



Advanced Energy Partnership for Asia

# Electric Vehicle Charging Infrastructure: Business Model and Tariff Design Support to the Lao PDR

Kaylyn Bopp, Owen Zinaman, and Nathan Lee | National Renewable Energy Laboratory (NREL)  
May 22, 2020

NREL/PR-7A40-77671



## NOTICE

This work was authored, in part, by the National Renewable Energy Laboratory (NREL), operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by the United States Agency for International Development (USAID) under Contract No. IAG-19-2115. The views expressed in this report do not necessarily represent the views of the DOE or the U.S. Government, or any agency thereof, including USAID. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

# Agenda

---

1. Overview of Electric Vehicle (EV) and EV Supply Equipment (EVSE) Deployment Objectives
2. Introduction to EV and EVSE Government and Utility Motivations
3. Introduction to Business Models for EVSE

# Overview of Electric Vehicle (EV) and EV Supply Equipment (EVSE) Deployment Objectives

# Scope: Electric Vehicles

Today's Scope:  
light-duty  
(privately owned)  
EVs in Laos



Electric taxi, Bangkok Airport. Photo by authors



Vientiane, Laos. Photo from Thanate Tan, licensed under CC BY 2.0

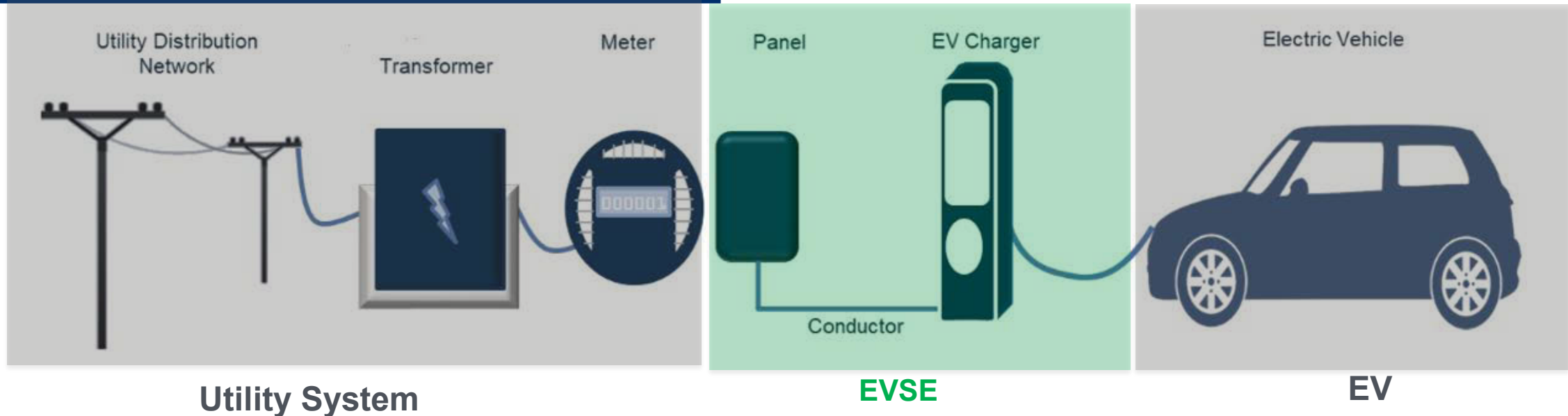


Toyota HiAce outside gasoline station, Vientiane. Photo by authors



Photo from Smith Electric Vehicles

# Scope: Electric Vehicle Supply Equipment (EVSE)



- EVSE is the charging infrastructure for EVs.
- EVSE consists of multiple parts:
  1. Connections from the distribution system to the EVSE meter
  2. Connections from the meter to the charging infrastructure (EV charger)
  3. The EV charger or EVSE equipment itself.
- This work focuses on the EVSE (in green above). Need to consider the distribution system and EVs to discuss business models, tariffs, and standards.

**Today's  
Scope: public  
EVSE  
installations**

# Scope: Electric Vehicle Supply Equipment

EVSE	EVSE Connectors	EVSE Ports
		

## Purposes of EVSE

- Connects EV to grid to provide charging services
- Prevents overloading circuit
- Provides safe connection before power flows
- Prevents EV battery damage
- Enables payment collection
- Enables data collection

Photos by NREL, 41587, 49468, 26453

# Scope: Grid vs. Off-Grid EVSE Connections

## Grid Connection



Photo from Asian Development

*Traditionally, EVSE is connected to the electrical grid*

- Best in areas where there is already network infrastructure
- Can charge multiple vehicles per day
- Most common type of EVSE connection worldwide
- More affordable (where grid infrastructure already exists)

## No Grid Connection



Photo from Envision Solar

*New technology exists for off-grid solar (plus battery) powered EVSE*

- Could be an option in areas with no electrical infrastructure
- Limited charging capacity (can fully charge 1 car 1x per day)
- Limited use worldwide so far
- Very expensive



# Introduction to EV and EVSE Government and Utility Motivations

# Government Motivation: EV and EVSE Deployment

## What motivates governments to invest in EV and EVSE deployment?

- **Increased energy security/reduced fossil fuel imports:** Shift away from imported transport fuels (oil, gasoline, diesel, etc.) and increased reliance on domestic electricity for transport. Reduced foreign exchange expenses.
- **Local and urban air-quality improvements:** Zero direct exhaust emissions from EVs and reduction of conventional fuel vehicles reduce local pollutant emissions (NO<sub>x</sub>, SO<sub>x</sub>, VOCs, and particulates).
- **International climate and environment commitments:** Greenhouse gas reductions targeted in nationally determined contributions.
- **Ensured reliable transportation:** Reliable transportation for people and goods is vital for economic development. Governments can ensure equitable access to charging infrastructure for populations and increased mobility.
- **Economic Development:** EV and EVSE deployment offers multiple private sector (and utility) opportunities. This includes EV manufacturing, sales, maintenance, and other services. EVSE deployment offers private-sector opportunities for charging and related services.
- And other context-specific motivations



