Energy Safety and Control Lab

Chicago Advanced Energy Stakeholder Breakfast
Energy, Mobility and Transportation
Chicago, USA, 1-Dec-2016

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ESCL Members - Acknowledgement

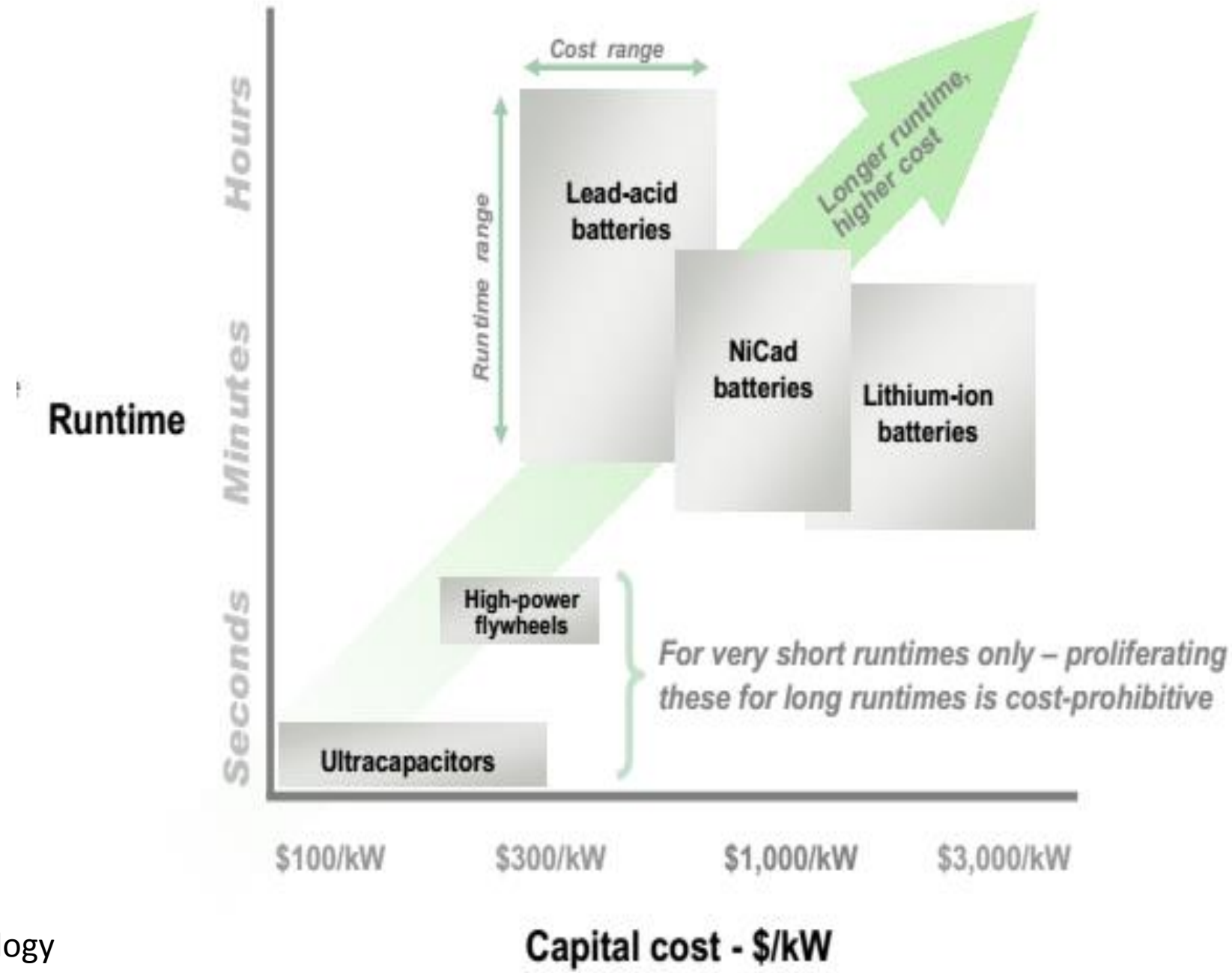
- Affiliated / Collaborators (Internal-UOIT, National (Waterloo, Memorial, Windsor), and International (Malaysia, China, Japan, Qatar, UAE, Egypt, Brazil, Mexico)
- Postdoc: (2)
- PhD: (4)
- Masters: (8)
- Undergrad / Research Students: (9)

What are the Challenges?

- How to meet GHG reduction in transportation, in view of electrification, with CNG combination?
- How to overcome energy storage limitations, including range and dynamic performance?
- How we evaluate and enhance the performance of energy storage systems in transportation networks?
- How to achieve economically viable energy solution for sustainable transportation system?

Research Objectives

- Design high performance Flywheel Energy Storage Platform (FESP) for transportation systems, including buses, rail, fleet
- Optimize FESP locations: buses, charging stations, and as integrated with microgrid as energy storage
- Design and performance optimization of charging stations, with respect to charging / discharging mechanisms and trip routes



