De la viziune utopică la orașele viitorului: o perspectivă energetică

Dr Ioana Pisica

Ioana.Pisica@brunel.ac.uk

W13: Tranziția Energetică și Orașele Verzi: Perspective academice pentru un viitor sustenabil

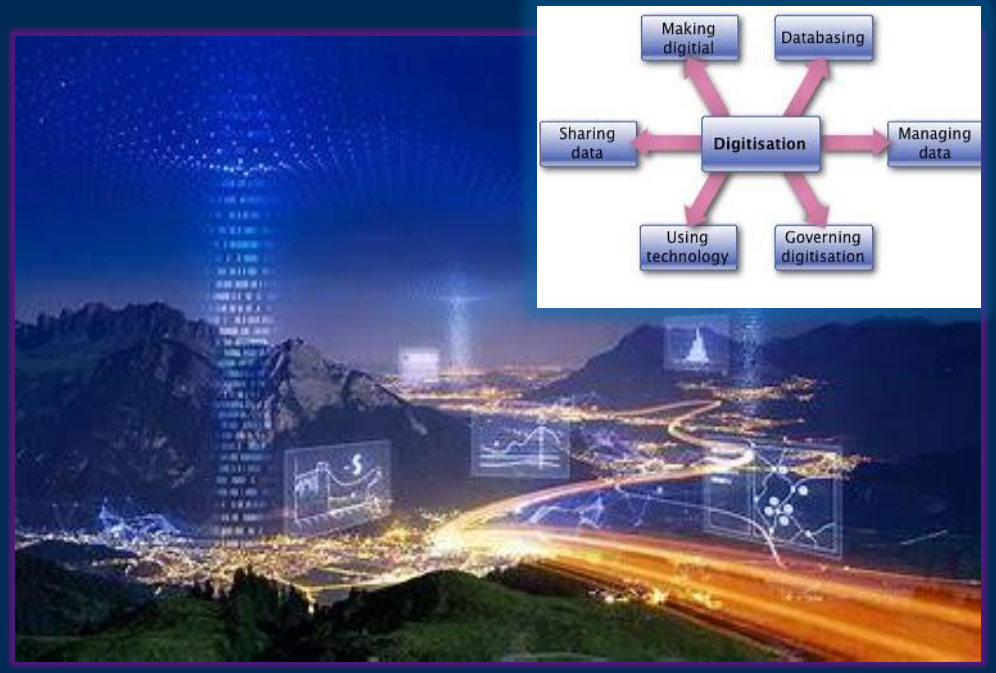
Smart Diaspora 2025
CONFERINȚA DIASPORA ȘTIINȚIFICĂ ROMÂNEASCĂ
Cluj-Napoca | 4-7 noiembrie 2025

BIPS Research Centre

Brunel University of London

- Director: Prof Gareth Taylor (EEE)
- Deputy Director: Dr Ioana Pisica (EEE)

- Originally established at Brunel in 1991
  - Prof Sir Michael Sterling and Prof Malcolm Irving
- Interdisciplinary **Power Systems** Research
  - Institute of Energy Futures
  - Smart Grids and Renewable Energy Systems
- Current Research Centre Membership
  - EEE (10): Taylor; Li; Abbod; Darwish; Zobaa; Pisica; Huang, Lai, Aunedi, Ekwue (RAEng VP)
  - CEDPS (2): Date, Louvieris CBASS: Manika
  - Researchers: 2 RAs/RFs, 20 Doct. Researchers



Key Expertise

- Power Transmission & Distribution Systems
- Power Electronics & Power Quality
- DC Transmission & Distribution
- Digitalisation of Future Power Systems
- Renewable Energy Systems
- Decarbonisation of Power Systems
- Smart Grids
- Energy Economics & Power Markets
- Power System Informatics & Communications

Brunel University of London



Implementing digitalisation in Turkish distribution networks



Pathways to increasing diversity in electric vehicle adoption



Information systems and data exchange for renewables' integration



Investigation and modelling of fast frequency phenomena



Understanding the impact of the distribution of inertial response



AI for optimisation and demand side response of built environment management

De la viziune utopică la orașele viitorului: o perspectivă energetică





The Jetsons
Desene animate din 1962



Realitate

apeluri video, ceasuri inteligente, televizoare cu ecran plat, aspiratoare robotizate și asistenți virtuali controlați vocal, precum Alexa

In dezvoltare(?):

Vehicule zburatoare pentru uz personal, roboti personali

BBC

Uber brings forward trialling driverless taxis in UK

10 June 2025

Zoe Kleinman
Technology editor

Share Save



A specially adapted Wayve-powered autonomous vehicle on the streets of London

Uber will trial robotaxis - autonomous cars with no human safety driver at the wheel - in London next spring.

No way? Yes Waymo! Driverless taxis are coming to London next year

Waymo will bring its fleet of self-driving Jaguar I-Pace taxis to London in 2026



By: **Tom Jervis**
15 OCT 2025



Source: Waymo.

Hot on the heels of news that Uber is set to trial driverless taxis in the UK from Spring next year, US firm Waymo has also thrown its hat into the ring. It has confirmed that London customers will be able to hail a ride in one of its robotic taxis from 2026.

Electric air-taxi project is launched

1 October 2025

Galya Dimitrova
Oxford

Share Save



The project also hopes to provide a "robust business case" for the commercialisation of regional electric vertical take-off and landing aircraft (eVTOL).

A six-month project to test and demonstrate the commercial and operational viability of an electric air-taxi between Oxford and Cambridge has been launched.

Electric 'flying taxis' to be built at Cotswold Airport

23 September 2025

Share Save



The company said it is still considering "locations in the UK and beyond" for full production

A company developing an all-electric air taxi says it is hoping to have it certified for commercial use by 2028 - with the initial builds happening in Gloucestershire.

Bristol-based Vertical Aerospace (VA) is planning to set up a factory at the Cotswold Airport producing 25 flying taxis, known as the VX4, per year.

It will also build a new battery facility next to its research and development centre in Avonmouth, to triple production of the battery packs needed for the VX4.

Electric air-taxi project is launched

1 October 2025

Galya Dimitrova
Oxford

Share Save



The project also hopes to provide a "robust business case" for the commercialisation of regional electric vertical take-off and landing aircraft (eVTOL).

A six-month project to test and demonstrate the commercial and operational viability of an electric air-taxi between Oxford and Cambridge has been launched.

Electric 'flying taxis' to be built at Cotsw

23 September 2025





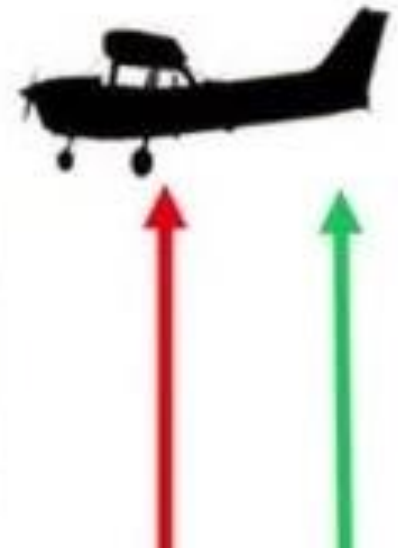
The company said it is still co
and beyond" for full productio

A company developing
says it is hoping to have
commercial use by 202
happening in Glouceste

Bristol-based Vertical A
planning to set up a fac
Airport producing 25 fl
VX4, per year.