Transmission lines outside Vientiane; EV Lao charger outside Ministry of Energy and Mines (MEM) offices. Photos by authors

# Utility Motivation: EV and EVSE Deployment

## What motivates electric utilities to invest in EV and EVSE deployment?

- **Create additional demand (revenue):** Increased EV deployment increases demand for electricity, and charging infrastructure (EVSE) provides customers with access to this service.
- **Address seasonal surpluses of electricity:** In countries with surplus electricity from hydropower in wet seasons (years), EV deployment provides domestic demand and revenue for power when demand for power export is low.
- **Boost cross-subsidization of low-income customers:** Most car owners are wealthy (or businesses); EV deployment creates an opportunity for EV owners to pay into power system to support lower-income customers with slightly higher tariffs.
- **Increase access to utility capital, expertise, and resources:** EV deployment ensures utility involvement to lower distribution system, maintains reliability, minimizes grid impacts, and lowers infrastructure costs through coordination.
- **Improve understanding and control of vehicle charging:** Involvement allows access to data and operational strategies to control future load and renewable energy integration.
- **In the future, EVSE can be a flexible grid resource:** EV deployment increases opportunities to use EVSE to provide grid stability and balancing as EVs have long dwell times.
- And other context-specific motivations



Hydropower and Vientiane traffic. Photos by authors

# Introduction to Business Models for EVSE

# Introduction to Business Models for EVSE

## What is a business model?

*For the purposes of this presentation, a business model defines how EVSE services are deployed and offered to customers.*

Relevant questions for business models include:

- Who owns the EVSE?
- Who installs the EVSE?
- Who manages the EVSE?
- What is the role of the government?
- What is the role of the utility?
- What is the role of the private sector?
- How is the EVSE financed?
- How do customers pay for charging?
- How is money earned from EVSE?

# Key Considerations for EVSE Business Models

---

1. There are many different EVSE business models available.
2. Multiple EVSE business models can be present in the same country, region, and/or city.
3. Different EVSE business models may be appropriate for different circumstances.
4. Not all EVSE business models are profitable, but they may be necessary.
5. EVSE often operates as a network of multiple units.

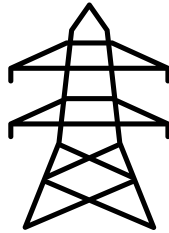
## -Key Term -

**EVSE charging network:** A collection of EVSE, often geographically dispersed, that is operated by the same institution

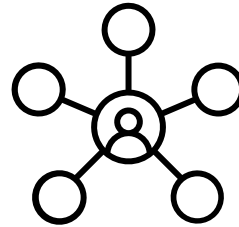
# Who Owns and Manages Public EVSE?