Ref. FW Technology

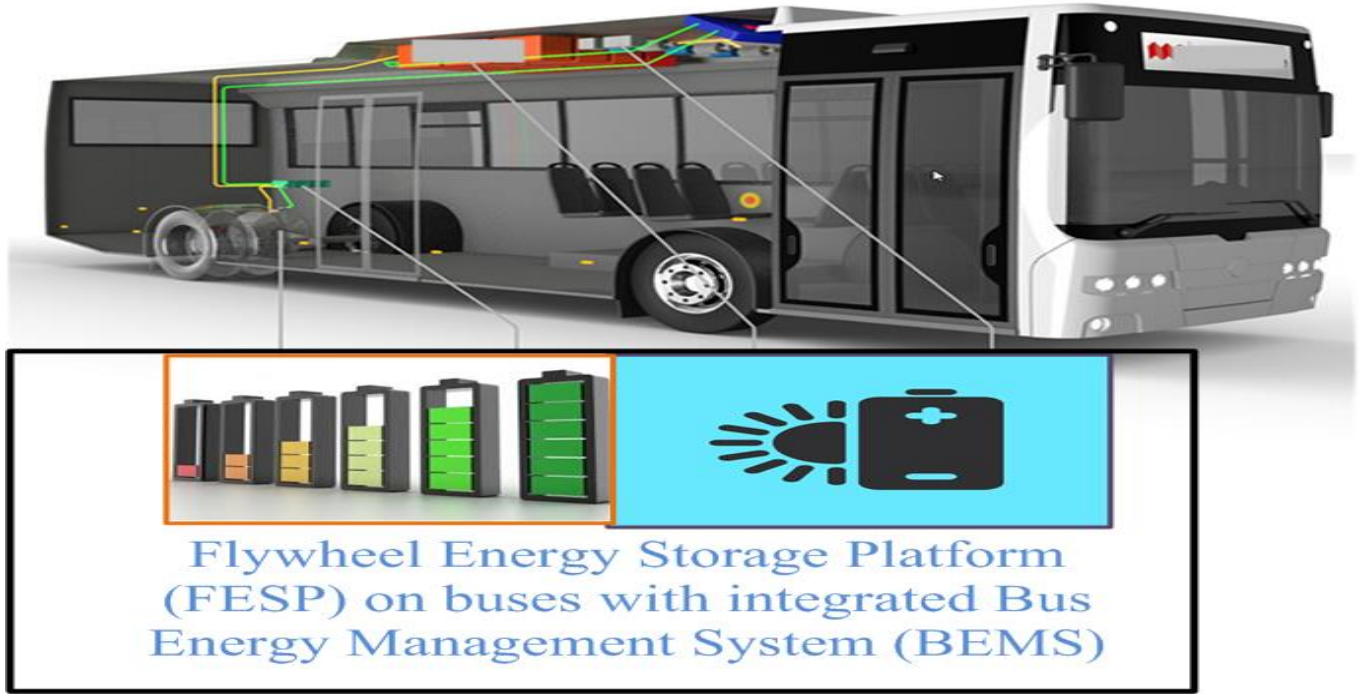
System Features

- FESP is integrated with advanced dynamic control scheme to enhance the flywheel performance and storage capabilities, reduce the charging time, and to increase the operating life time.
- Provide a replacement energy storage module at charging stations to reduce the charging waiting time in some cases as well as to achieve optimal operating costs.
- Design intelligent control actions to optimize the decision to charge or replace at each station.
- Global management and optimization of the bus system using integrated Bus Energy Management System (BEMS), with the following functions:
  - Monitor and control the FESP in each bus during the trips;
  - Monitor and control the charging of FESP at the charging stations; and
  - Monitor and control replacement of energy storage module at the charging station.
- Utilization of performance indicators for decision making and optimization of transportation infrastructures in view of economic and technical criteria.

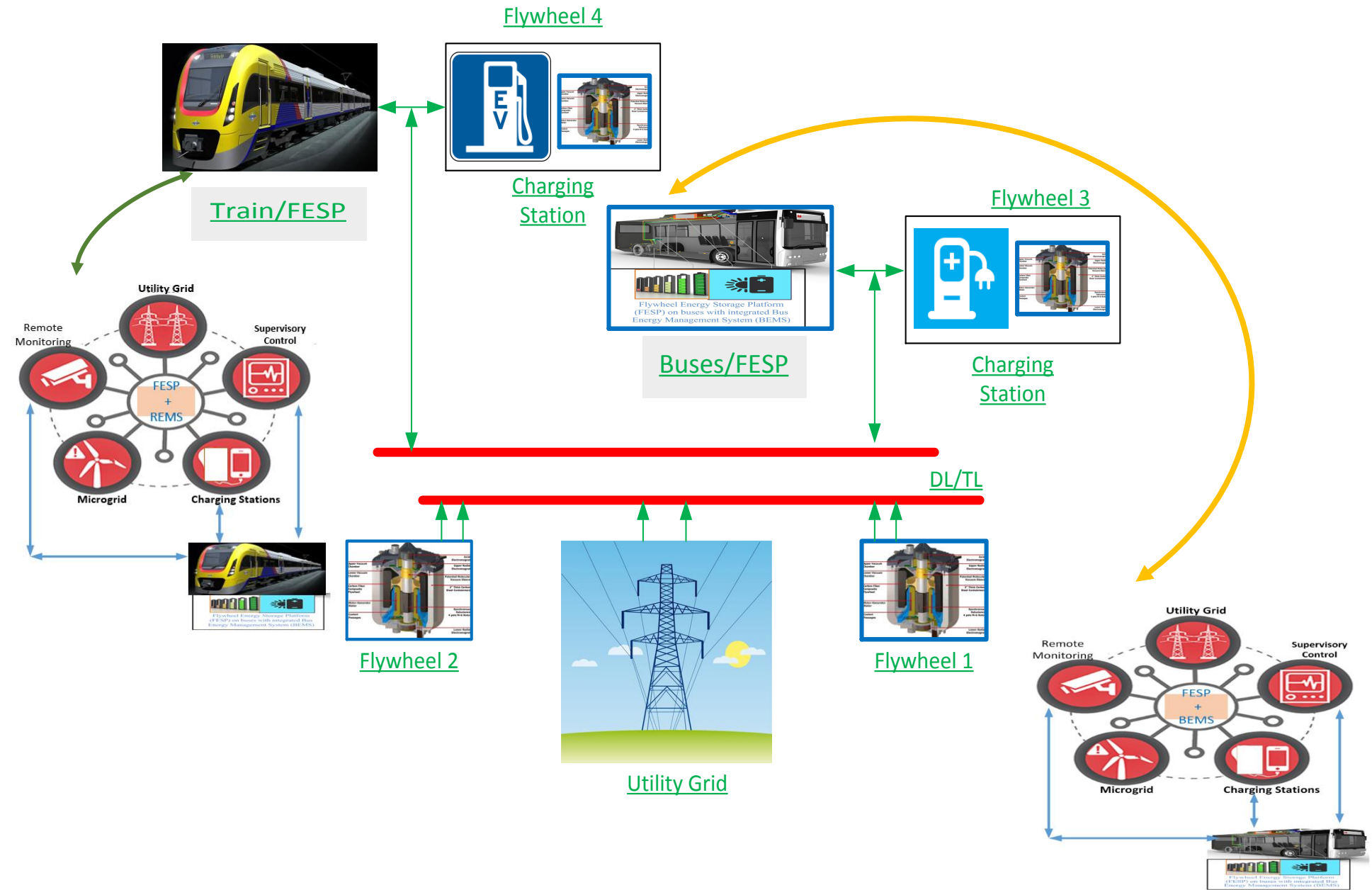
Implementation Challenges in Bus Systems

Optimum integration of Flywheel Energy Storage Platform (FESP) within the transportation bus network, using Bus Energy Management System (BEMS)