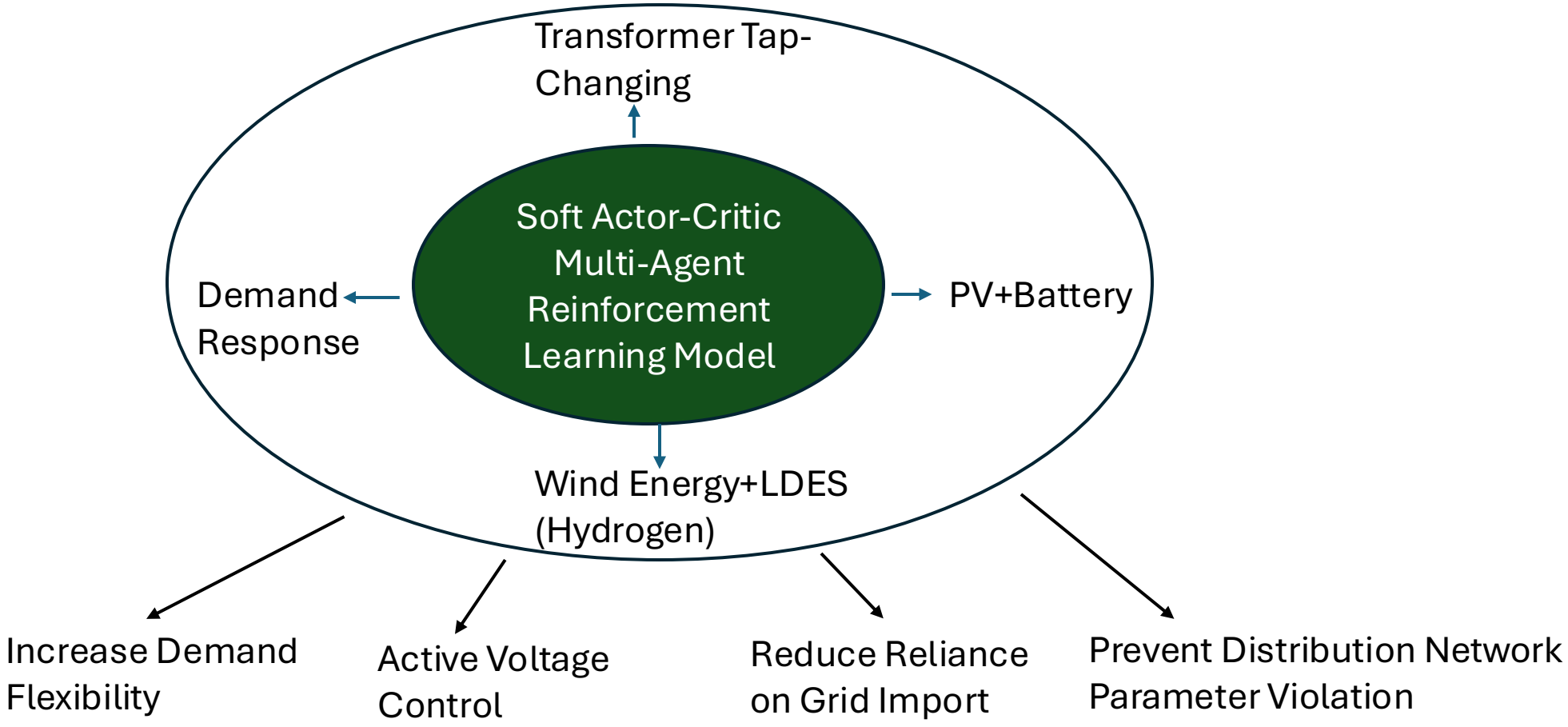
It will also build a new
research and developm
Avonmouth, to triple pr
packs needed for the V






HYDROGEN H2

Example 1– part of PhD work of Thet Paing Tun



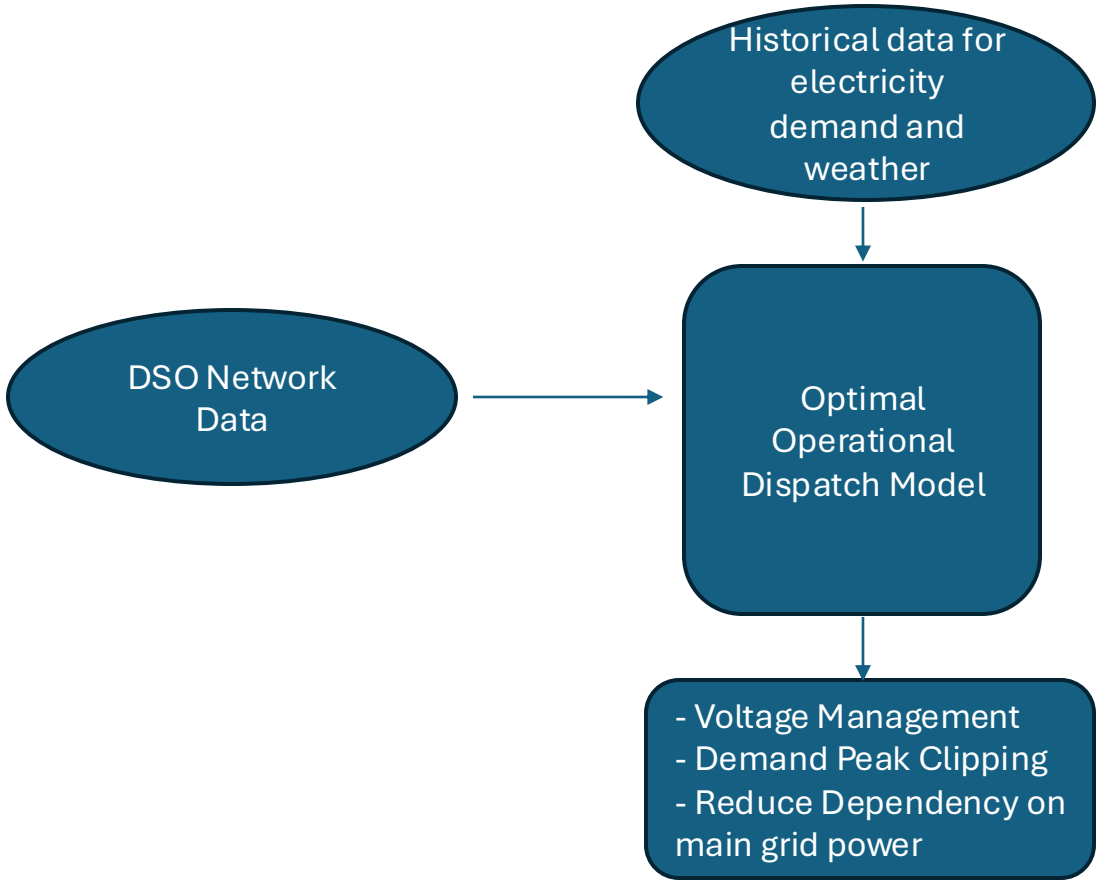
Objectives

Identify the optimal operational strategy for the practical deployment of community-integrated energy systems

Assess the potential of shared local energy solutions to achieve the benefits from technical, commercial and social aspects.

Reduce the dependency on imported power from main grid

Methodology



Set-up

Input Data and Software Tools

Input Data	Source
Domestic electricity consumption data	SSEN Smart Meter Data [3]
Electric Vehicle consumption data	Low-Carbon-London project [4]
Weather Data (Temperature, Wind Speed)	OpenMeteo [5]
Building thermal variables	Standard Assessment Procedure [6]
	EPC data [7]
Retail Electricity Price	Octopus Energy [8]
Wholesale Electricity Price	Nordpool [9]
Power Network Topology	Hillingdon Substation (by Scottish Southern Energy Networks) [10]

Tools	Source
Main Programming Language	Python
Power Flow Analysis	Pandapower [11]
Wind Farm model analysis	Pywake [12]
Method for operation optimization	Deep Reinforcement Learning (Soft Actor-Critic) [10]
Neural Network construction	PyTorch [13]
Deep Reinforcement learning Model development	OpenAI Gym [14]

3. "SSEN Distribution Data Portal," *Ssen.co.uk*, 2023. https://data.ssen.co.uk/
4. "Low Carbon London Electric Vehicle Load Profiles – London Datastore." https://data.london.gov.uk/dataset/low-carbon-london-electric-vehicle-load-profiles
5. "Free Open-Source Weather API | Open-Meteo.com," open-meteo.com. https://open-meteo.com/
6. "Standard Assessment Procedure (SAP 2012) - BRE Group," bregroup.com, Apr. 23, 2019. https://bregroup.com/sap/standard-assessment-procedure-sap-2012/ (accessed Jul. 03, 2022).
7. "Energy Performance of Buildings Data England and Wales," epc.opendatacommunities.org. https://epc.opendatacommunities.org/
8. "Octopus Energy," Octopus Energy. https://octopus.energy/tariffs/
9. "Nord Pool | Data Portal," Nordpoolgroup.com, 2024. https://data.nordpoolgroup.com
10. "T. P. Tun and I. Pisica, "Active Voltage Control and Demand Peak-Clipping Using Soft Actor-Critic Method," 2024 59th International Universities Power Engineering Conference (UPEC), Cardiff, United Kingdom, 2024, pp. 1-6
11. L. Thurner et al., "Pandapower—An Open-Source Python Tool for Convenient Modeling, Analysis, and Optimization of Electric Power Systems," in IEEE Transactions on Power Systems, vol. 33, no. 6, pp. 6510-6521, Nov. 2018.
12. "PyWake documentation," topfarm.pages.windenergy.dtu.dk. https://topfarm.pages.windenergy.dtu.dk/PyWake/
13. A. Paszke et al., "PyTorch: An Imperative Style, High-Performance Deep Learning Library," arXiv (Cornell University), Dec. 2019
14. G. Brockman *et al.*, "OpenAI Gym," *arXiv (Cornell University)*, Jan. 2016