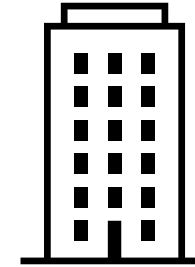
1. Government



2. Utility



3. Private Station  
Network



4. Site Host

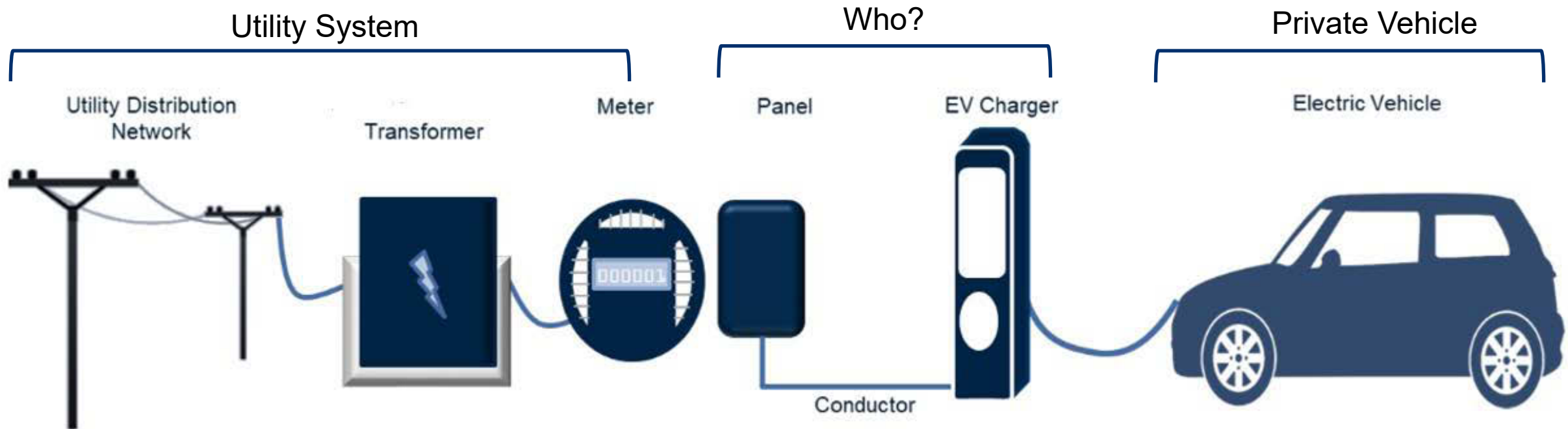


5. Partnership

## -Key Term -

**EVSE site host:** The owner of the property where EVSE is installed

# EVSE Infrastructure



## Key Consideration

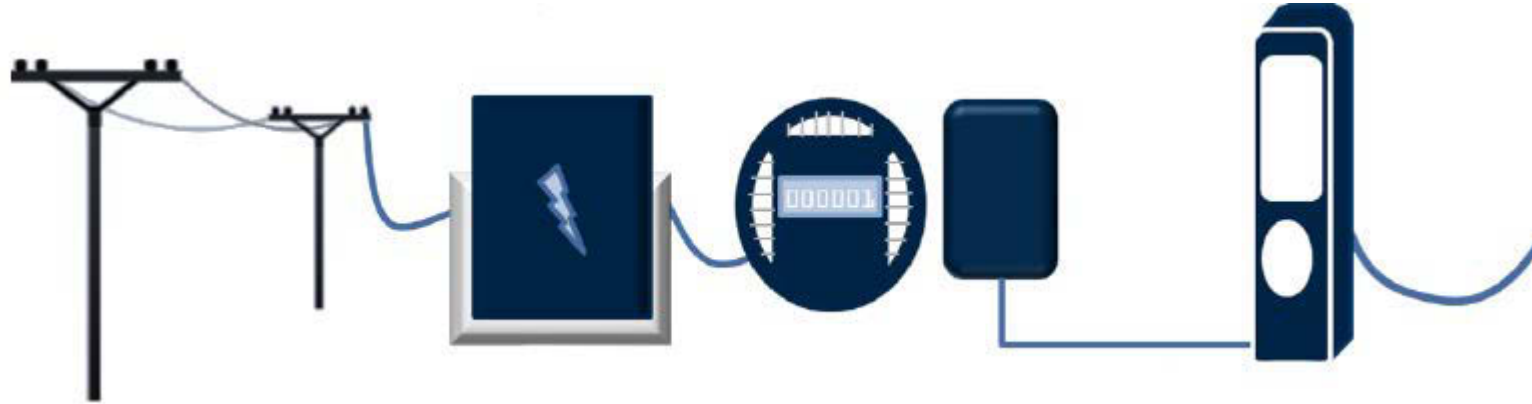
- What are the roles of the government, the electric utility, the private sector, and others?
- Who installs, owns, and manages each component?
- Who earns money and how?









# Potential Business Models

**Investment**

-  Utility
-  Private sector
-  Utility & Private Sector

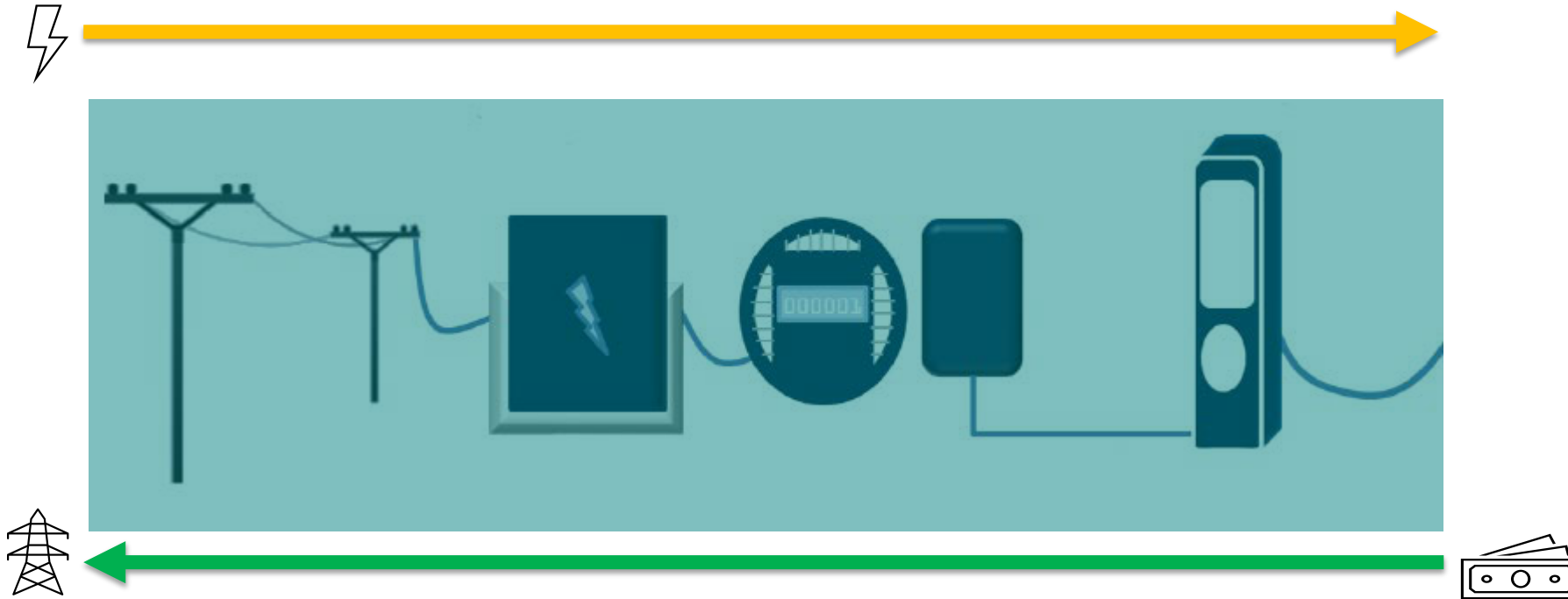


- ①  Electric Utility owner-operator
- ②  Electric Utility with private concessionaire
- ③  Electric Utility make-ready
- ④  Electric Utility with government incentive
- ⑤  Electric Utility to meter
- ⑥  Others?

