Northumbria University NEWCASTLE

Efficient Energy Management with Emphasis on EVs Charging/Discharging Strategy

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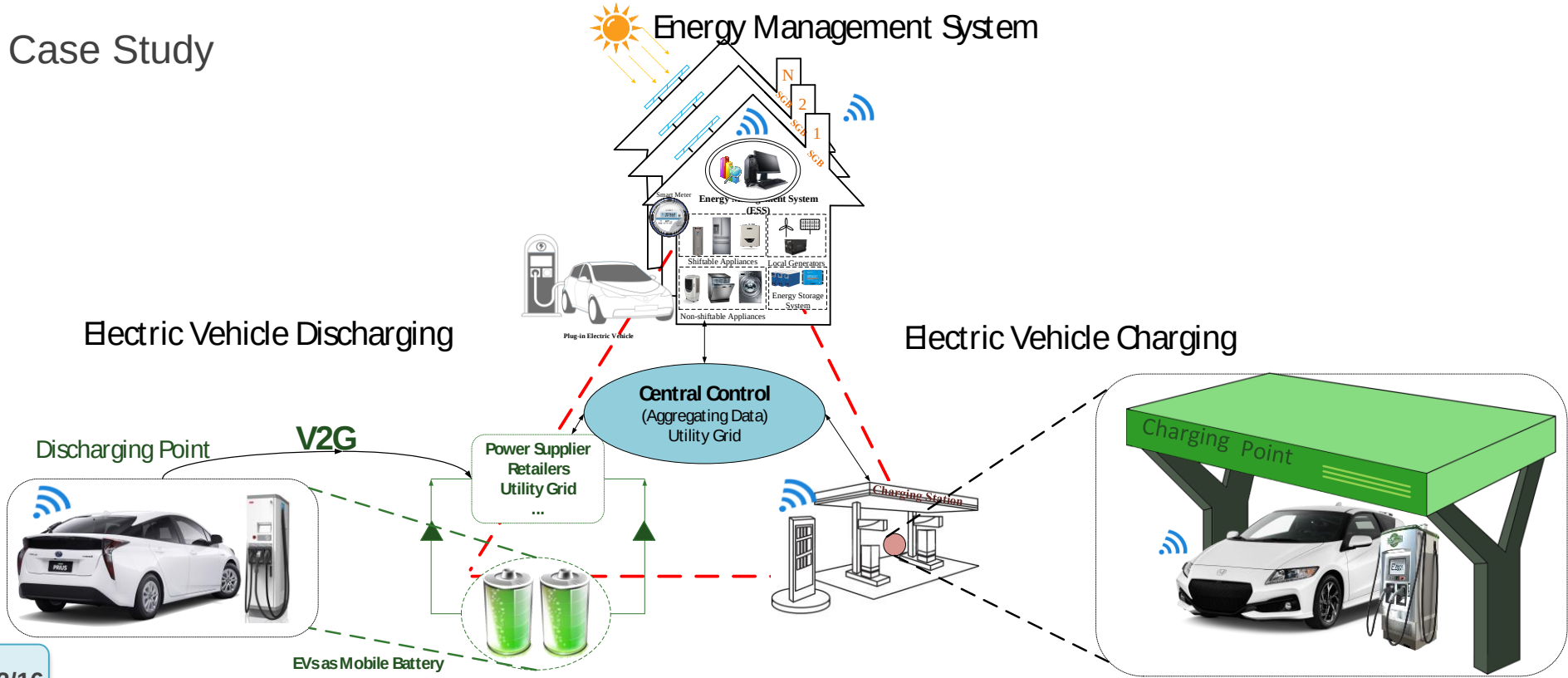
Outline