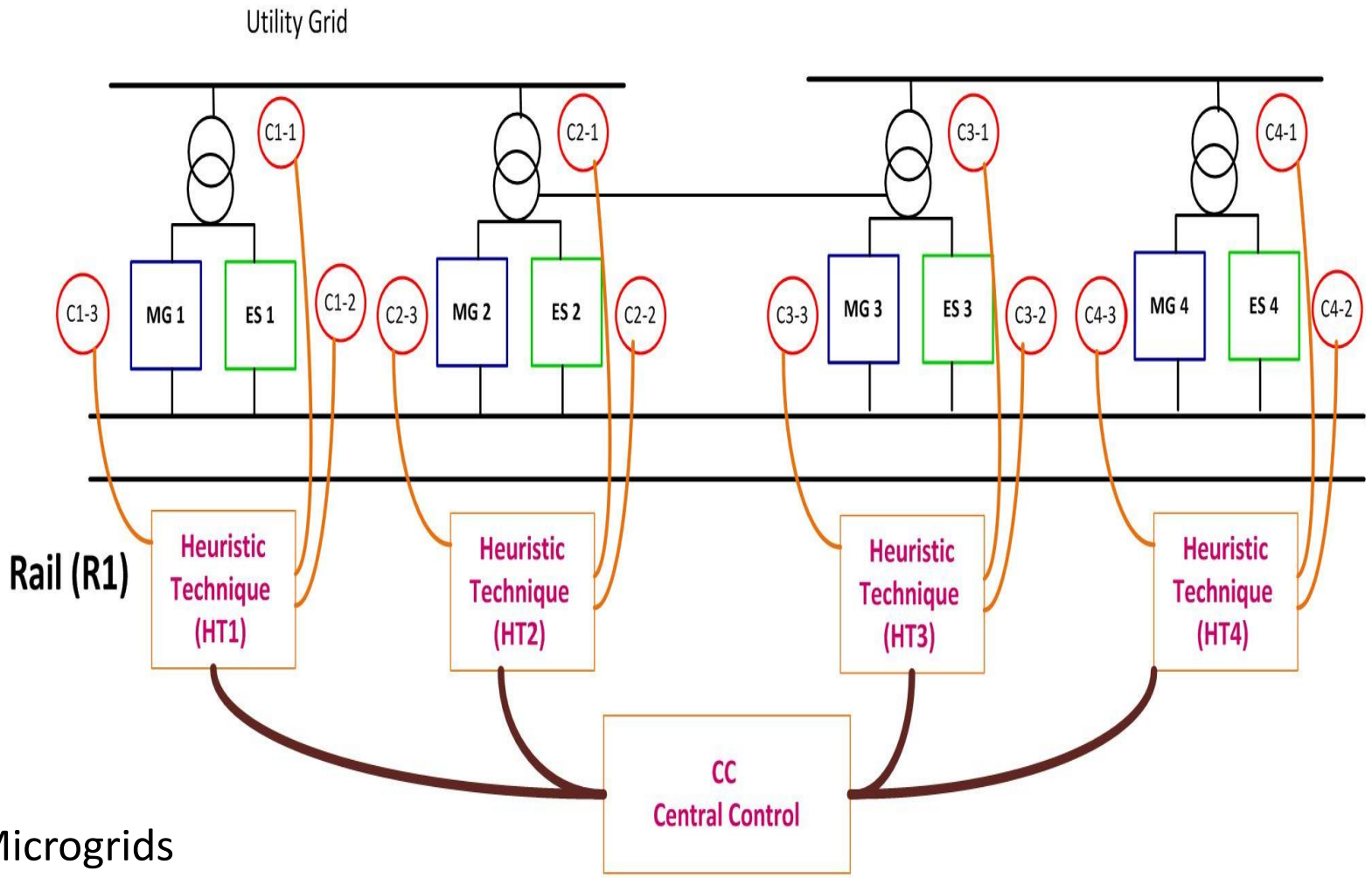
Optimize energy storage capacity within transportation buses



Flywheel Energy Storage Platform (FESP) for Energy Efficient Transportation Buses and Railway