# ① Electric Utility Owner-Operator

**Investment**

- Utility
- Private sector
- Utility & Private Sector

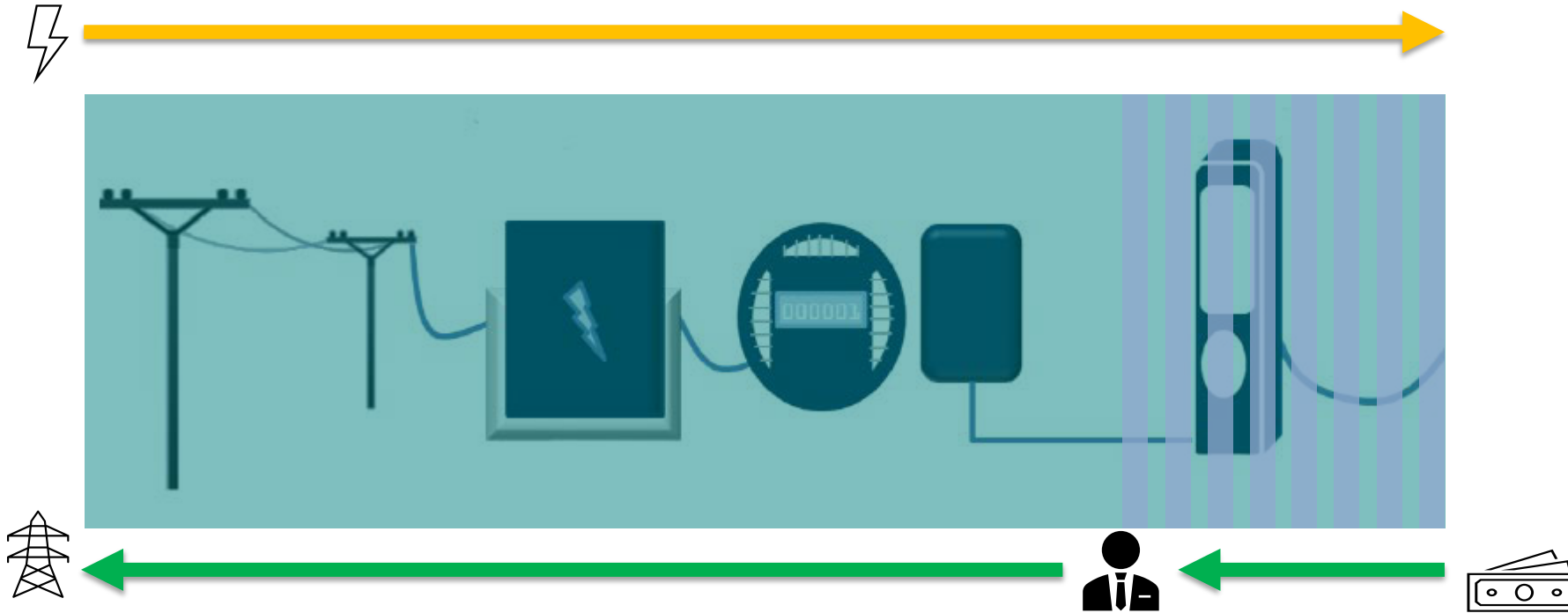


- The electric utility installs, owns, and manages all components of the utility system and EVSE.