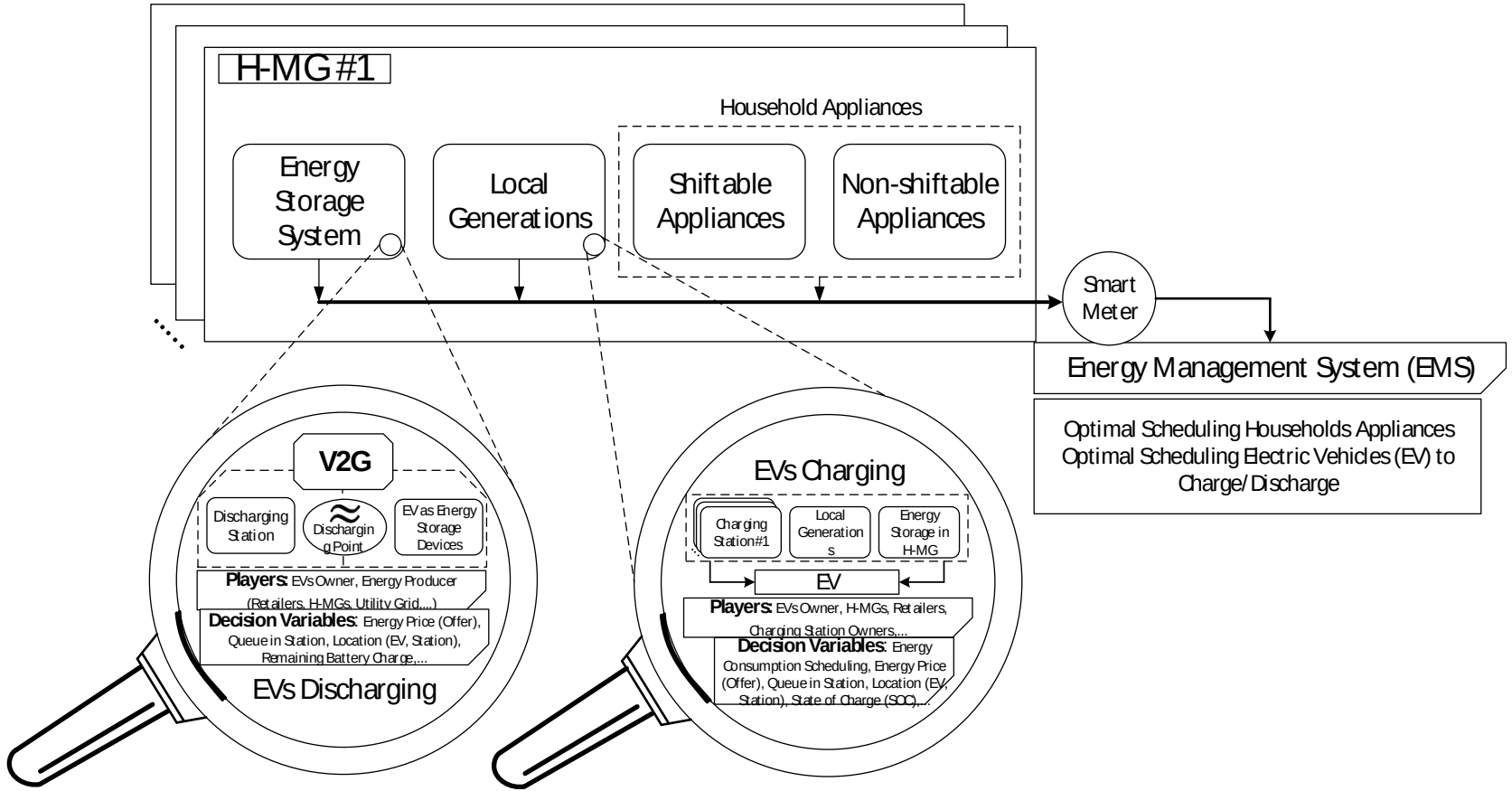
- Problem Definition
- Research Questions
- Aims & Objectives
- Methodology
- Work-Plan

Problem Definition

Case Study



Problem Definition



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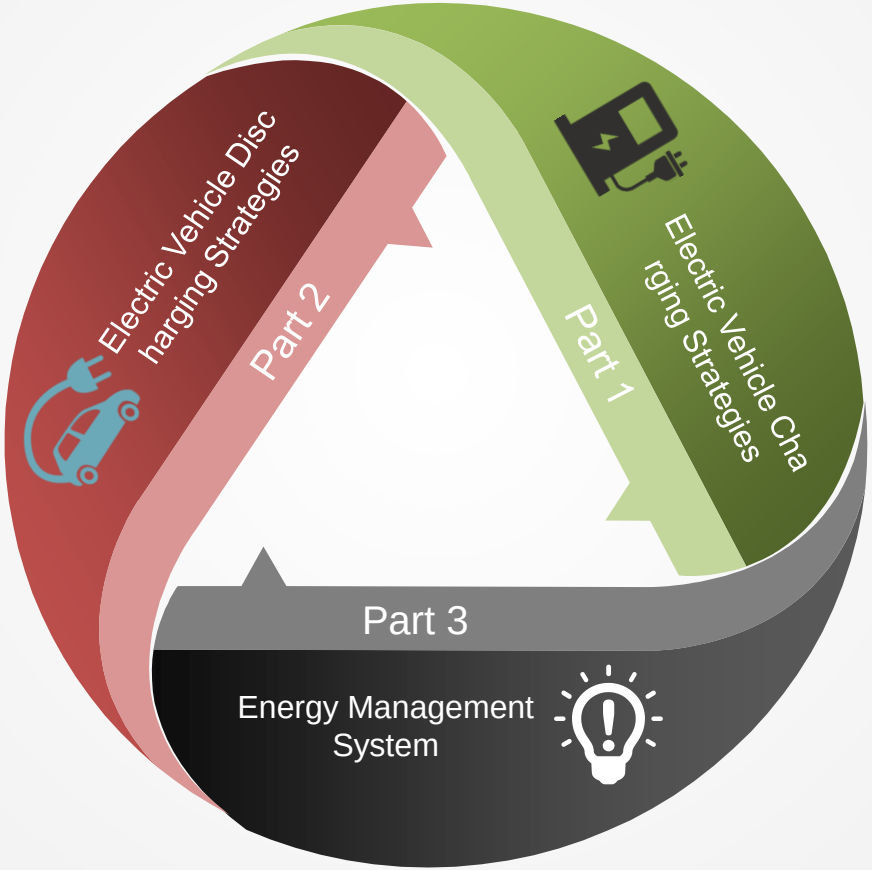