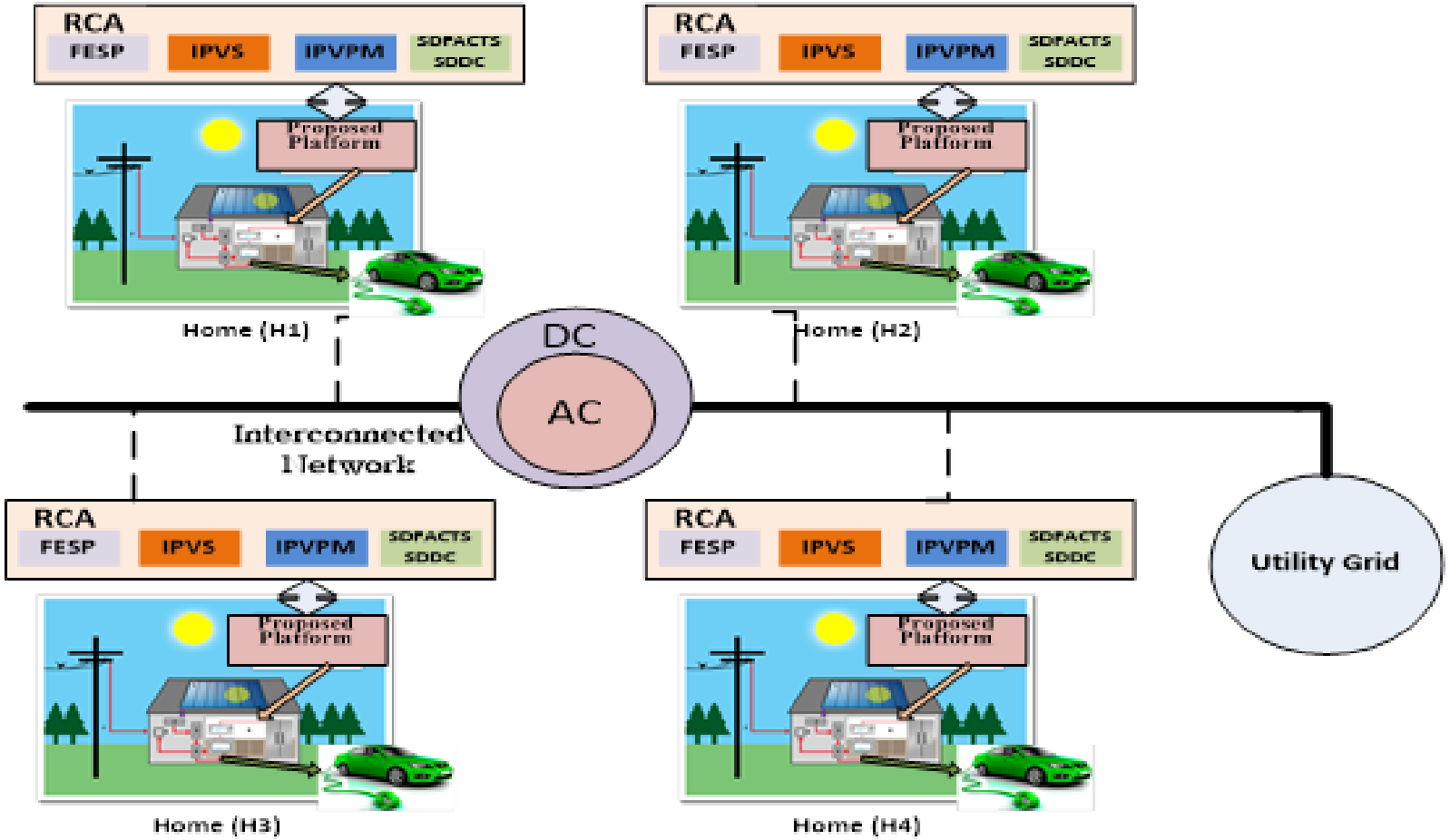


Flywheel Energy Storage Platform (FESP) for Energy Efficient Transportation Systems



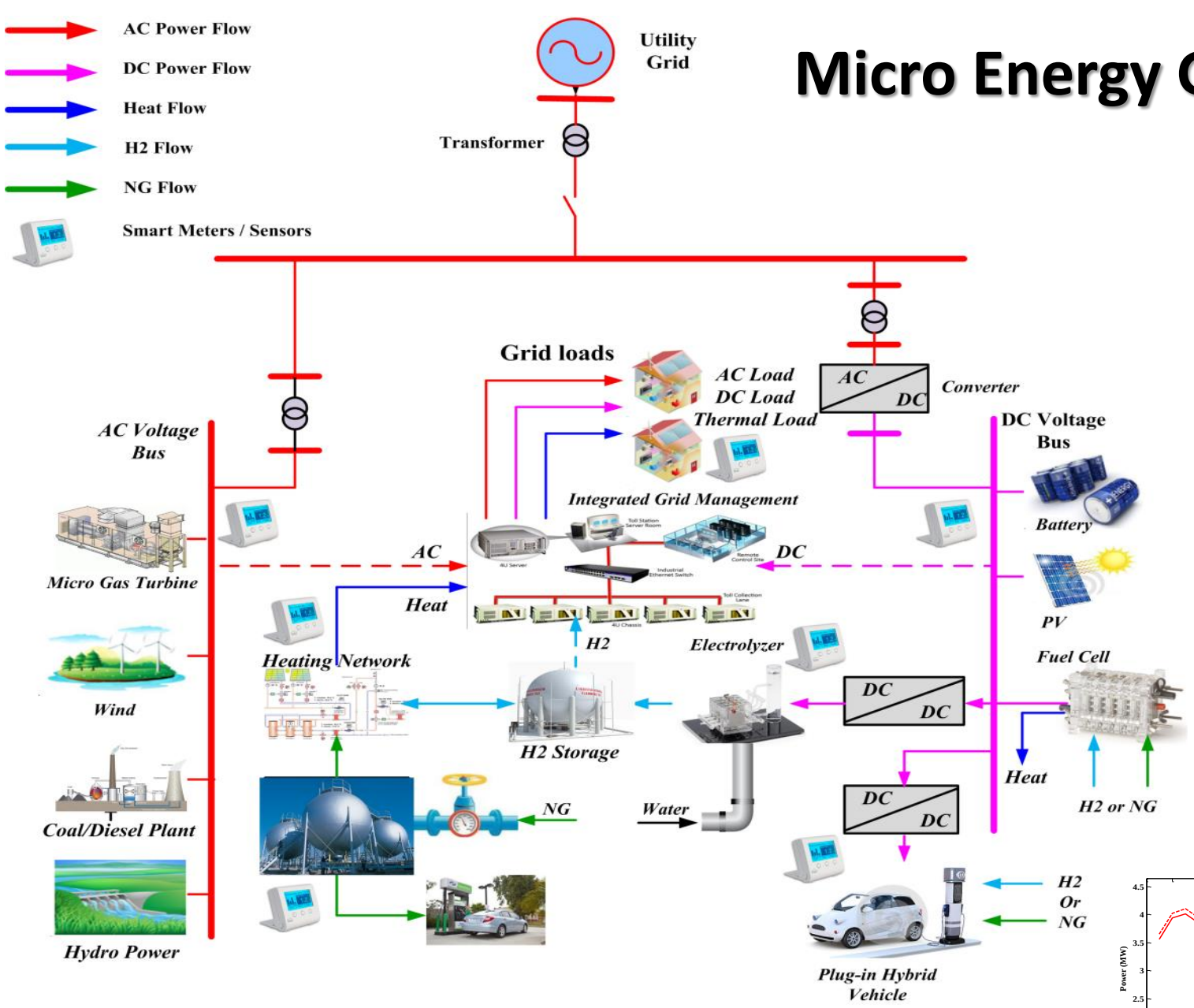
MG1, MG2 ...: Microgrids
ES1, ES2..: Energy Storages
c1,c2..: contact & data point

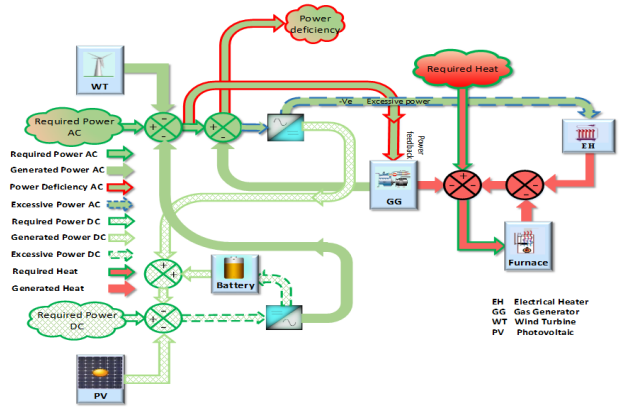
Interconnected Homes/Community for Utility Grid-Connection and Transportation Networks

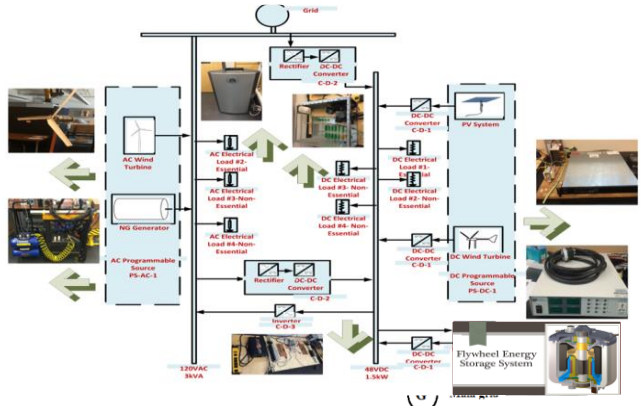


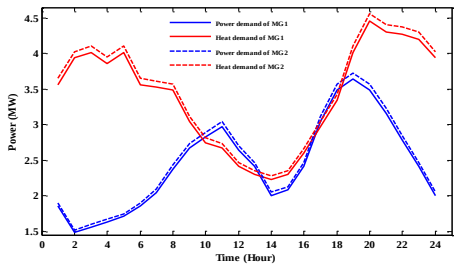
High Performance Zero Net Energy (ZNE) Infrastructures for Transportation Networks