## ② Electric Utility with Private Concessionaire

**Investment**

- Utility
- Private sector
- Utility & Private Sector

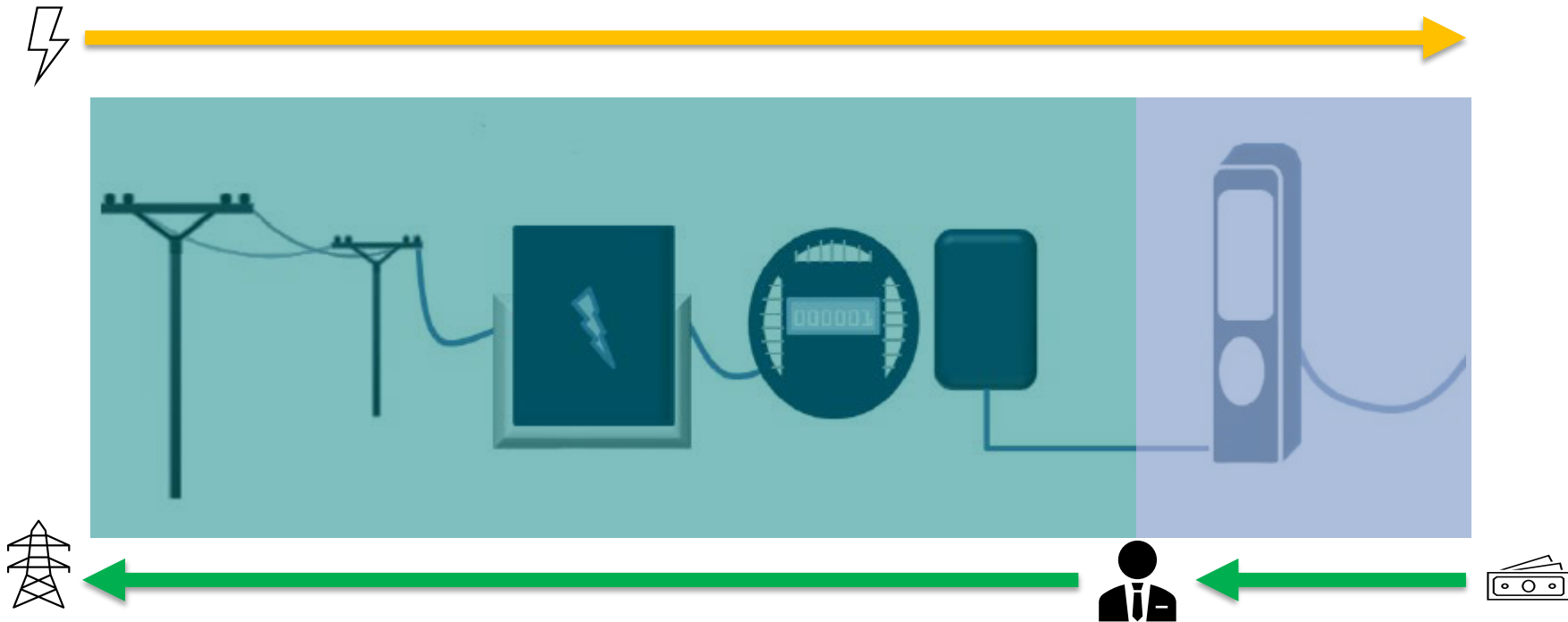


- The electric utility installs and owns all components of utility system and EVSE.
- A private business manages the EVSE through a contract with the electric utility.

# 3 Electric Utility Make-Ready

**Investment**

- Utility
- Private sector
- Utility & Private Sector

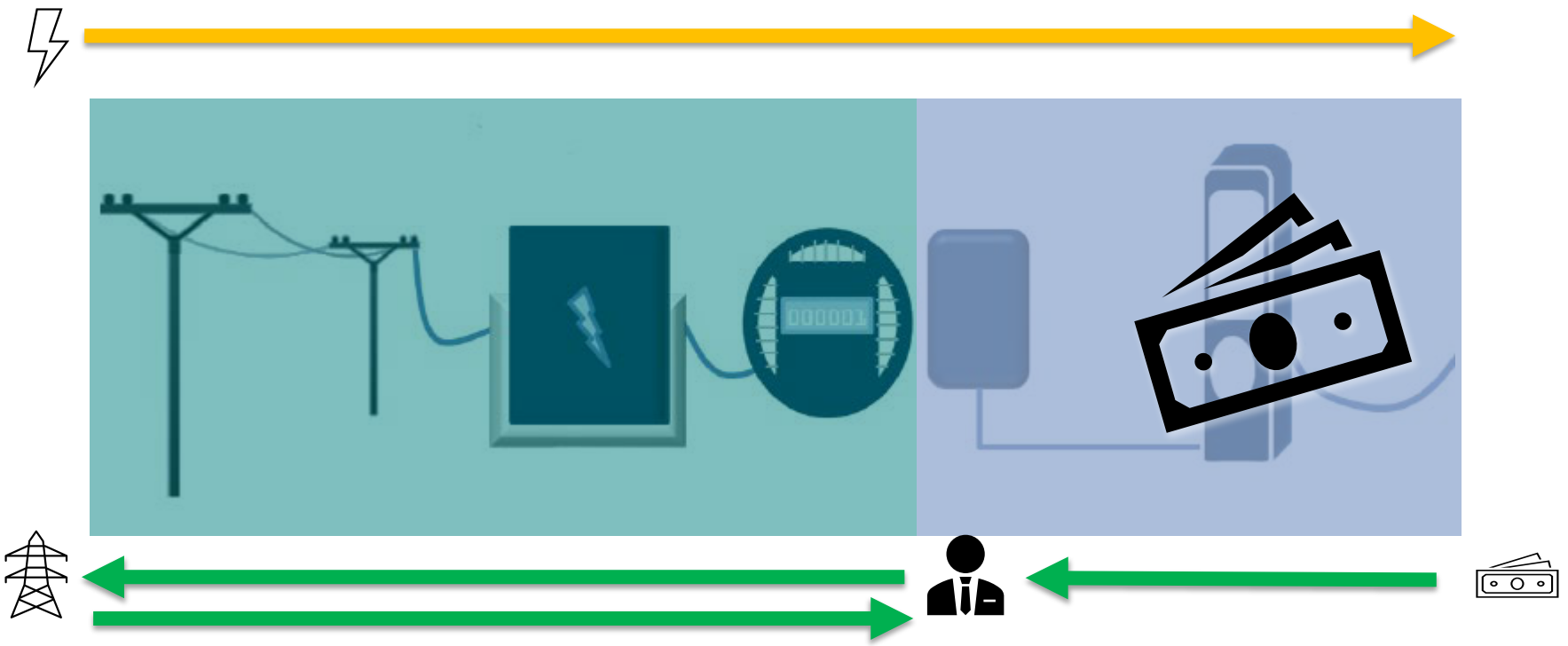


- Private sector installs, owns, and manages the EVSE.
- All infrastructure up to electrical panel is installed by the electric utility.
- Electrical panel owned and operated by the private sector.