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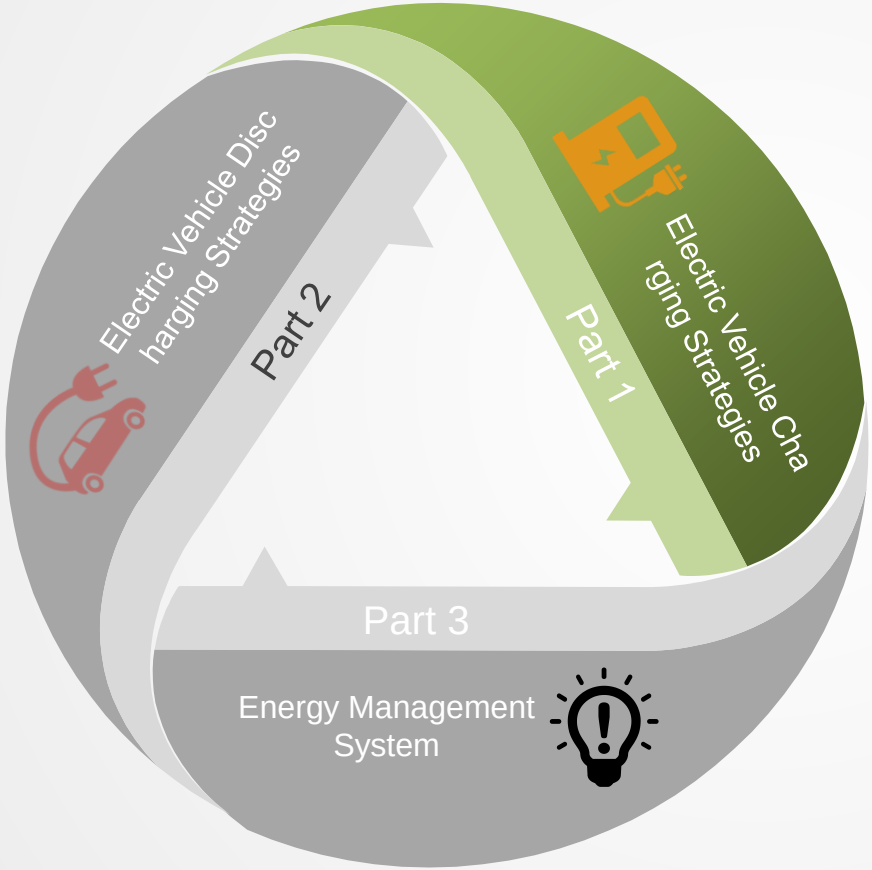
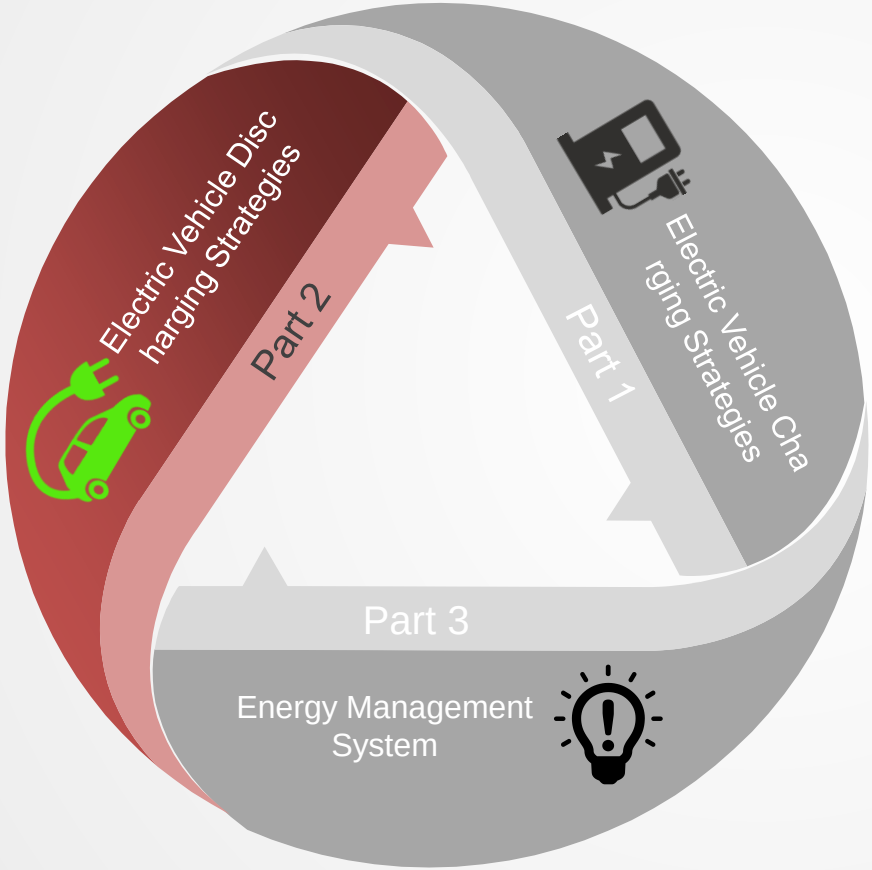


