proper rural electrification and infrastructure development is a pre-condition
- With or without electrification, current Motorcycle taxi business sector in Cambodia need modernization, i.e. formalization and stronger regulations for safer, better services

5. Comparative Impact Analysis of the Three Scenarios

Criteria / Scenario		BAU	AS#1	AS#2	Analysis & Further Consideration
[STEP 1 SELECTION] Primary Criteria	GHG Emission	(0: Baseline)	(++)	(+)	Overall GHG Emission reduction effect is bigger in AS#1
	Cost Effectiveness	(0: Baseline)	(++)	(+)	Cost effectiveness for GHG Emission reduction is higher in AS#1
	Environmental Impact 1: Air Pollution	(--) GHG Emission	(++)	(-)	Air pollution is higher in BAU and lowest in AS#1
	Other Environmental Impact	(--) Gasoline and diesel leakages lead to soil and water contamination	(--) Lead acid battery results in soil and water pollution. Production of Lithium ion battery consumes large amount of water		All three options have environmental impact. BAU incur more environmental damage during operation (driving), while AS#1 and AS#2 in resource extraction and manufacturing stage. The later (AS#1 and AS#2) is easier to control and manage (as the source and agent is concentrated) Extraction of material and manufacturing of batteries need to be manage through environmental management and safety regulations.

5. Comparative Impact Analysis of the Three Scenarios

Criteria / Scenario		BAU	AS#1	AS#2	Analysis & Further Consideration
[STEP 1 SELECTION] Primary Criteria	Health Impacts	(--) Gasoline / diesel combustion leading to excessive air pollutants	(++) During driving, air pollutants are not emitted. Thus overall health impacts associated with air pollution and traffic exhaust gases would be reduced in the long term.		One of the biggest benefits of E-Mobility is cleaner environment and reduced health damages associated with the air pollution. The extent of improvement of air quality would be determined the bulk of air pollution emission saved by introducing E-Mobility in AS#1 and AS#2.
[STEP 2 SELECTION] Secondary Criteria	Social Impact 1: Poverty Reduction & Economic co-benefits	X [Deselected from Step 1 selection]	(++)	(+)	E-Motorcycles are more affordable transport modality to broader segment of population (including lower income groups) than 4 wheeled vehicles when considering private ownership.
	Social Impact 2: Gender and Vulnerable Group Coinsideration	X [Deselected from Step 1 selection]	(++)	(+)	Due to lower purchasing power, Cambodian women in general has less car ownership. It favors E-Motorcycle (AS#1). However, additional incentives are required to effectively implement AS#1 in rural area to shortage of electricity and grid connectivity as well as limited affordability.

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1. Barriers for E-Mobility in Cambodia

In promoting the E-Mobility in Cambodia, six types pf barriers are identified.

- **Data and Information gap**
  - **Database on E-Mobility for Evidence-based Policy making and Planning**
  - **Lack of information Leading to Low Level of Public Awareness of E-Mobility**
- **Policy and planning gap**
- **Institutional gap**
- **Technical capacity gap**
- **Financial gap**
- **Market and infrastructure gap**

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1. Actions for E-Mobility

Based on the barrier (gap), set of action areas are suggested. Each action is categorized into three Categories;

❖ Primary Action Area

The core component of the E-Mobility Policy Action Plan, largely to be carried out by the Cambodian government for kick-starting the E-Mobility diffusion effect.

❖ Secondary Action Area

Complementary but still essential component of the E-Mobility Policy Action Plan, to be carried out by the Cambodian government and partly supported or collaborated by other entities

❖ Enabling Conditions

Area of action that is not within the scope of E-Mobility Policy Action Plan and essentially required for effective E-Mobility diffusion and achievements of NDC targets and other objectives and co-benefits of E-Mobility.