# ④ Electric Utility with Government Incentive

**Investment**

- Utility
- Private sector
- Utility & Private Sector

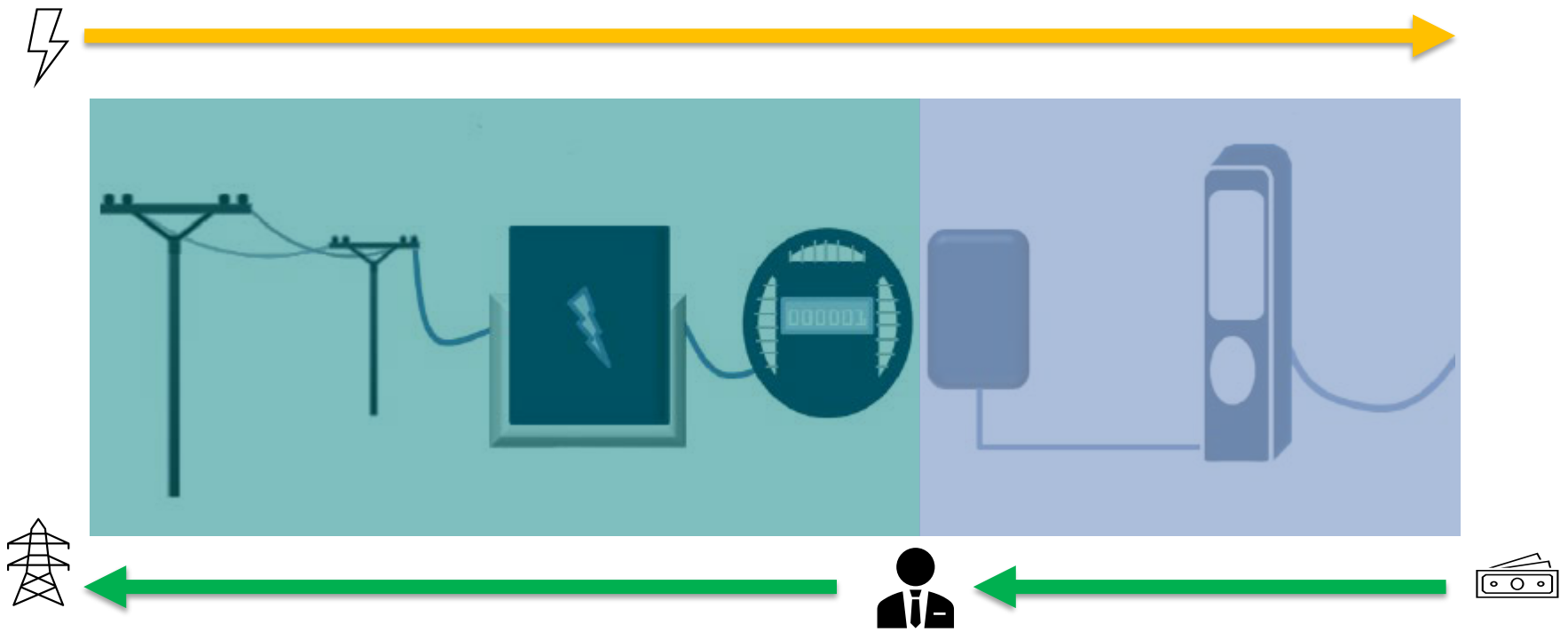


- The private sector installs, owns, and manages the electrical panel and EVSE unit.
- Government provides an incentive to the private sector to help install the EVSE.