EVs Charging

- EVs owners want to charge their battery from the most profitable Energy Producer Whenever they wish.
- **Purchasing Energy from:**
  Charging Stations, H-MGs, Retailers,…
- **Charge Priority:**
  Charge from WT, PV
  The Profitable Energy Source
- **Objective Function:**
  SOC, Queue, Trust of Station, Location, Electricity Price,…

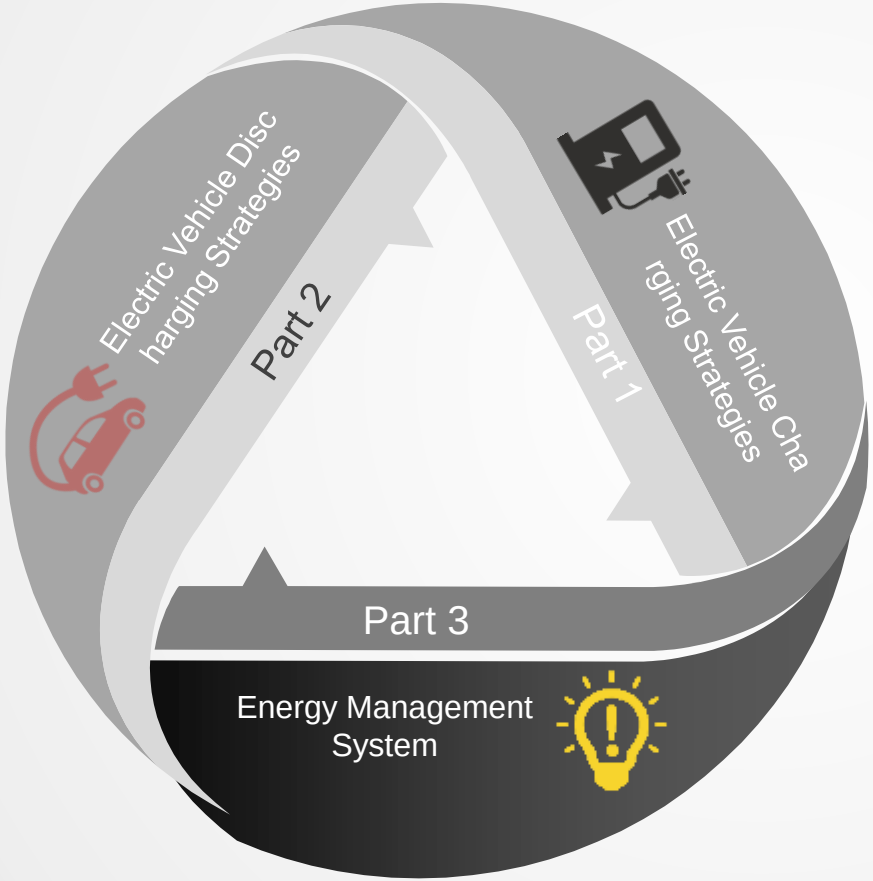
Problem Definition



EVs Discharge

- To Meet Unpredictable Consumer Demand
- Known as Short-time Ancillary Services. **(V2G)**
- **Selling Energy to:**
  H-MGs, Retailers, Utility Grid,…
- **Discharge Priority:**
  Discharge in H-MG (ES, Immediate use)
  The Profitable Buyer
- **Objective Function:**
  Queue, Location, Electricity Price, Remaining of Battery,…

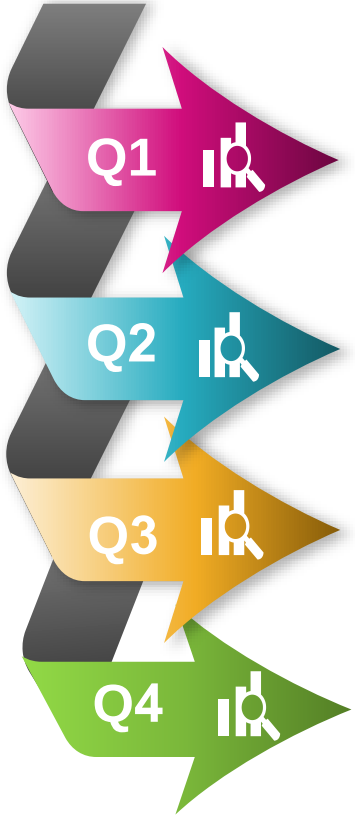
Problem Definition



Energy Management System

- Home Micro-Grid is known as Smart Green Building (SGB)
- Energy Generation Units (WT,PV,DG,EWH,…)
- Household Appliances (Shitfable,Non-shiftable)
- **Production & Consumption (Simultaneous)**
- **Consumption Priority**: WT,PV
- **Production Priority**: WT,PV
- **Scheduling Appliances Consumption:**
  To Minimize H-MG's Owner Costs

Research Question



What are the applicable strategies for generation units and consumers to control the peak and reduce costs, respectively?