Methodology

(Electric Vehicle and Heat Pump Consumption Calculation)

Procedure Construction_of_Electric_Vehicle_Profile ( )

For each hour **i** from 0 to 23 do
- **PD_sum** = 0
- For each EV consumption value **c** in per-unit do
  - Calculate Probability Density (PD) for EV consumption value at hour **i**
  - Add PD value to get **PD_sum**
- **End** For
- For each EV consumption value **c** in per-unit do
  - Divide PD value of each EV consumption value **c** by **PD_sum** and get **PD_c / PD_sum**
  - Multiply **PD_c / PD_sum** by respective consumption value
- **End** For
- Sum all multiplication results and get the nominal EV consumption value at hour **i**

End For

End Procedure

$$Q_{leak} = [U_{flr}.A_{flr} + U_{rf}.A_{rf} + U_w.A_w + U_{wd}.A_{wd}] \times \Delta T$$

$$Q_{venl} = 0.33 \times n \times V \times \Delta T$$

$$Q_{demand_per_temp} = \frac{Q_{leak}+Q_{venl}}{\Delta T}$$

$$COP = \frac{T_H}{T_H - T_C}$$

$$E_{Space} = \frac{Q_{demand_per_temp}}{COP}$$

$$E_{DHW} = \frac{(\rho_w \times V_w \times c \times \Delta T)}{COP_H}$$

$$E_{HP} = E_{Space} + E_{DHW}$$

where Q_{leak} = Total expected heat loss from building

U_{flr} = U value of building's floor

U_{rf} = U value of building's roof

U_w = U value of building's wall

U_{wd} = U value of building's window

Q_{venl} = Heat loss due to ventilation

n = air-change rate per hour (0.5 assumed)

V = Volume of building

$Q_{demand_per_temp}$ = heating energy demand per deg C/Kelvin

T_H = Hot side temperature (Indoor Temperature) in Kelvin

T_C = Cold side temperature (Outdoor Temperature) in Kelvin

$\Delta T = T_H - T_C$

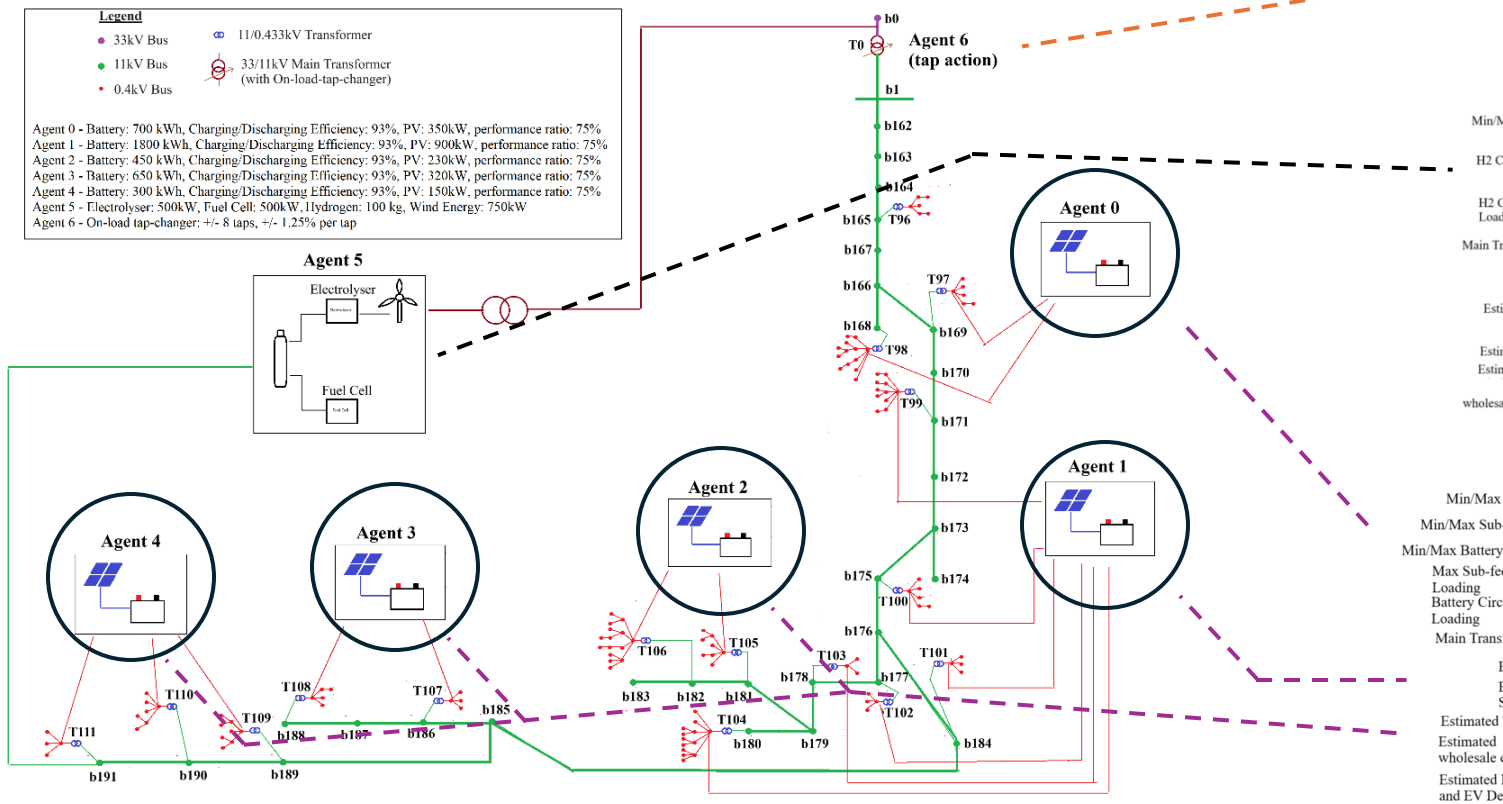
COP = Coefficient of Performance

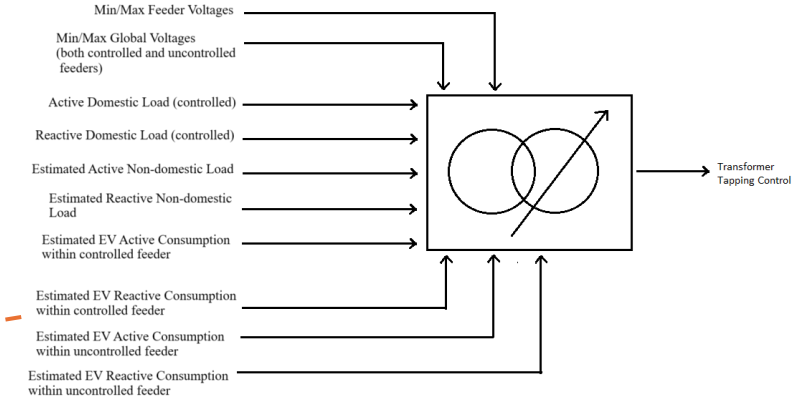
E_{Space}, E_{DHW} = Heat Demand for Space Heating, Domestic Water Heating

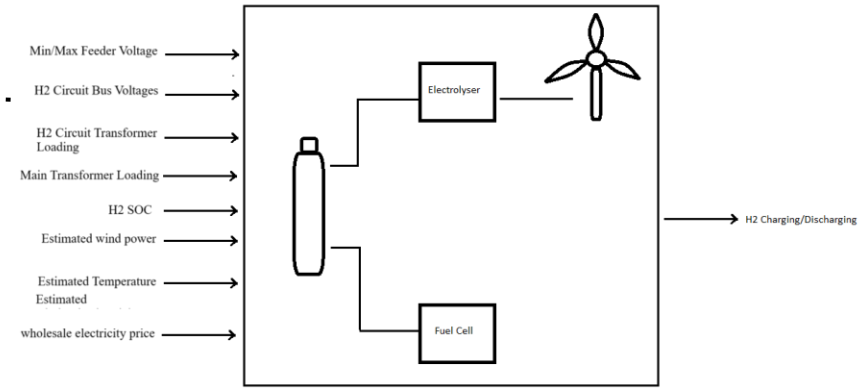
E_{HP} = Total heat demand by heat pump per consumer/household