# 5 EDL to Meter

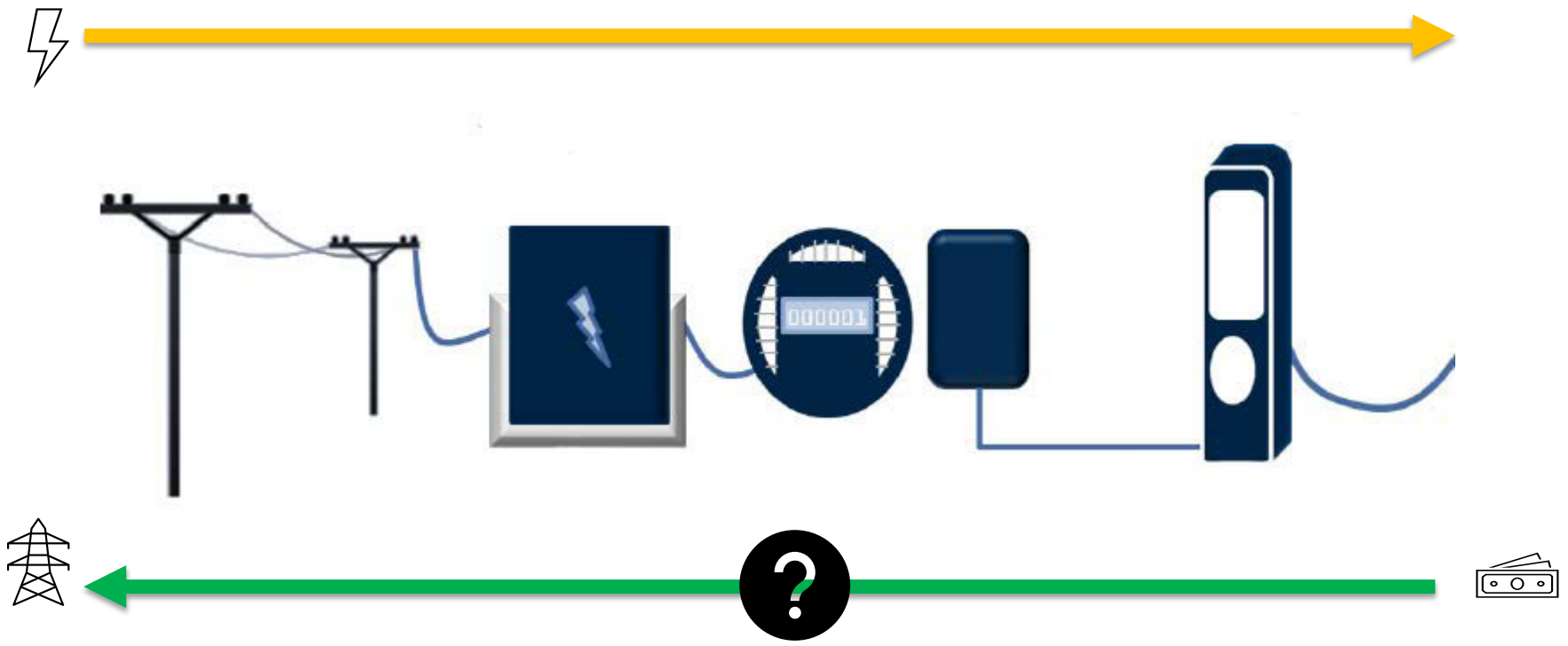
**Investment**

- Utility
- Private sector
- Utility & Private Sector



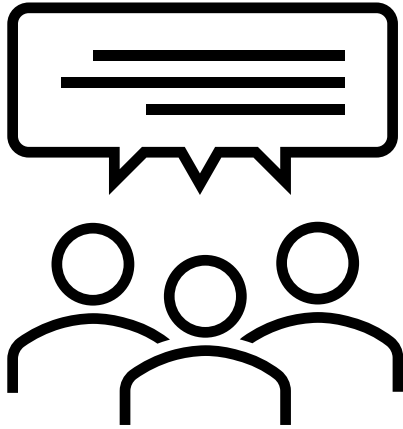
- The private sector installs, owns, and manages the electrical panel and EVSE unit.

# 6 Others?



# Business Models: Discussion

---



- Would certain models be appropriate in your jurisdiction for different locations or segments of the market?
- What business models are you considering?
- Are there any models that you want to learn more about?



# Factors Affecting Business Model Selection

## 1. Anticipated Demand



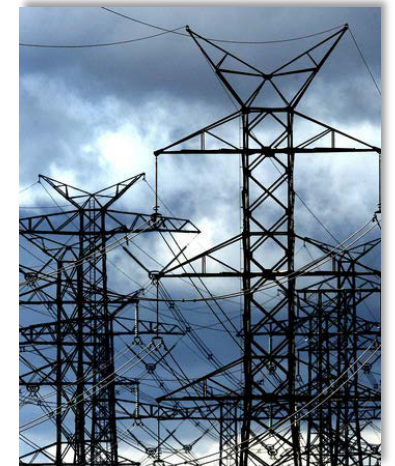
## 2. Type



## 3. Location



## 4. Desired Benefits



# Factors Affecting Business Model Selection: **Anticipated Demand**

## Consider the future adoption rate of EVs and the anticipated EVSE demand

- Low EVSE utilization could mean a longer return on investment (ROI)
- Low EVSE utilization could mean charging customers higher fees to achieve a desirable ROI

Example: Government-set Goal  
Lao PDR



Matthew Staver, NREL



Margaret Smith, NREL

200 electric  
vehicle  
charging  
stations by  
2030

Electric  
vehicles  
account for  
30% of total  
vehicles by  
2030

Source: "Strategy on Green Energy for Transportation 2019 for Lao PDR"

### -Key Term -

**Utilization rate:** The percentage of time an EVSE unit is being used by a customer

# Factors Affecting Business Model Selection: **Type of EVSE**



## Level 2 Charger

- 16–32 km per hour of charging
- Cheaper to install
- Cheaper to operate
- Opportunity charging

7.2 kW – 30 Amp – 240 V

## DC Fast Charger

- 95–128 km per hour of charging
- Expensive to install
- Expensive to operate
- Similar to current fueling

(varies) 36 kW – 75 Amp – 480 V



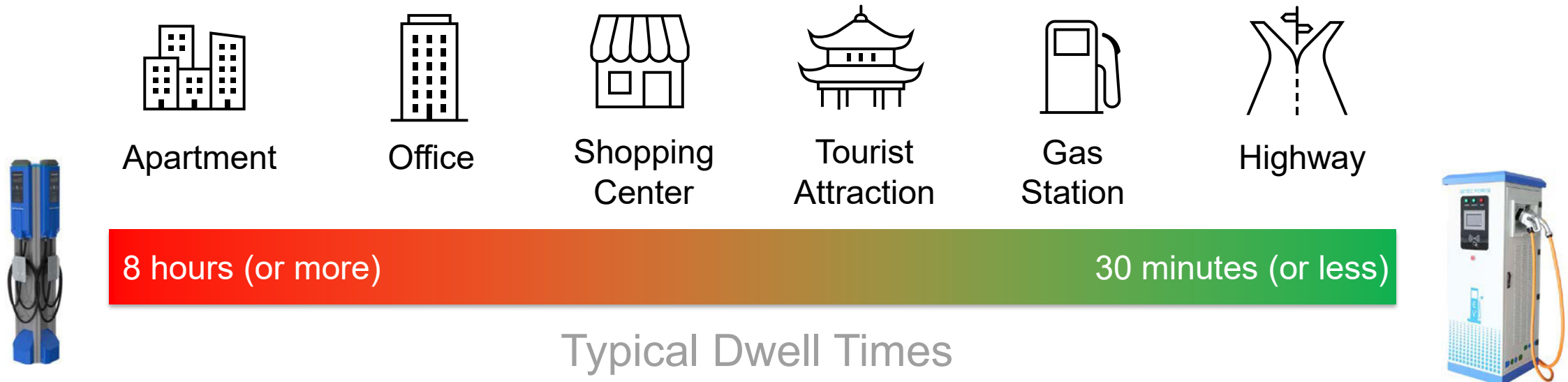
### -Key Term -

**Opportunity charging:** Charging an EV at available breaks throughout the day, such as at work or while shopping (not necessarily to achieve a full state of charge)