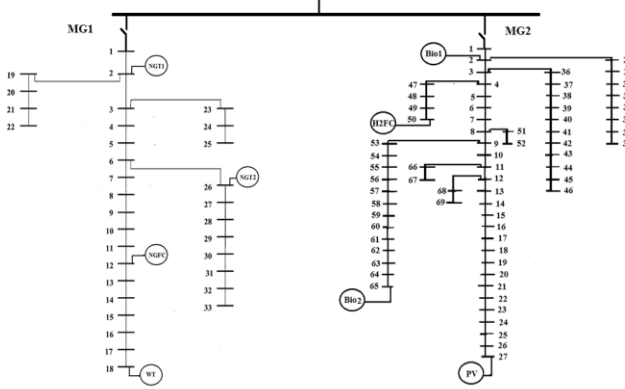
Micro Energy Grids Management System

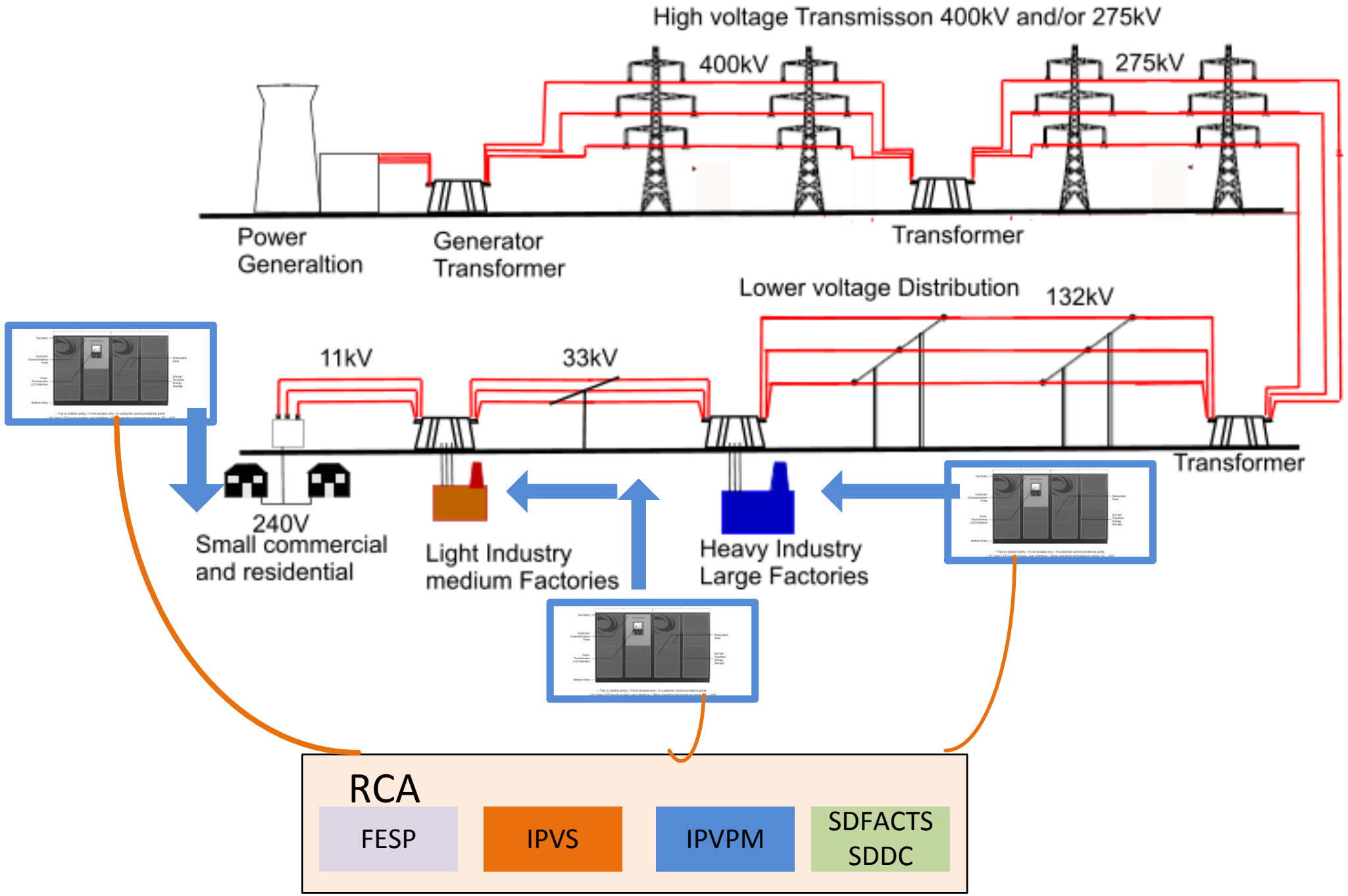






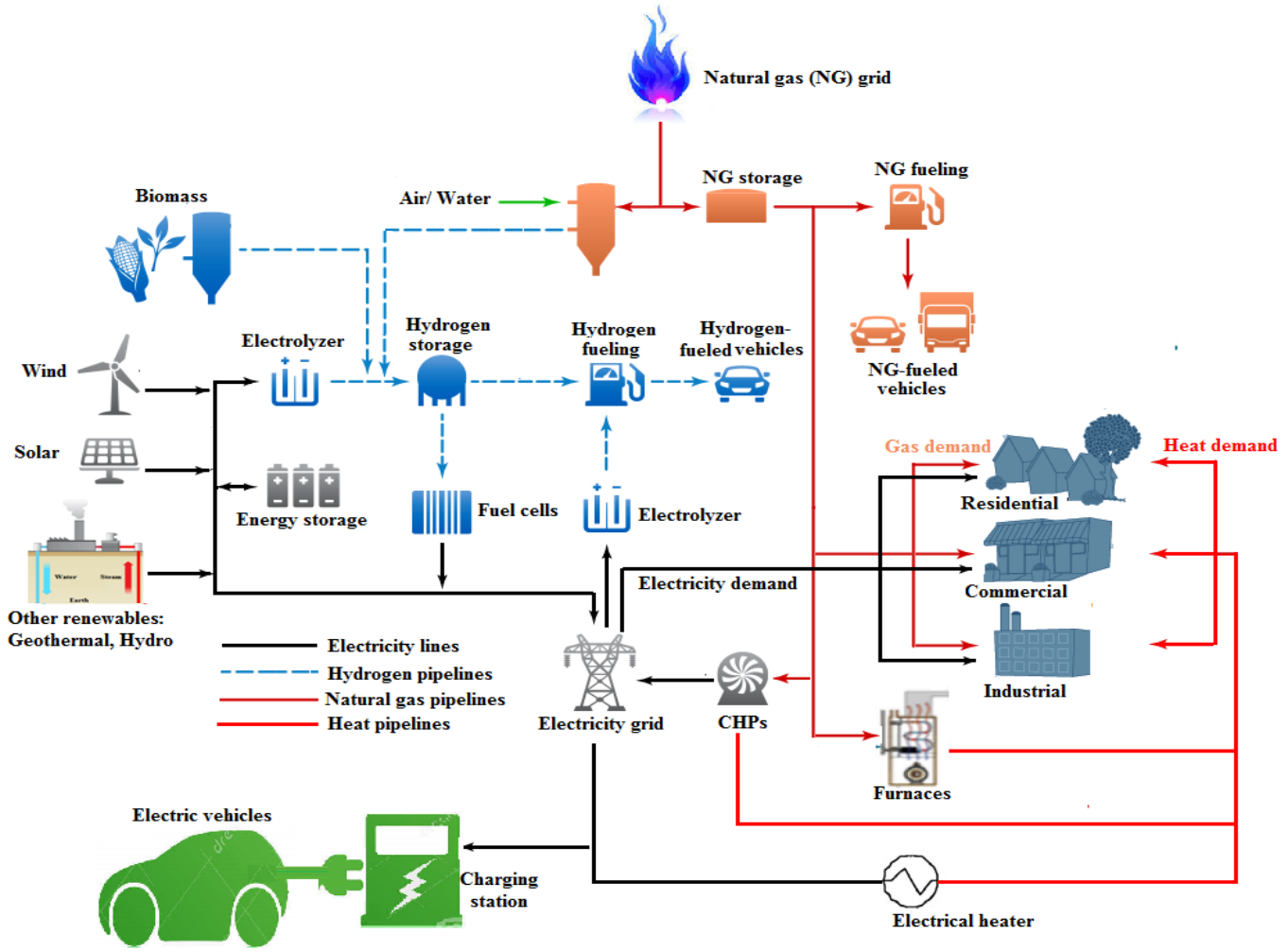




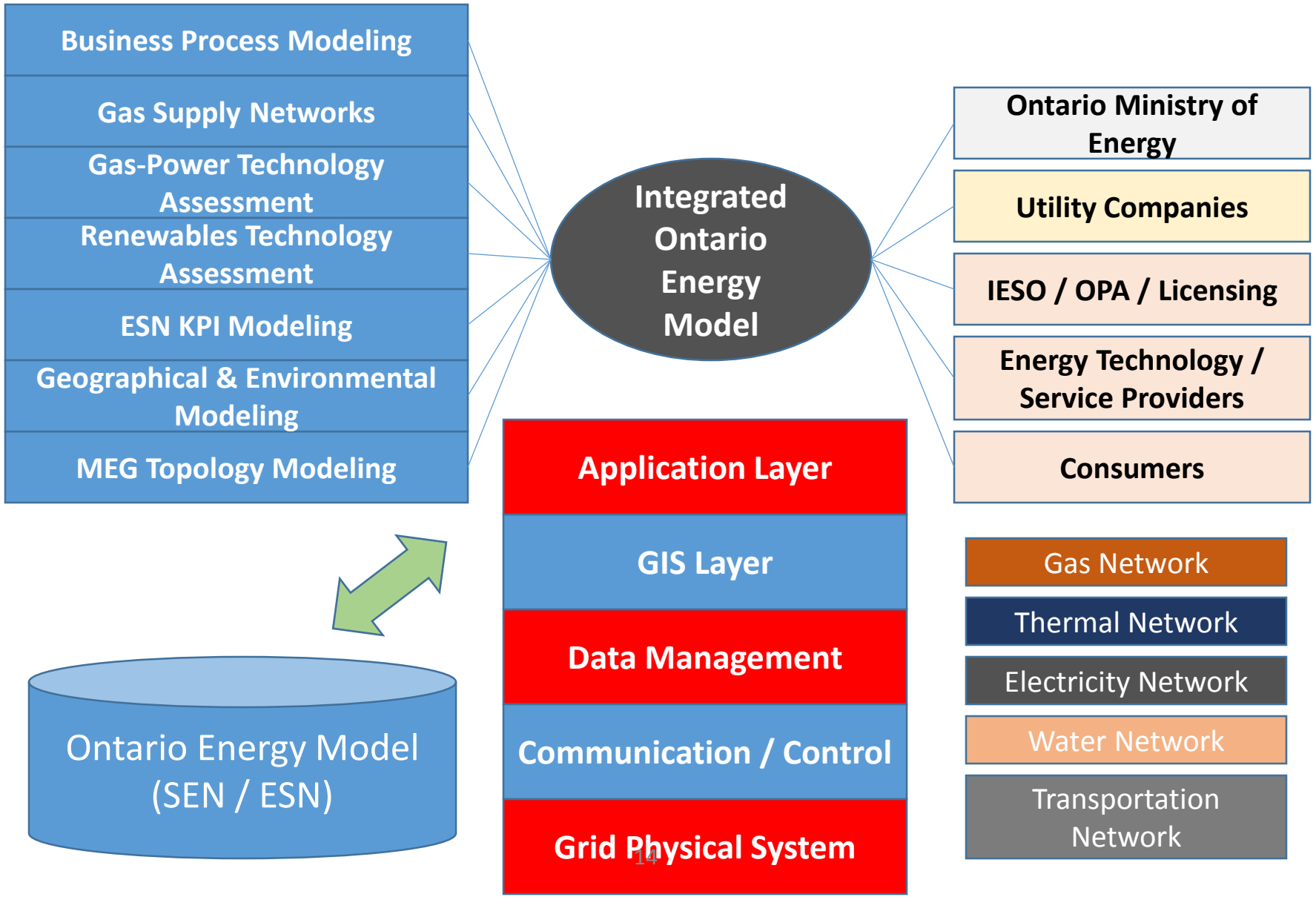

High voltage Transmisson 400kV and/or 275kV
400kV
275kV
Power
Generaltion
Generator
Transformer
Transformer
Lower voltage Distribution
132kV
11kV
33kV
Transformer
240V
Small commercial
and residential
Light Industry
medium Factories
Heavy Industry
Large Factories
RCA
FESP
IPVS
IPVPM
SDFACTS
SDDC