What is the impact of demand-side management on the scheduling consuming applications, and thereby cost reduction?

What is the optimum scheduling to charge & discharge batteries as well as to use the power?

How might the energy management, in terms of profit and loss, simultaneously lead to optimal collective pay-off?

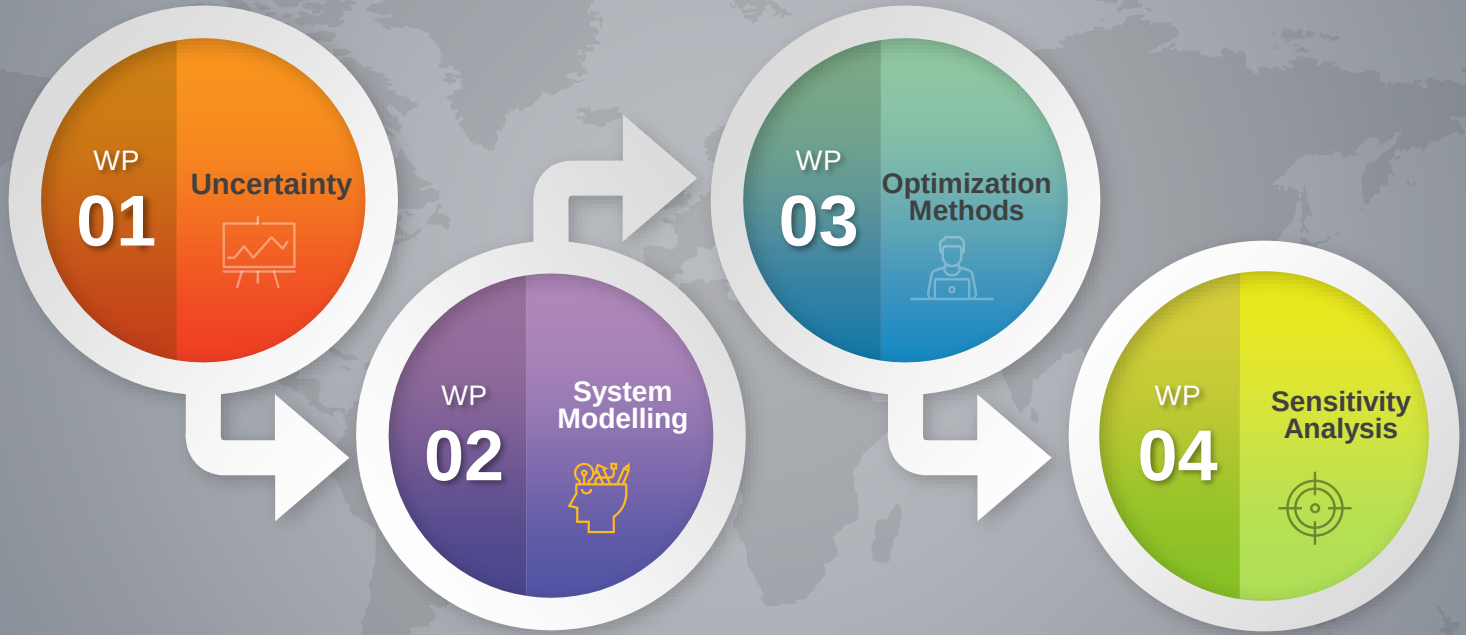
...