# Factors Affecting Business Model Selection: **Location of EVSE**

## -Key Term -

**Dwell time:** The amount of time a visitor stays at a location



# Factors Affecting Business Model Selection: **Desired Benefits for EVSE**

## **Different motivations to install EVSE:**

- **EVSE station network:** Earn money reselling electricity; sell more electric vehicles
- **Government:** Decrease gasoline imports and dependency
- **Utility:** increase electricity use and revenues; potential for “grid-friendly” charging through tariffs and other programs for flexible loads
- **Shop owner:** Increase customer dwell time and therefore increase in-store sales
- **Employer:** Provide a benefit to employees

# EVSE Infrastructure and Operating Expenses



## Utility Network

- Transformers
- Meters
- Conductors
- Substations

## Administrative

- Financing
- Land acquisition
- Permitting

## EVSE Construction

- EVSE unit
- Service panel
- Circuit breakers
- Labor
- Signage

## Operation

- Owner energy Costs
- Owner payment Collection fees
- Site maintenance

# EVSE Deployment for Successful EV Adoption

## Widespread EV adoption depends on well-planned EVSE deployment

- **Urban areas:** Many EV owners live in urban areas. Need a high density of chargers to accommodate the likelihood of higher adoption rates.
- **Destinations:** EV owners need assurance they can travel to the same locations as gas cars. EVSE should be installed at national parks, small and large cities.
- **Corridors:** Current EV models generally have a lesser range than gas cars. This requires careful deployment of EVSE at measured intervals along popular routes.



This Photo by Unknown Author is licensed under [CC BY-NC-ND](https://creativecommons.org/licenses/by-nc-nd/4.0/)

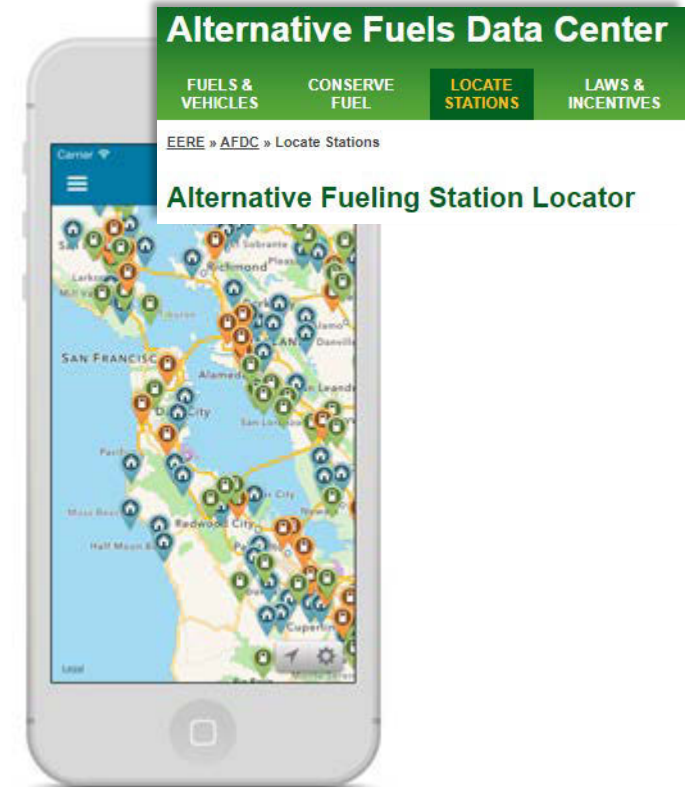
### -Key Term-

**Range anxiety:** Concern that a vehicle has insufficient range to reach its destination

# Finding EVSE and Technology Considerations

## Widespread EV adoption depends on well-planned EVSE deployment

- **“Smart” EVSE:** EVSE connected to Wi-Fi or cell service can allow customers to locate it, make payments, see if it is in use, and know if it is operational. Also allows station or network manager to get critical usage data.
- **EVSE location database:** EV owners need to know where stations are located, especially when planning a trip. Each network may have its own map, but it is important to have this information aggregated. Can be done by the government, the utility, or a private organization.
- **Mobile apps:** Many EVSE networks have an associated mobile application. These apps allow EV drivers to access information (e.g., vehicle charge status), make payments, and locate units on the go.





# Discussion: Business Models for EVSE

---

1. Are these any of these business models applicable for your jurisdiction?
  - Which models? Where are they applicable?
  
2. Are there other business models that could support EVSE deployment in your jurisdiction?
  - Could these business models be adapted to fit your jurisdiction?

# THANK YOU!



**USAID**  
FROM THE AMERICAN PEOPLE



## Advanced Energy Partnership for Asia

This work was authored, in part, by the National Renewable Energy Laboratory (NREL), operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by the United States Agency for International Development (USAID) under Contract No. IAG-19-2115. The views expressed in this report do not necessarily represent the views of the DOE or the U.S. Government, or any agency thereof, including USAID. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.