Planning support tool for regional transportation infrastructure with sustainable fuel production and supply strategies (PSTF-Tool)

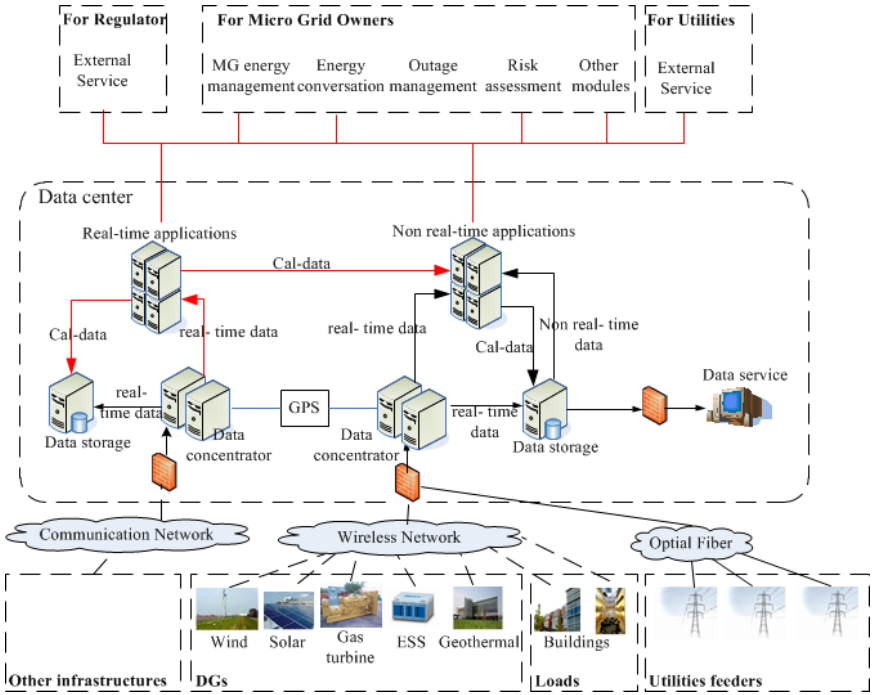
Synthesize, analyze, evaluate, and optimize different scenarios of transportation network operation and technologies (electric, natural gas, hydrogen, etc.) with performance indicators.

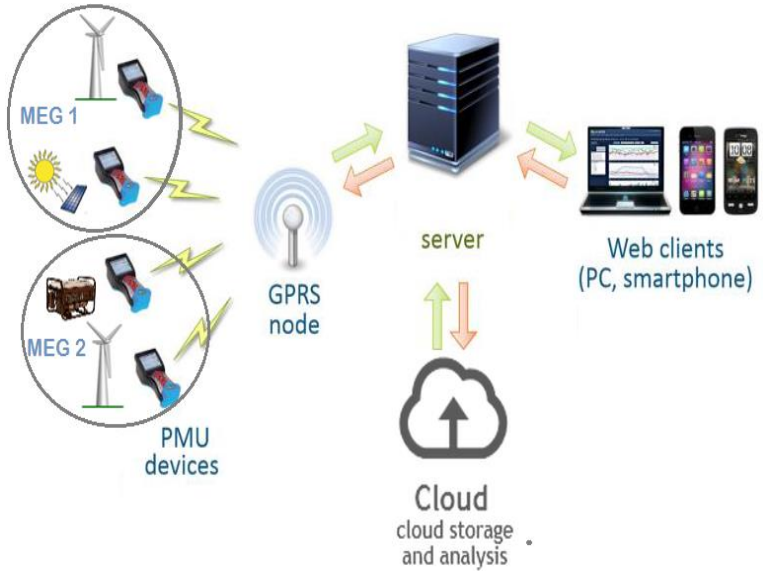


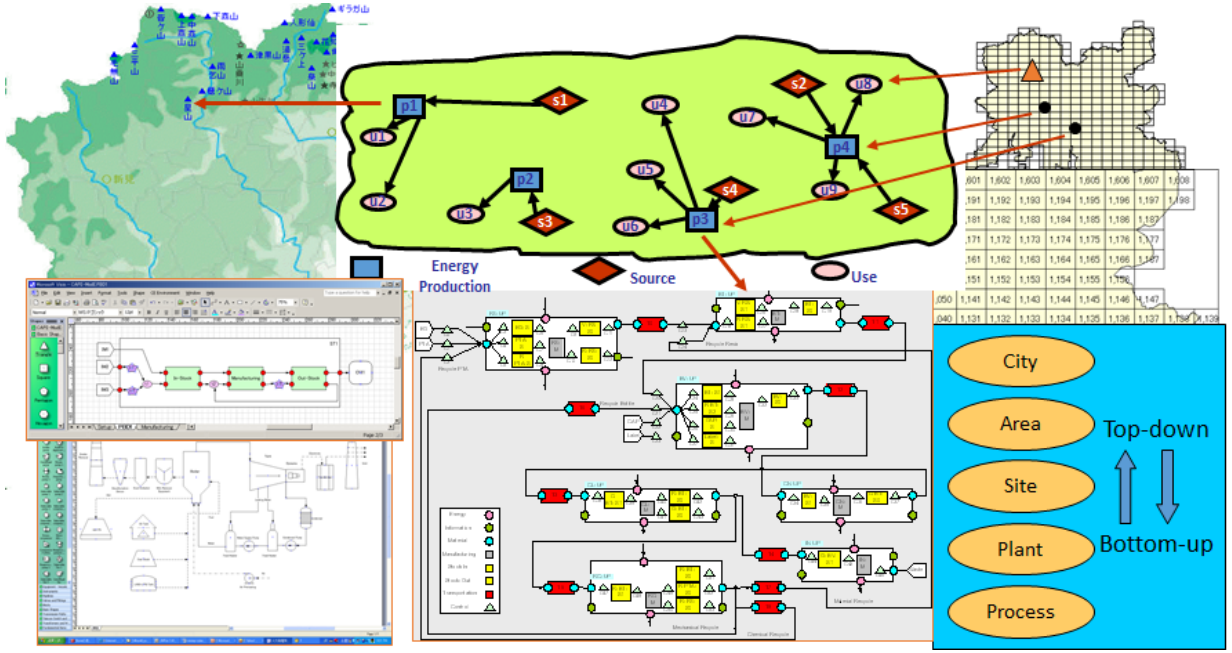
Proposed Integrated ESN / FSN System Architecture