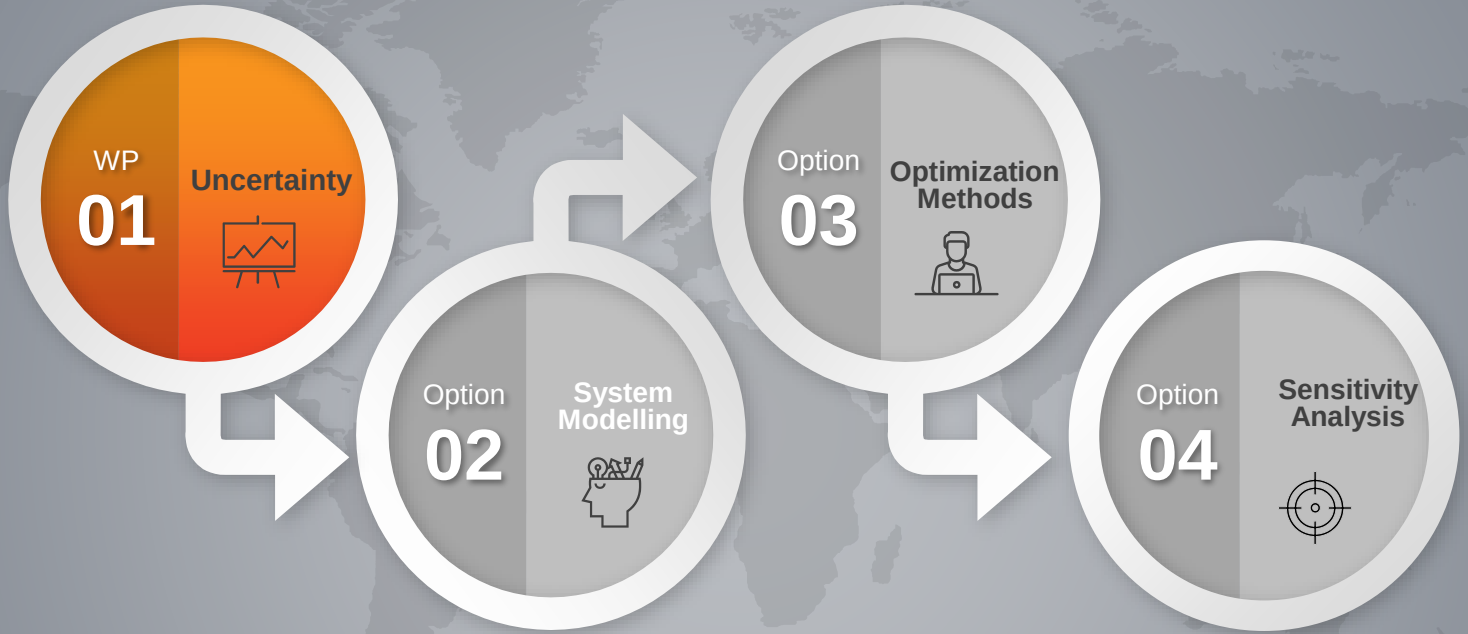
aim

- Empowering efficient management of the power supply and demand
- Minimizing the total operational costs
- Manage and handle the peak time
- Achieve cost optimization
- Reduce carbon emissions
- Expand the use of renewable energy resources
- Facilitate the exchanges between EVs with energy providers
- Make power system reliable
- Improve grid stability

Methodology

The proposed Approach consists of four work-packages (WP) including:

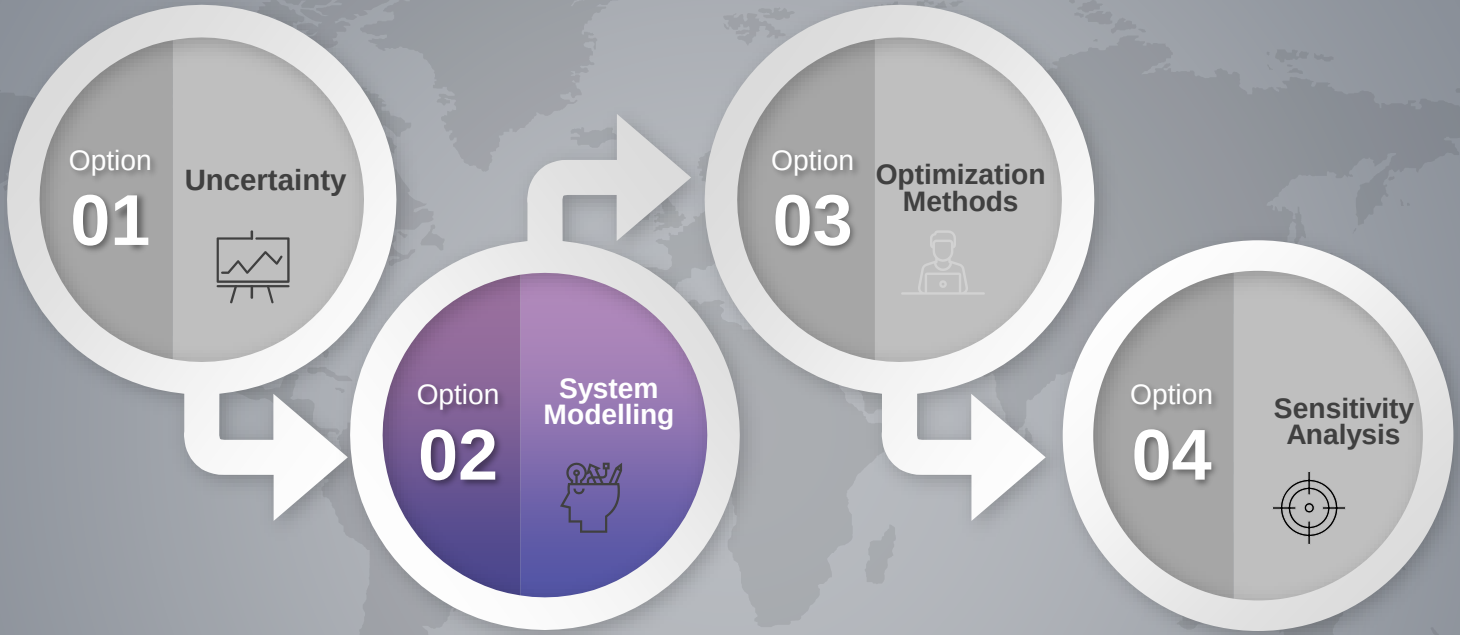




01

In the project, uncertainty includes:

