Game Theory Optimisation for Energy Systems Integration

Mel Devine
University College Dublin
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• Game theory optimisation
  • Mixed Complementarity Models
  • Bi-level Optimisation
  • Typically involve stochastic optimisation

- Conventional Generator maximizing profits
- Wind generator maximizing profits
- Consumers Minimising cost
Applications: energy market\systems modelling
  • Electricity market modelling
    • Market Investment Model
      • Demand Response
      • Power to gas
    • Feed-in Tariffs & Renewable Energy Auctions
    • Capacity markets
  • Gas market modelling

Limitations
  • Does not account for integer variables... yet
Example: Electricity Market Investment Model

Generators:

- Maximise profit
- Decisions:
  - Generation
  - Investment/Decommission
- **May exert market power

Consumers:

- Minimise costs
- Decisions:
  - PV or micro generation
  - Load shifting/shedding
  - Investment in storage, PV, Micro generation
Model Uses for Energy Systems Integration

• Research questions so far...
  1. How does Demand Response affect different consumer groups, generator profits, generation investments?
  2. How does market power affect the above?
  3. Power-to-gas
     • Optimal investment in power-to-gas

• Potential areas for collaboration
  • Model does not account for engineering and network constraints
The graph illustrates the consumer costs (in million €) for different levels of load shifting (%). The costs are compared across various load levels: 600 MW, 400 MW, 200 MW, 0 MW, and 600 MW (No MP). As load shifting increases, the consumer costs generally decrease, showing a clear trend for each load level.
Questions

mel.devine@ucd.ie

https://sites.google.com/site/meldevine07/