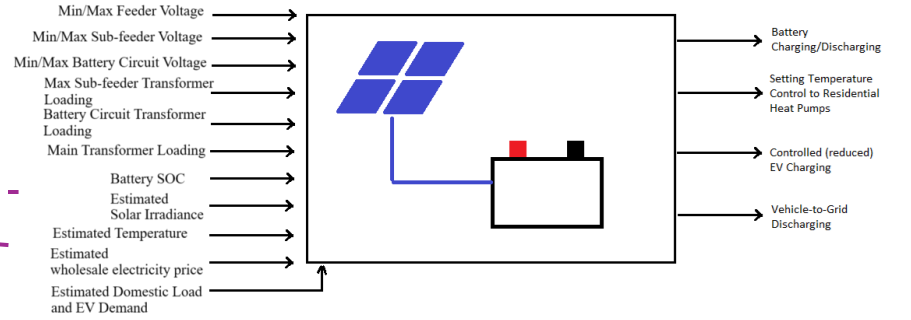
Methodology

Optimal Energy Dispatch Model Development









Methodology

Optimal Energy Dispatch Model Development (Reward Calculation)

$$R_{ag0-4} = 0.5V_{pen0-4} + Tr_{pen0-4} + ar_{HP} + ar_{EV} + ar_{V2G} + R_{fin04}$$

$$ar_{HP} = a_{HP}(Trm + Vm)$$

$$ar_{EV} = a_{EV}(Trm + Vm)$$

$$ar_{V2G} = a_{EV}(Trm + Vm)$$

$$Trm = \begin{cases} 0.7(Trl - 0.8)\ if\ Trl \geq 0.8 \\ -2(0.8 - Trl)\ if\ Trl < 0.8 \end{cases}$$

$$Vm = \begin{cases} 0.7(0.95 - V)\ if\ V \leq 0.95 \\ -2(V - 0.95)\ if\ V > 0.95 \end{cases}$$

where R_{ag0-4} = Reward for agent 0-4
V_{pen0-4} = penalty for voltage violation (covering 11kV and 0.4kV buses within the respective controlled area with maximum possible value = 0)
Tr_{pen0-4} = penalty for transformer loading violation (covering 11/ 0.433kV buses within the respective controlled area with maximum possible value = 0)
ar_{HP} = heat pump reduction action reward
ar_{EV} = EV charging reduction action reward
Trm = Marginal loading of transformer before violation
Trl = Current loading of transformer
Vm = Marginal voltage profile before violation
V = Current value of voltage
R_{fin04} = Financial reward for agent 0-4
= (Discharging Power * Selling Price)
– (Charging Power * Purchasing Price)
– (Incentive * Reduced Demand)

$$R_{ag5} = 0.8V_{pen5} + 0.8Tr_{pen5} + R_{fin5}$$

where R_{ag5} = Reward for agent 5
V_{pen5} = penalty for feeder voltage violation (maximum possible value = 0)
Tr_{pen5} = penalty for Hydrogen System Transformer and main transformer violation (maximum possible value = 0)
R_{fin5} = Financial reward for agent 5
= (Desorption Power * Selling Price [20])
– (Adsorption Power * Purchasing Price [21])
– (H2 system self-consumption* Purchasing Price)

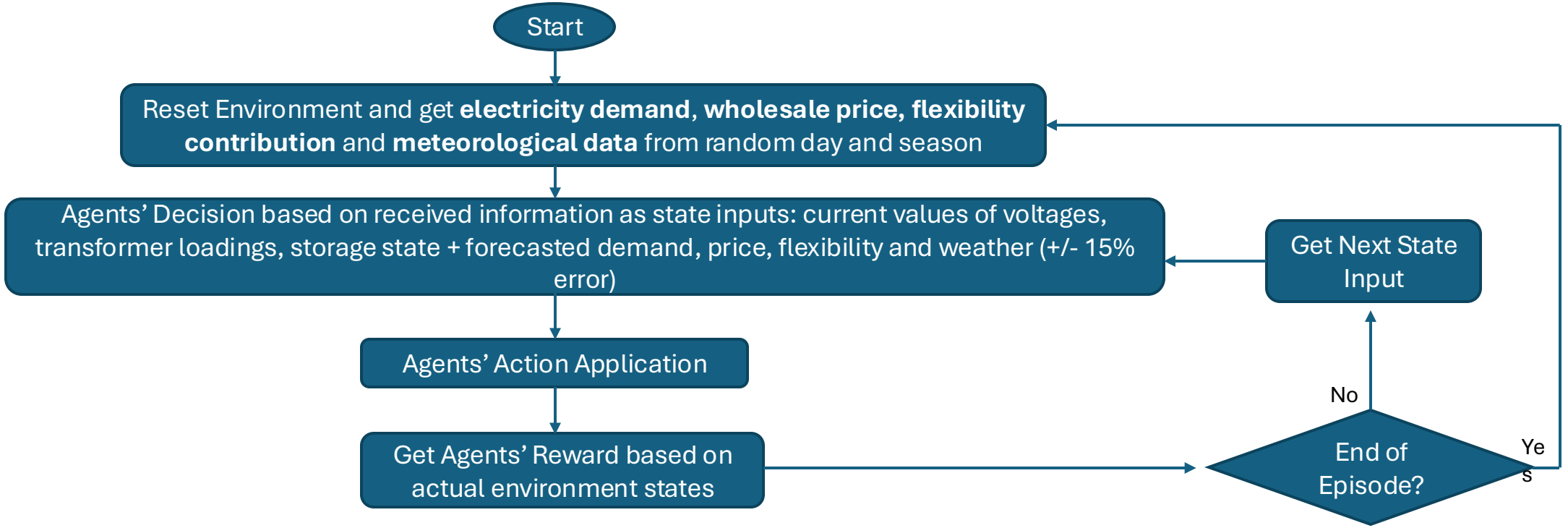
$$R_{ag6} = 0.125V_{penglobal}$$

where R_{ag6} = Reward for agent 6
V_{pen5} = sum of penalty for voltage violation in all feeders of 33/11kV Substation (maximum possible value = 0)

Methodology

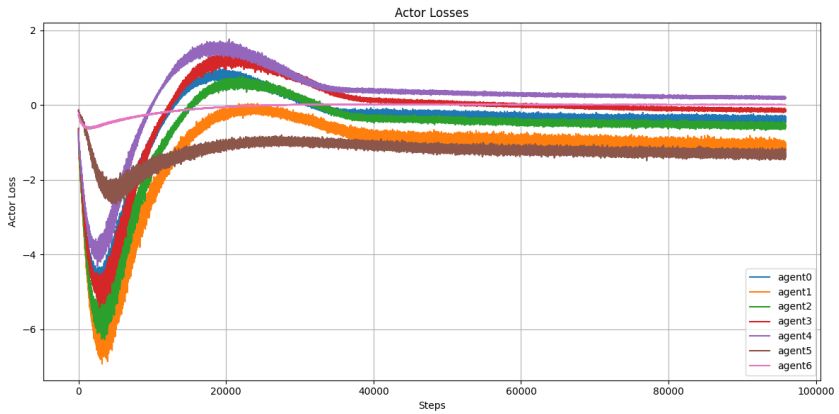
Optimal Energy Dispatch Model Development

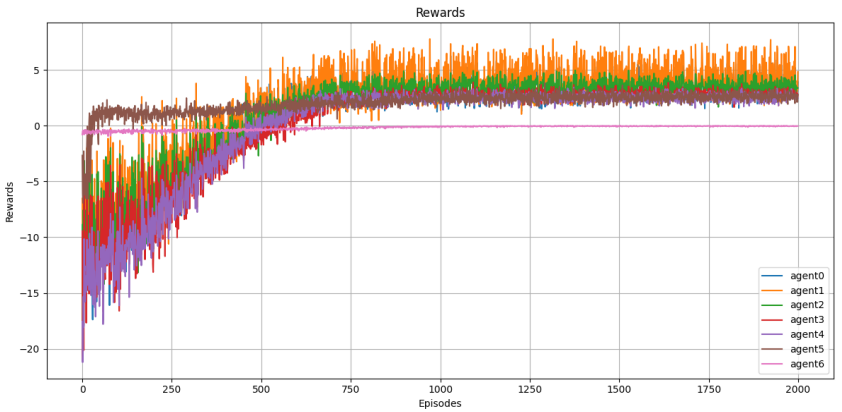
(Step Function)

