

Final Project 2

PMG 497

Project Template

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Project title

Student name

.....

Final Project - 2

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Acknowledgment

Dedication

Abstract

Purpose:

Methodology:

Findings:

Originality & Implication:

Keywords:

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1. Chapter 1: Introduction

1.1. Research Background

Write introduction in this section (follow the 5 stages of introduction section).

Not less than 3 pages

This section includes ONLY paragraphs

1.2. Research Problem

Write brief introduction to this section (paragraph)

This section divided into two sub-sections

1.2.1. Theoretical Gaps

1.2.2. Practical Gaps

This section ends with the main research question

1.3. Research Significance

In this section, the student should clarify the importance of the study at the theoretical level, and the empirical level

1.3.1. At the theoretical level

1.3.2. At the practical level

1.4. Research Questions

1.5. Research Objectives

1.6. Research Hypotheses

1.7. Research Model

1.8. Scope of The Study

1.9. The Project Structure

2.Chapter 2: Literature Review

2.1. Introduction

Brief introduction for the chapter

2.2. The independent variable

2.3. The dependent variable

2.4. The relationship between the independent and the dependent variables

2.5. Conclusion

3. Chapter 3: Research Methodology

3.1. Introduction

The objective of this research was to explore the possible technical and financial practicality of using electric vehicles (EVs) for vehicle-to-home (V2H) and vehicle-to-grid (V2G) strategies in households with photovoltaic (PV) systems in Amman, Jordan. To do so, a holistic approach was developed that involves several central points.

3.2. Operational definitions for research variables

- **Electric Vehicle (EV):** A car driven by one or more electric motors powered by rechargeable batteries.
- **Vehicle-to-Home (V2H):** The capacity of an EV to supply electricity to a home's energy needs from its own battery.
- **Vehicle-to-Grid (V2G):** The capability of an EV to use its battery power to send electricity back to the power grid.
- **Photovoltaic (PV) System:** An array of solar panels that convert sunlight into electrical energy.
- **Electricity Cost:** The total cost borne by the household towards their electricity consumption including any income from V2G.

3.3. Research design (research onion)

This study follows a quantitative research approach and utilizes the research onion framework to guide methodological choices.

3.3.1 Scenarios

An owner of a residential EV with charging bidirectional can choose and blend the V2G or V2H technologies in different ways. Additionally, they can be combined with a PV system. In this thesis, we try to compare such strategies. Thus, these questions will be examined further through a series of simulations that include various charging preferences (scenarios) and user profiles. The main emphasis is about five simulations including one reference scenario without any control and a PV-system as well. Besides, there are four other scenarios which are interchanged between aiming at reaching high self-sufficiency and achieving high profits. However, the level of self-sufficiency is limited by discharging the EV battery into the household only while for high profit scenario it will discharge it both to the household and to the grid. Results will be given by means of Without EV load profile to differentiate between effects caused by electric vehicle on the household's consumption patterns

The study evaluates five different scenarios:

1. Uncontrolled Charging: The EV is charged directly from the grid without any optimization.
2. Controlled Charging with PV, Discharge to Home: The EV charging is optimized to use PV-generated electricity, and the EV can discharge to the home.
3. Controlled Charging without PV, Discharge to Home: The EV charging is optimized without PV, and the EV can discharge to the home.
4. Controlled Charging with PV, Discharge to Home and Grid: The EV charging is optimized to use PV-generated electricity, and the EV can discharge to both the home and the grid.

5. Controlled Charging without PV, Discharge to Home and Grid: The EV charging is optimized without PV, and the EV can discharge to both the home and the grid

3.3.2 EV user profiles:

The scenarios are simulated with 5 different EV user profiles. The load profiles are listed as:

- User profile 1: People driving to work with the possibility to charge their car at work with a driving distance of 15 km.
- User profile 2: People driving to work with the possibility to charge their car at work and with a driving distance of 60 km.
- User profile 3: People driving to work with no possibility to charge their car at work and with a driving distance of 60 km.
- User profile 4: People with other modes of transport to work, working from home or staying at home, hence daily driving distance is 0 km.
- User profile 5: People driving to work while working on a night shift with a driving distance of 30 km.