2. Actions areas for implementation of E-Mobility

Barriers	Details	Action Areas	Action Type
Data & Info Gap	1. Insufficient data & information collection	(1) Introduction EVs and electric Motorcycle registration system (2) Establish DB on the current EV and Motorcycle stocks (e.g. technical specification, engine types, user group analysis, pricing etc. & conduct trend analysis) (3) Set up air quality monitoring DB over-time during the E-Mobility Action Plan implementation	Primary Action
	2. Insufficient access to information	(1) Conduct public information and campaign for awareness raising on E-Mobility	Primary Action
Policy & Planning Gap	3. Insufficient Policy to Incentivize low carbon transport & E-Mobility	(1) Set up specific NDC target for E-Mobility (by different modalities: E-Motorcycles, E-Car and buses etc. (2) Prioritize key incentives, set up supporting policies and allocate budgets (3) Financial incentives to end users (electricity and/or Motorcycle subsidies/import tax (tariff vs. duty) exemptions or favored rates) etc. (4) Non-financial incentives to end users (special land and/or parking allocation, battery return cash-back/credit system etc.)	Primary Action

2. Actions areas for implementation of E-Mobility

Barriers	Details	Action Areas	Action Type
Policy & Planning Gap	4. Lack of insufficient Plan on E-Mobility Infrastructure development	(1) Setup plans with concrete time-bound targets to develop # units of battery charging stations, repair and other related shops and infrastructure (2) Setup incentives to support for the start-ups on and private investment in E-Mobility business	Primary Action
Institutional Gap	5. Lack of collective (consultive) decision making mechanism for policy adoption	(1) Establish multi-party consultation mechanism involving all relevant stakeholders for E-Mobility diffusion in Cambodia (including government and public, business, and academic as well as the transport occupational associations etc.)	Primary Action
	6. Lack of environmental management and safety regulations on battery production, recycling and dismantling	(1) Phase our lead acid battery type of E-Motorcycles with a clear sunset policy & dismantle lead acid battery manufacturing and recycling facilities (2) Introduce tracking and reporting system on resource extraction for battery production of imported and domestically manufactured EVs and electric Motorcycles	Secondary Action

2. Actions areas for implementation of E-Mobility

Barriers	Details	Action Areas	Action Type
Institutional Gap	7. Insufficient management and regulations on transport business operators (including Motorcycle taxis), leading to unsafe and irregular services	(1) Formalization and modernization of public transport sector operations, including mandatory registration and business licensing regulations, mandatory safety and occupational training on drivers and associated employees, standardization on fares etc. (2) Quality control of the licensed E-Motorcycles and EV & enforce strict vehicle emission standards	Enabling condition
Technical Capacity Gap	8. Insufficient local experts and engineers on E-Mobility R&D, innovation, and business operations	(1) Identify technical capacity gap and required level of human resources in Cambodia for government and business sector (2) Provide training on engineers and nurture local E-Mobility experts (e.g. scholarship overseas education etc.)	Secondary Action
Financial Gap	9. Insufficient public and private investment on E-Mobility Market	(1) Improve banking for EV-related business &U enterprises etc.	Secondary Action
	10. Existence of contradictory financial incentives	(1) Gradually phase out fossil-fuel subsidies and any incentives on conventional Motorcycle purchase	Enabling condition

2. Actions areas for implementation of E-Mobility

Barriers	Details	Action Areas	Action Type
Market & Infra. Gap	11.Insufficient suppliers	(1) Incentivize new entrance on the E-Mobility Market (2) Foster supply of electric two-wheelers	Secondary Action
	12.Insufficient, unstable, or unaffordable electricity	(1) Improve reliability of electricity supply, including voltage fluctuation	Enabling Condition
	13.Lack of poorly conditioned road esp. remote rural areas	(1) Ensure achieving the country's rural road infrastructure development target as planned.	Enabling Condition

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Thank you

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Experienced Renewable Energy Developers

ENVELOPS is focused on clean and renewable energy. We bring light to people who go through daily lives without enough power. We provide comprehensive solutions from initial research, feasibility study, public affairs, financing, contracts, and finally to construction and O&M.
Our business is centered around the importance of diversity; diversity in generation type, geography, and lifecycle stage will provide stable, long term returns for our investors and partners.
We believe in the value of coexistence and sustainable growth of local communities to bring positive change.