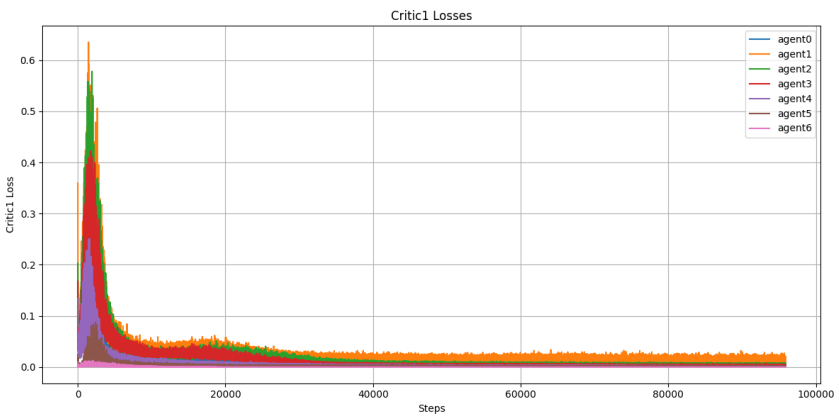


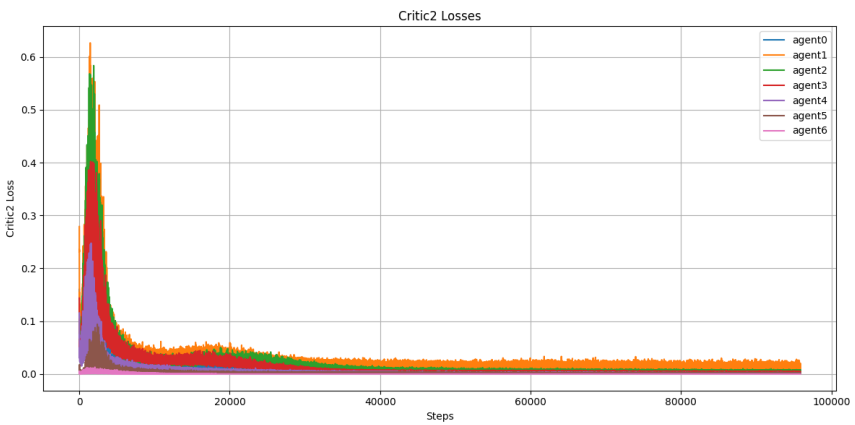
Results

Training Outcomes



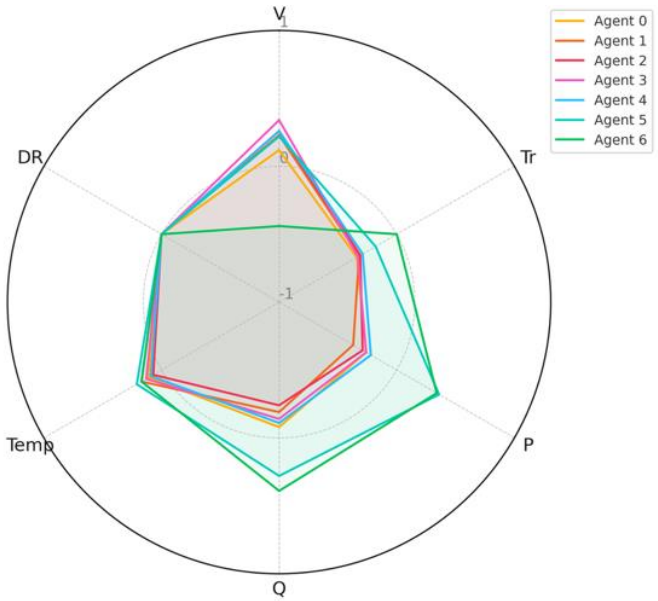






Results

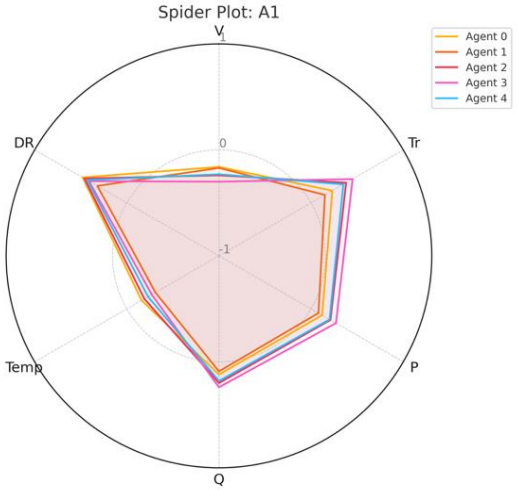
Correlations between actions and input states



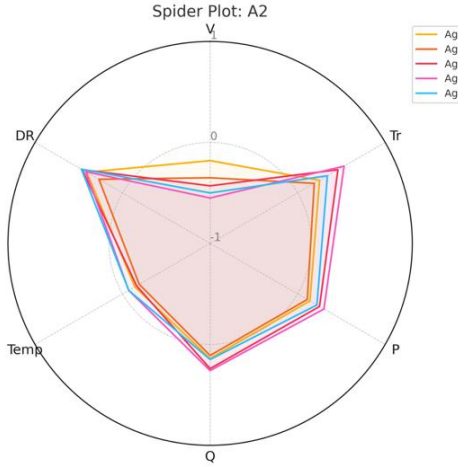
Energy Storage Action (Agent 0-5) and Transformer Tapping Control (Agent 6)

	Agent0	Agent1	Agent2	Agent3	Agent4	Agent5
SOC	-0.09	-0.16	-0.13	-0.11	-0.11	-0.22
Renewable Energy	0.18	0.19	0.22	0.22	0.2	0.53
Electricity Price	-0.37	-0.5	-0.42	-0.43	-0.38	-0.39

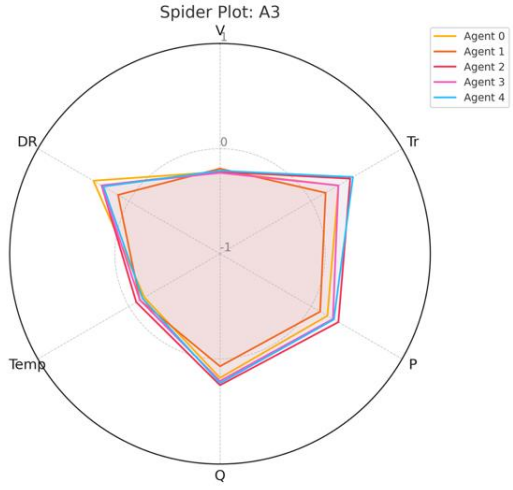
V = bus voltages
Tr = transformer loadings
P = active power demand
Q = reactive power demand
Temp = ambient temperature
DR = Demand Response Rate