3.3.3 System description

The house analyzed is located at Amman, Jordan and it is a medium-sized one with two floors and a basement. District heating ensures that electricity is not the source of heat, which implies that load of household consists only of home appliances. The system will be studied at an hourly resolution over the course of 2020 to get electricity price and solar radiation data for this year.

A Nissan LEAF SV Plus was used as the car in this simulation. It has a battery capacity of sixty kWh with laminated cell structure and Ni-Co-Mn positive electrode material. The Environmental Protection Agency (EPA) estimated driving range tested by their agency is about 340 km that corresponds to approximately 0.16 kWh/km power consumption. This vehicle can charge through a bidirectional Type 2 AC charging cable with charge rate up to seven kilowatts (7 kW).

3.3.3.1 Simulink Model

The MATLAB Simulation consists of the following main components:

- **Household Electricity Consumption:** This is the model which considers representation Jordanian household hourly consumption profile based on national average values.
- **PV System Generation:** The model calculates hourly photovoltaic energy generation based on size of household PV system as well as location specific solar irradiance with a help of PVGIS database.
- **EV Charging/Discharging:** Using factors such as driving distance, battery capacity among others the different user profiles depending on their availability to charge in any given time are simulated
- **Electricity Pricing:** The model uses historical electricity tariff data from Jordan's utility provider to calculate the household's electricity costs under the different V2H and V2G scenarios.
- **Optimization Algorithm:** The model employs an optimization algorithm to determine the optimal charging and discharging schedules for the EV to minimize the household's electricity costs, while considering the constraints of the PV generation, electricity tariffs, and EV user preferences.

3.4. Data collection method

The primary data for this study is collected through a MATLAB simulation model. This model includes household's electricity consumption, PV generation, EV charging/discharging patterns and electricity pricing to assess technical and economic performance of V2H and V2G strategies.

3.5. Types of data

This study uses two kinds of data:

- Quantitative data encompasses hourly electricity consumption, PV generation, electricity prices and EV charging/discharging profiles.

- Qualitative data covers technical specification for EVs, PV systems and grid integration requirements.

3.6. Statistical analysis procedures

To assess the V2H and V2G strategies, a simulation model was established containing various key performance indicators. These indicators are:

1. Electricity Cost Savings:

- This means that the model calculates all electricity cost in the house under different scenarios, considering any revenue from V2G discharging.
- Total annual energy costs are analyzed depicting the savings.

2. Reduction in Grid Electricity Consumption:

- It keeps track of grid electricity usage versus self-consumption of PV-generated electricity by a household.
- A reduction in grid electricity consumption is quantified and compared across these scenarios.

3. Increase in Self-Consumption of PV Electricity:

- The concept behind this is to show how much a family can use its own PV generation with V2H and V2G methods.

- The increased rate of self-consumption of PV electricity is computed and matched for comparison purposes.

4. Battery Degradation:

- The battery degradation due to increased cycling because of using V2H and V2G operations is forecasted by this model.
- An analysis has been done on battery degradation regarding trade-offs between economic incentives and battery life.

3.7. Conclusion

This comprehensive methodology allows for a thorough investigation of the technical and economic feasibility of V2H and V2G strategies in Jordanian households with PV systems. The use of a simulation-based approach, combined with the analysis of both quantitative and qualitative data, provides a robust framework to address the research objectives.

4. Chapter 4: Statistical Analysis & Findings discussion

4.1. Introduction

4.2. Sample profile (descriptive statistics for research sample)

4.3. Validity & reliability tests for the questionnaires

4.4. Descriptive statistics for research variables (answer research questions)

4.5. Testing Hypotheses & Findings Discussion

4.6. Conclusion

5. Chapter five: Research limitations, Recommendations & Conclusion

5.1. Research Limitations & Future Research

5.2. Research Recommendations

5.3. Conclusion

References

Appendix