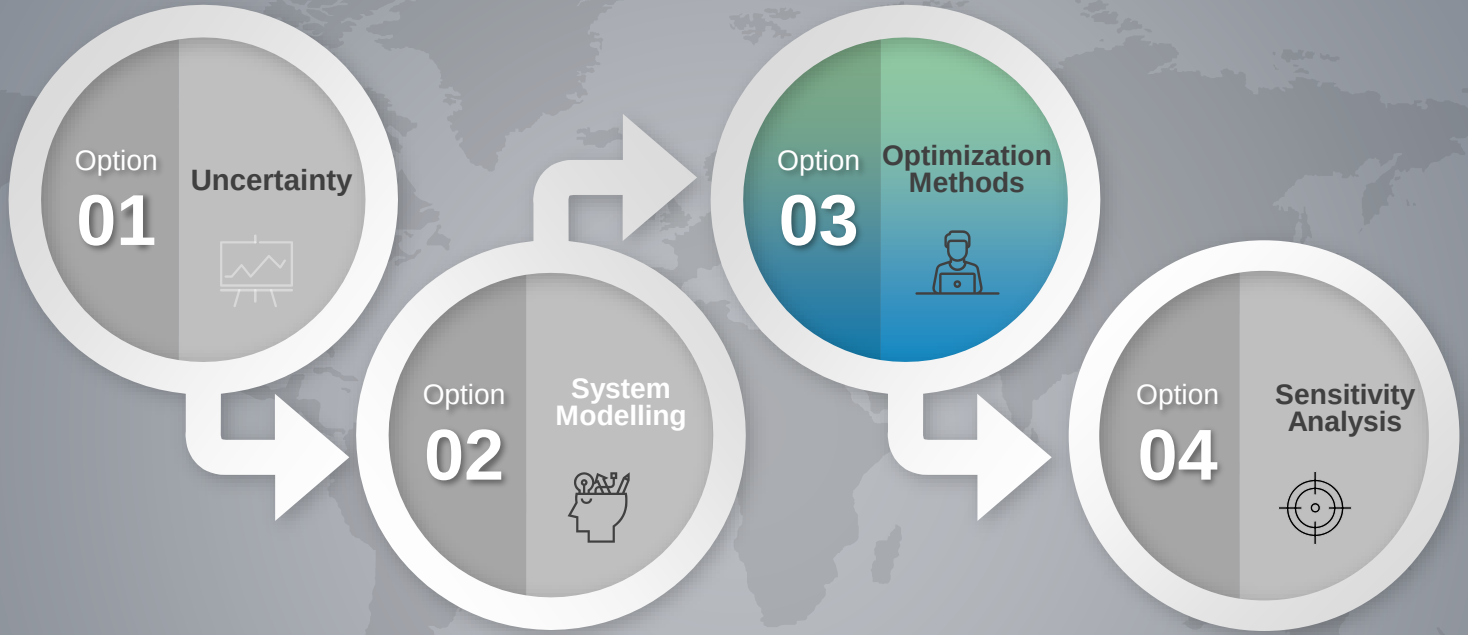
Uncertainty regarding EVs users' behaviours (Propose Several Categories for Trips)
Uncertainty regarding local generations (Weibull distribution and Markov chain, RSM (Response Surface Methodology), Taguchi, Scenario reduction,…)
Uncertainty regarding load profile data (Time series, Non-linear Regression, ARCH-GARCH)



02

The system modelling consists of three parts as follows:

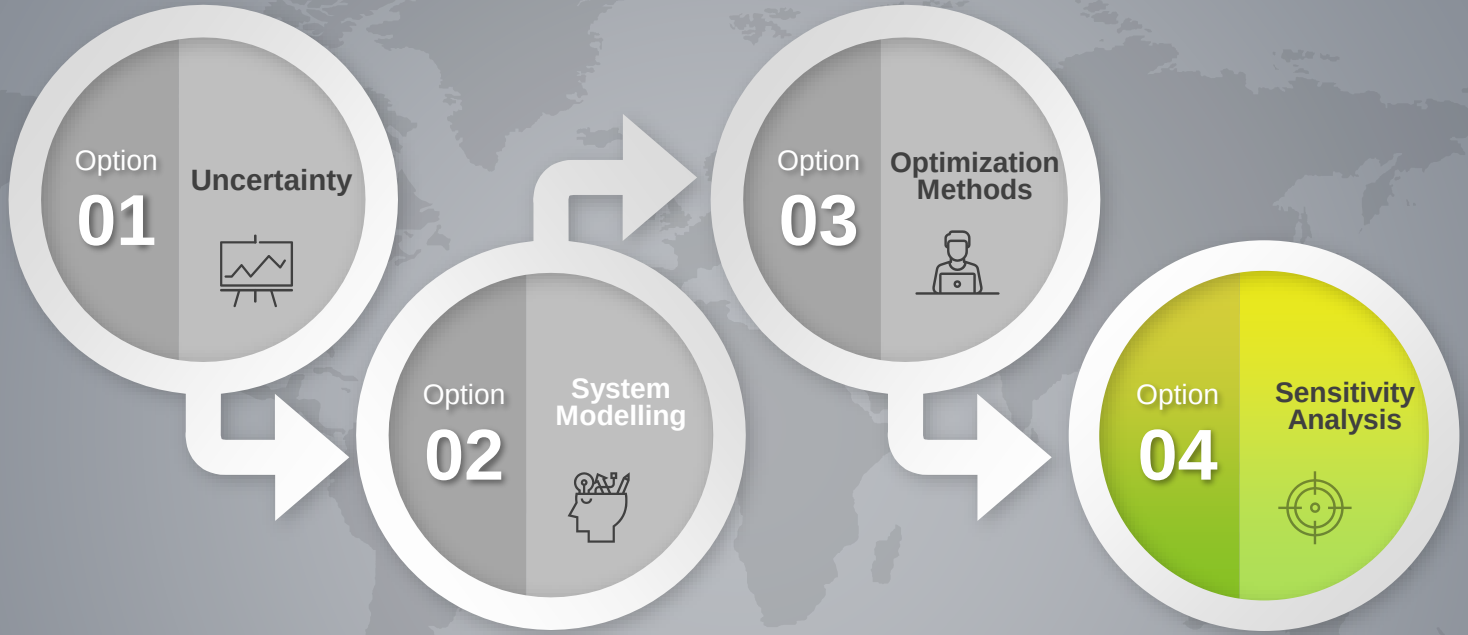
Households Appliances Scheduling
EVs Charging Scheduling
EVs Discharging Scheduling



03

Optimization Methods for:

- Optimal Scheduling for Home-Micro grids by Energy Management System (EMS)
- Optimal Scheduling for Charging/Discharging the EVs
- The Profitable Station to Charge/Discharge
- Battery Energy Storage Schedule
- Power Sold/Purchased from



04

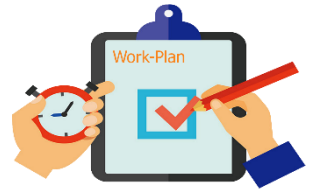
Sensitivity Analysis

Improvement of Mechanism Design
Designing Incentive Mechanisms for EVs, Stations, and H-MGs

Novelty and Originality

1. To maximize the number of facilitated local exchanges by H-MGs, and EVs
2. To minimize CO2 emissions as much as possible.
3. To enhance the charging station QoS by incentive mechanisms
4. To improve drastically reliability of power grid by improving V2G system

A three-year work-plan



Efficient Energy Management with Emphasis on EVs Charging/Discharging Strategy

Task	Description of Task	Year 1				Year 2				Year 3			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
0	**Management, Training and Reporting Activities**												
0A	Literature Review												
0b	Project Team Review Meeting	Biweekly											
0C	International Workshop and Seminar	Twice a Year											
1	**Statistical Analysis on Data**	Task 1											
1A	Data Collection (Type of trip (EVs), Generation units (WT,PV,DG,EWH,...), Previous Load Profiles)												
1B	Data Analysis												
1C	Estimation of Uncertainty (Time Series, NN, Linear Regression, RSM, Taguchi, Scenario Reduction Methods and etc)	1											
2	**Mechanism Design for Appliances Scheduling**		Task 2										
2A	Energy Consumption Modelling (Energy Management Regulation via Appliances Scheduling)												
2B	Energy Storage Strategy (DSM with ES)		2										
2C	Demand Response Market Modelling (Dynamic Pricing in Demand Response Markets)		P										
3	**Strategies for Plug-in Electric Vehicles Charging**					Task 3							
3A	Real-time Decision-making about the Profitable Charging Station (Under Objective-Function-EVC)												
4	**Strategies for Plug-in Electric Vehicles Discharging (EVs as Mobile ES)**							Task 4	3	P			
4A	To Motivate EVs as Mobile Storage to Support the Network at peak times (Utility Grid, Stations, Retailers,...)												
4B	Real-time Decision-making about the Profitable Discharging Station (Under Objective-Function-EVD)									4	P		
5	**Global Equilibrium of Network**										Task 5		
5A	Using Artificial Intelligence & Optimization Methods For Reaching Optimal Scheduling												
5B	Simulation results, Results From Real Data												
5C	Sensitivity Analysis, Comparing Results & Testing												
5D	Improvement and Adjustment of The Mechanism									P	5		

Milestone 1: Building a Valid and Reliable Data Collection

Milestone 2: To Schedule Households Appliances Consumptions

Milestone 3: To Find the Economics Charging Station from EVs Users Point of View

Milestone 4: To To Motivate EVs Users to Support the Network

Milestone 5: Reaching The Network Equilibrium & Improving it's Performance

Symbols

- Milestone
- P Potential Paper
- Link of Sub-tasks
- Link of Tasks


Thank You For Attention
Any Questions?