Heat Pump Control Action



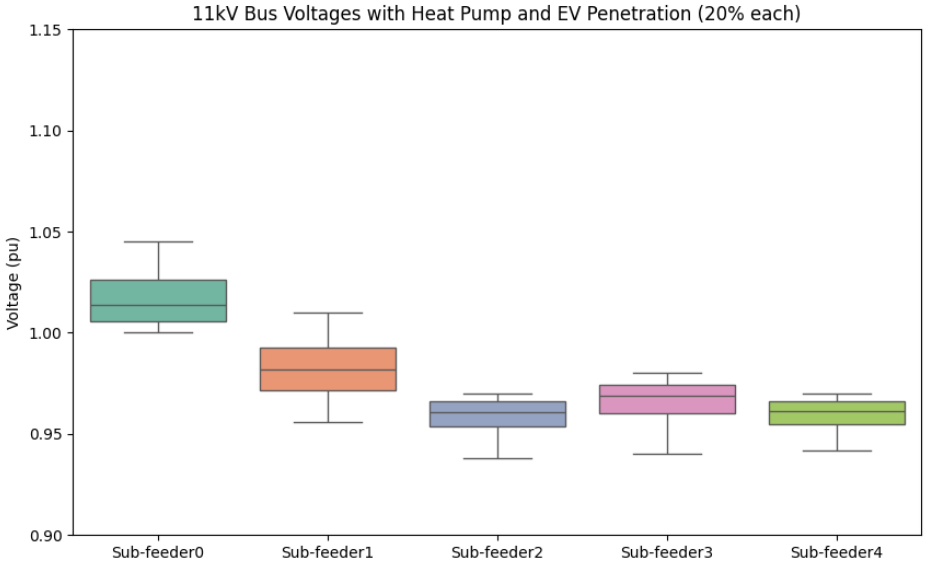
EV Charging Control Action

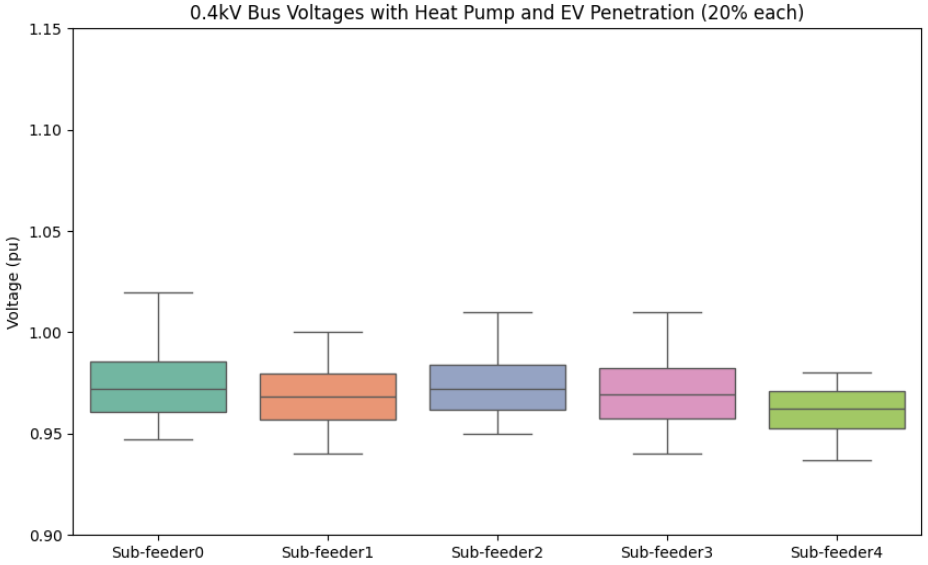


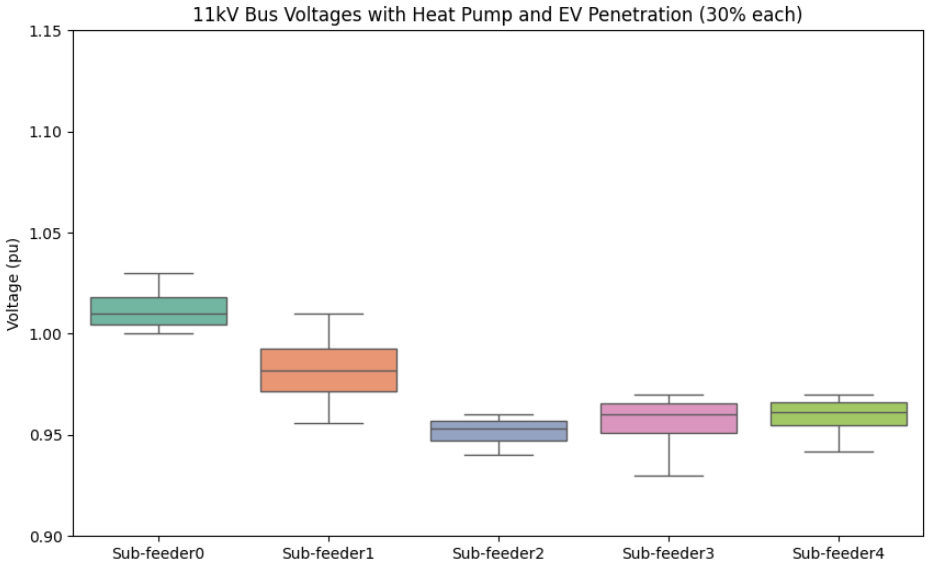
V2G Discharging Control Action

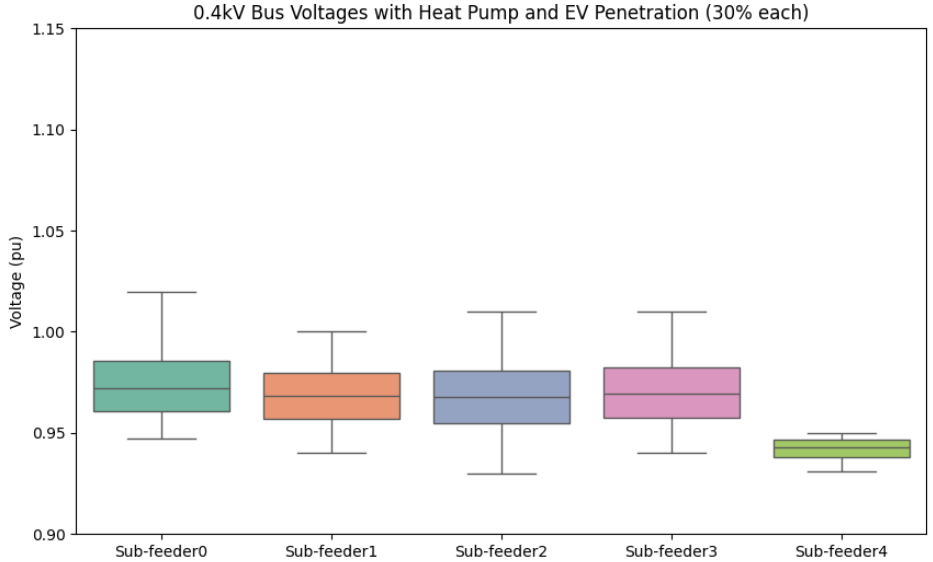
Results

Testing Outcomes









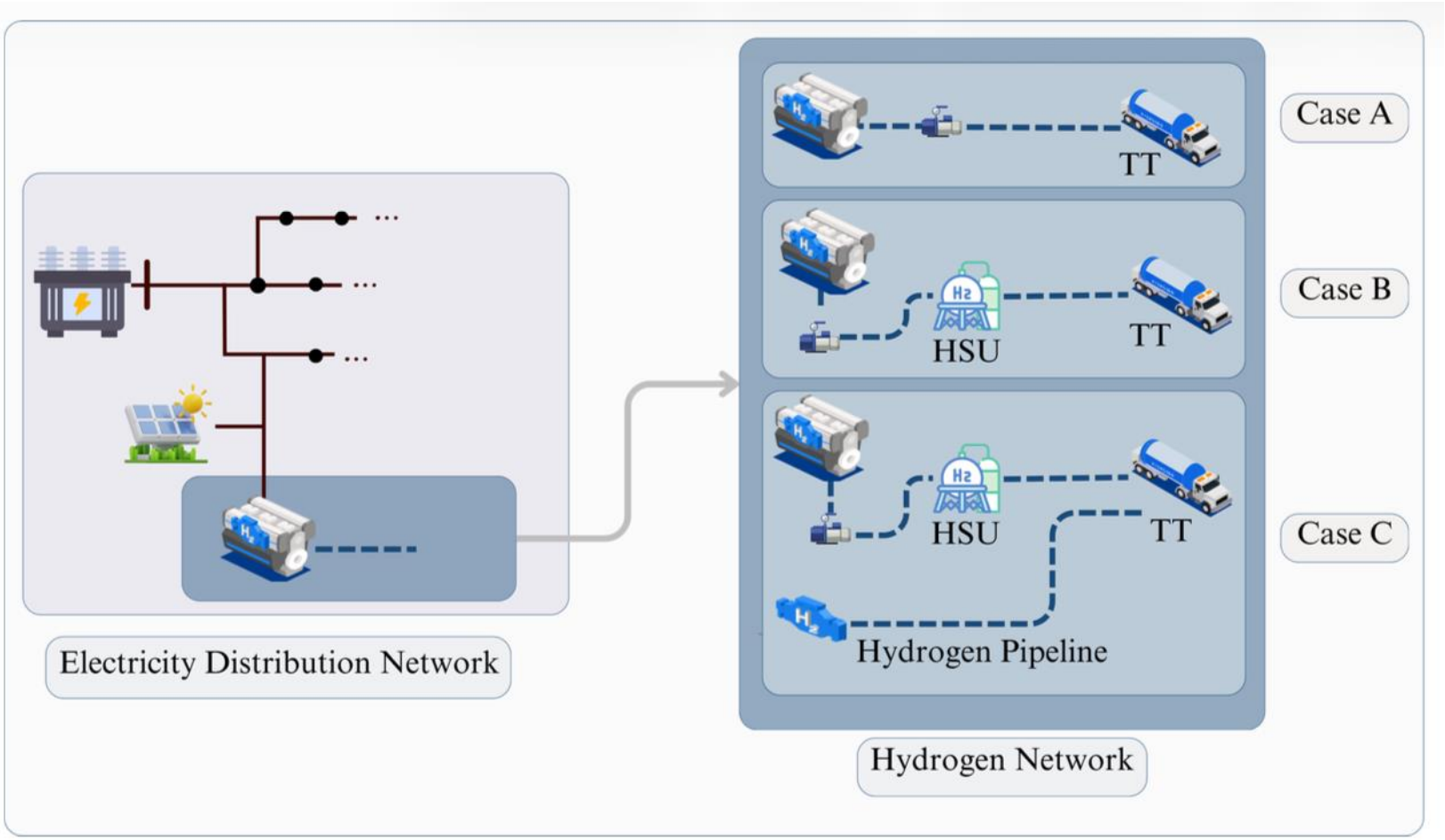
Discussions

- Reinforcement learning dynamically identifies high-dimensional control strategies that adapt to stochastic demand, intermittent renewable sources, and advancing technology across all energy system tiers, improving traditional optimisation [19].
- In this study, a multi-agent model has been implemented incorporating the dispatching function of local distributed energy as an extension to the previously developed single-agent model in [10].
- The actions showed the appropriate correlations with their corresponding state variables. This confirms that the trained model learned effectively.
- When hosting capacity rose to more than twice the current level, the minor voltage violations appeared at the end-buses (sub-feeder4).
- However, no violation occurred at 20% heat-pump and EV penetration, much above the original hosting capacity (12.5%).
- In future work, meta-learning will be added for further advancement to the SAC model.