Integrated Energy Data Center (Efficiency, Conservation, Safety, Reliability)







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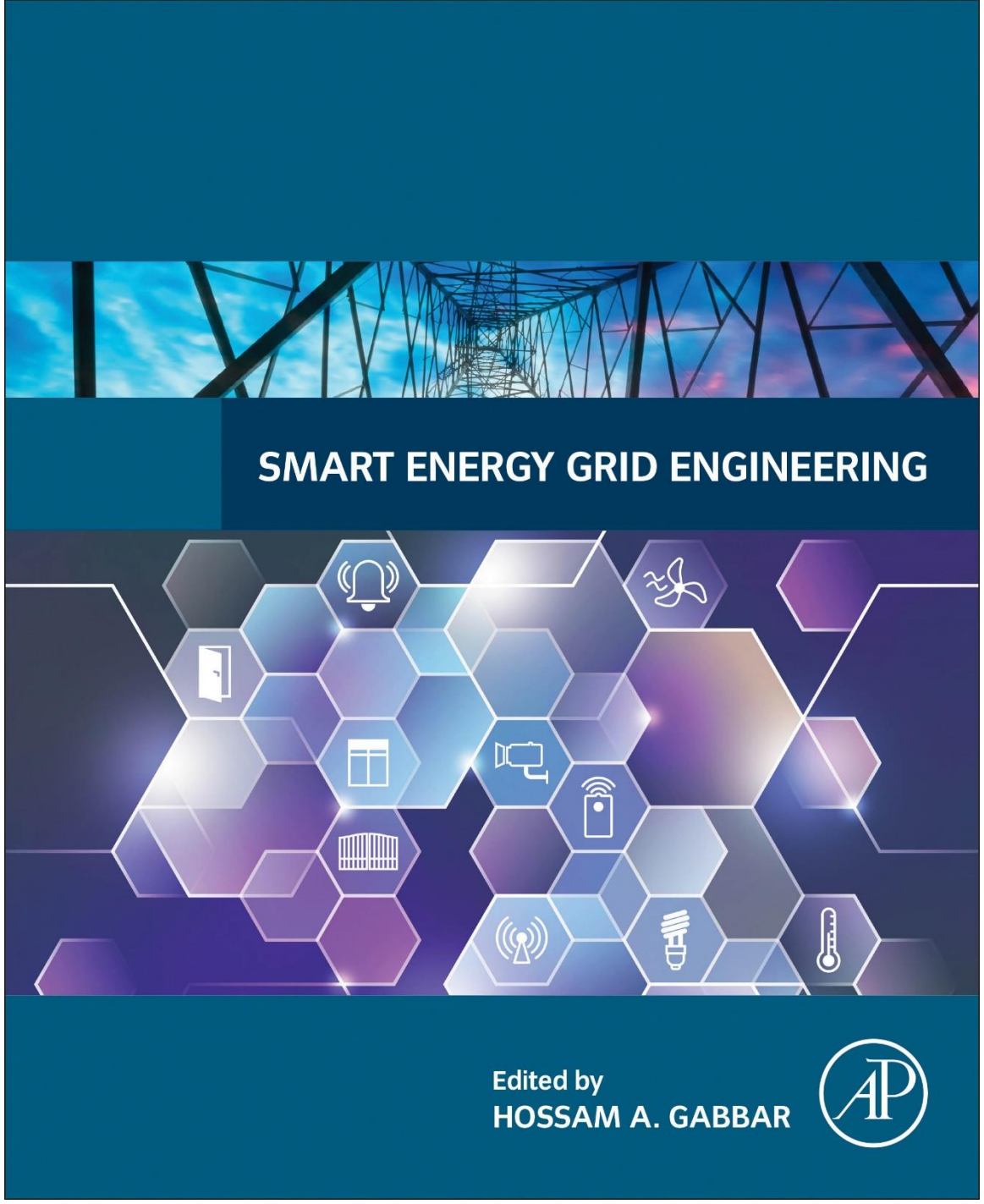
Recent Papers

- Hossam A.Gabbar, Ahmed Othman, Kartikey Singh, Heuristics-based Central Controller in Resilient Microgrids (RMGs) for Transportation Systems, Energy Procedia, Elsevier.
- Hossam A.Gabbar, Jason Runge, Ahmed Eldessouky, Evaluation of Renewable Energy Deployment Scenarios for Building Energy Conservation, AIMS Energy Journal, AIMS Energy Issue 5 Volume 4 2016.
- Hossam A.Gabbar, Aboelsood Zidan, Optimal scheduling of interconnected micro energy grids with multiple fuel options, Sustainable Energy, Journal of Grids and Networks, 2016, Volume 7, Pages 80-89.
- Aboelsood Zidan and Hossam A.Gabbar, DG mix and energy storage units for optimal planning of self-sufficient micro energy grids, Energies, Special Issue on Innovations in Cyber-Physical Infrastructures and Systems for Energy Sustainability in Smart Cities (Accepted)
- Khairy Sayed, Hossam A.Gabbar, Electric Vehicle to Power Grid Integration using Three-phase Three-level AC/DC Converter and PI-Fuzzy Controller, Energies, 2016, 9(7), 532; doi:10.3390/en9070532.
- Hossam A. Gabbar, Ahmed M. Othman, Aboelsood Zidan, Jason Runge, Owais Muneer, Manir U. Isham Negar Honarmand, Mayn Tomal, Enhancing Micro Energy Grid (MEG) Performance by Novel D-FACTS based on GA-ANFIS Integration, International Journal of Automation and Power Engineering (IJAPE), DOI: 10.14355/ijape.2016.05.002, pages: 17-31.
- Ahmed S. Eldessouky, Hossam A.Gabbar, SVC control enhancement applying self-learning fuzzy algorithm for islanded microgrid, AIMS Energy Journal, Special Issue on Smart Grids and Networks, DOI: 10.3934/energy.2016.2.363, 2016, Volume 4, Issue 2, 363-378.
- Yacine Labbi, Djilani Ben Attous, Hossam A.Gabbar, Belkacem Mahdad and Aboelsood zidan, A new Rooted Tree Optimization Algorithm for Economic Dispatch with Valve-Point Effect, International Journal of Electrical Power and Energy Systems Corresponding, Volume 79, July 2016, Pages 298-311.



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- IEEE SEGE: http://sege-conference.com/index.html
- Smart Energy Grid Engineering Book: http://store.elsevier.com/Smart-Energy-Grid-Engineering/Hossam-Gabbar/isbn-9780128053430/

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Thank You