10. “T. P. Tun and I. Pisica, "Active Voltage Control and Demand Peak-Clipping Using Soft Actor-Critic Method," 2024 59th International Universities Power Engineering Conference (UPEC), Cardiff, United Kingdom, 2024, pp. 1-6

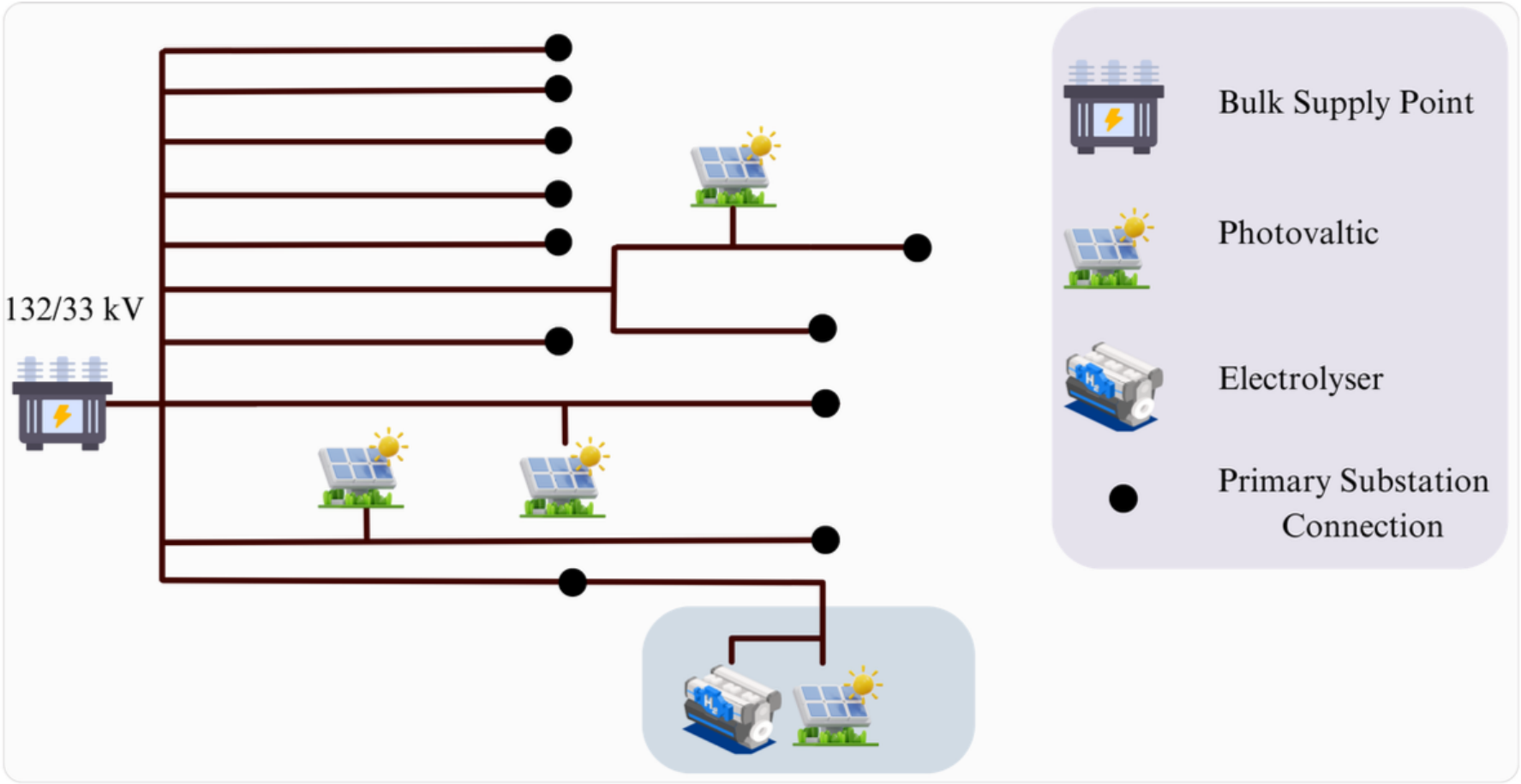
19. C. Lee, C. Avery, and S. Young, “Prospects for Reinforcement Learning: A guide for energy sector applications,” Catapult, United Kingdom, Apr. 2023. Accessed: May 13, 2025. [Online]. Available: https://es.catapult.org.uk/wp-content/uploads/2023/04/Prospects-for-reinforcement-learning.pdf

Example 2 – part of PhD work of Hilal Ozdemir



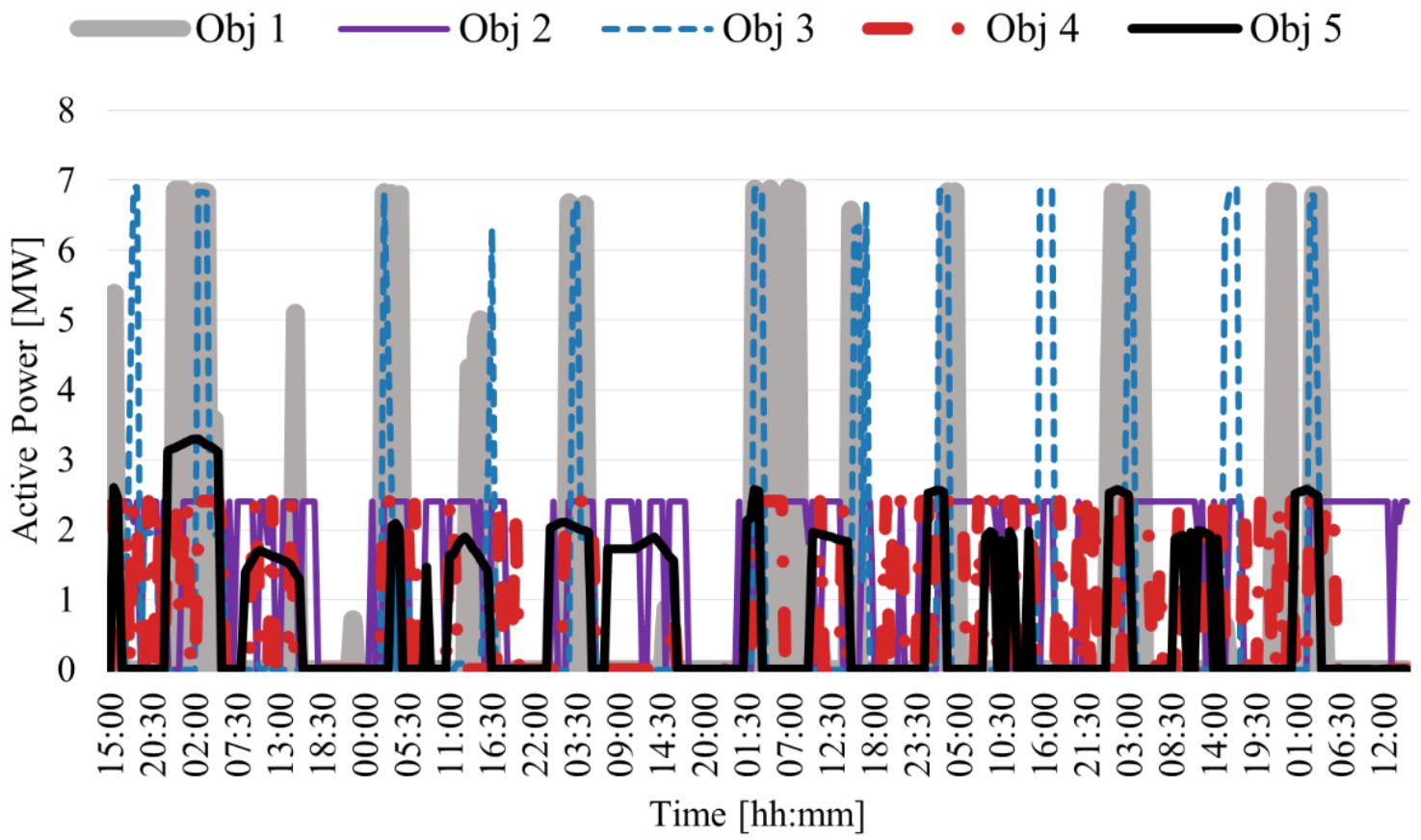
(a) Proposed hydrogen-electricity coupled multi-energy network methodology under different hydrogen supply configurations. TT: tube trailer, HSU: hydrogen storage unit.

Example 2 – part of PhD work of Hilal Ozdemir



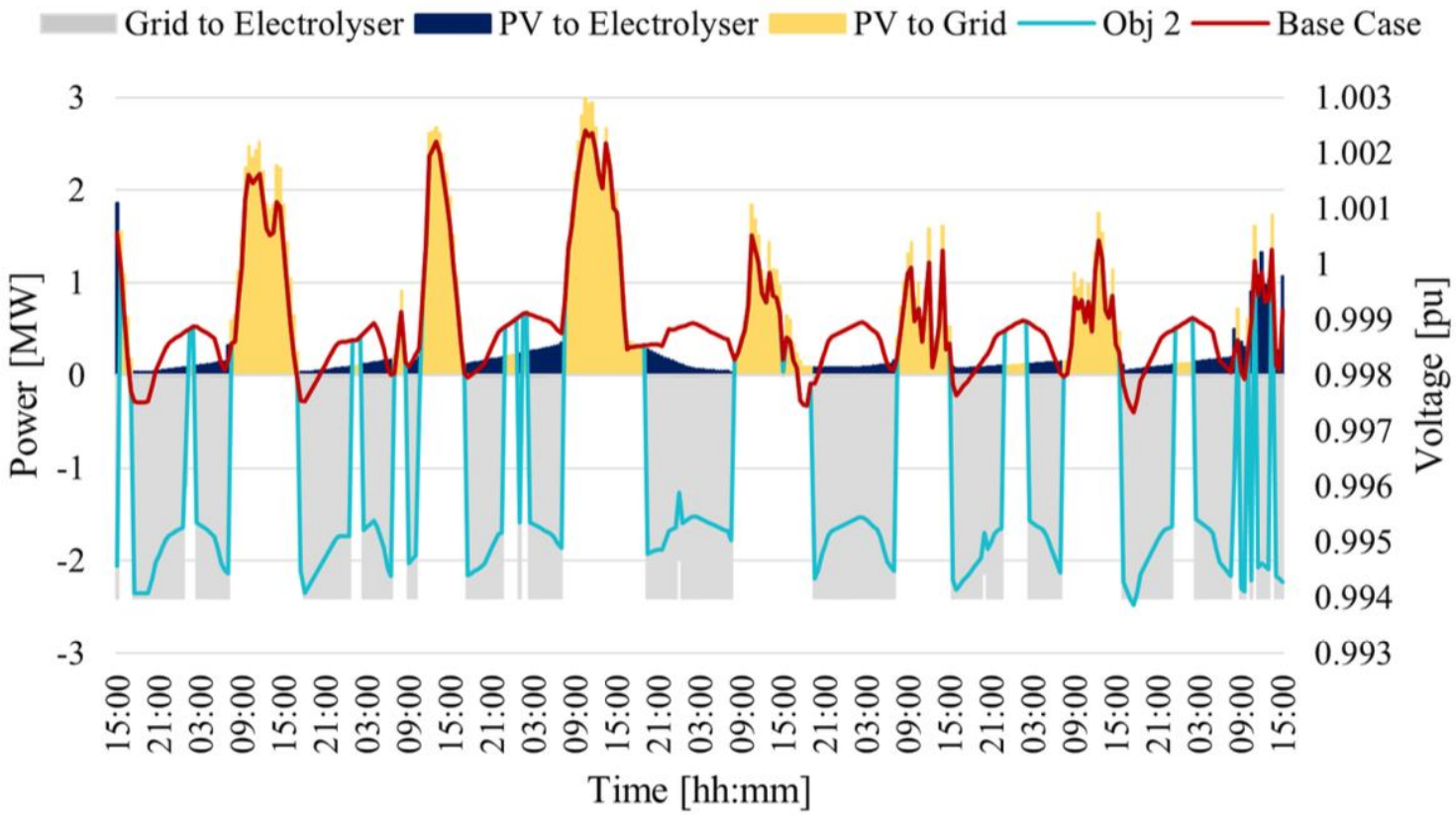
(b) Modified Braintree DN topology: bulk supply point to primary substation.

Example 2 – part of PhD work of Hilal Ozdemir



(a) Power transaction from the grid at the electrolyser-connected bus: optimisation of operational cost, LF, GHR, LF+GHR and loss objectives.

Example 2 – part of PhD work of Hilal Ozdemir



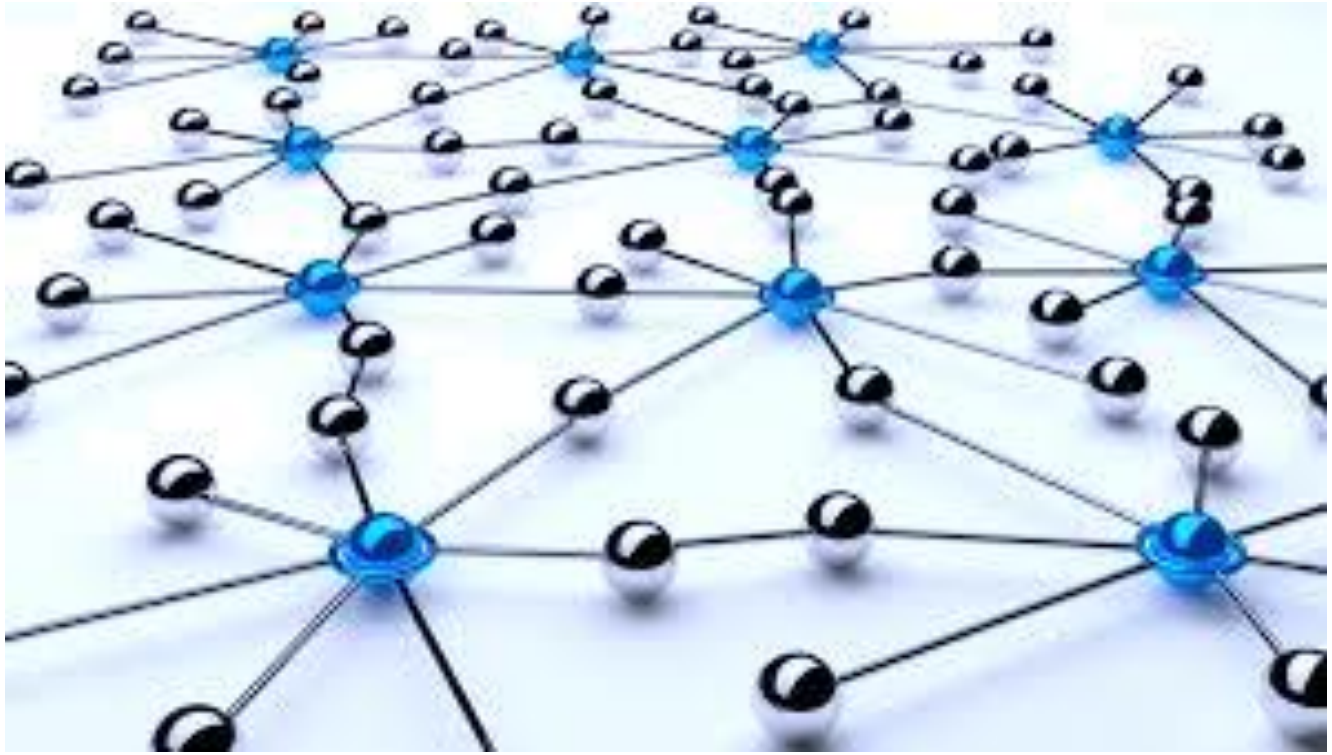
(b) Power flow and voltage profile at electrolyser-connected bus under maximisation of LF objective for case B.

Brunel University of London

MINISTERUL EDUCAȚIEI ȘI CERCETĂRII

UNIVERSITATEA TEHNICĂ DIN CLUJ-NAPOCA

In loc de concuzie



Brunel University of London

MINISTERUL EDUCAȚIEI ȘI CERCETĂRII

UNIVERSITATEA TEHNICĂ DIN CLUJ-NAPOCA

In loc de concuzie



Va multumesc pentru atentie

Dr Ioana Pisica

Ioana.Pisica@brunel.ac.uk

W13: Tranziția Energetică și Orașele Verzi: Perspective academice pentru un viitor sustenabil

Smart Diaspora 2025

CONFERINȚA DIASPORA ȘTIINȚIFICĂ ROMÂNEASCĂ

Cluj-Napoca | 4-7 noiembrie 2025