

PAST

Nash–Cournot Equilibrium and Its Impact on Network Transmission Congestion

Showed how to reduce congestion through strategic models like the Nash – Cournot Equilibrium

$$\max \pi_i(q) = q_i \left(\alpha - \beta \sum_{j=1}^n q_j \right) - a_i - b_i q_i - c_i q_i^2$$

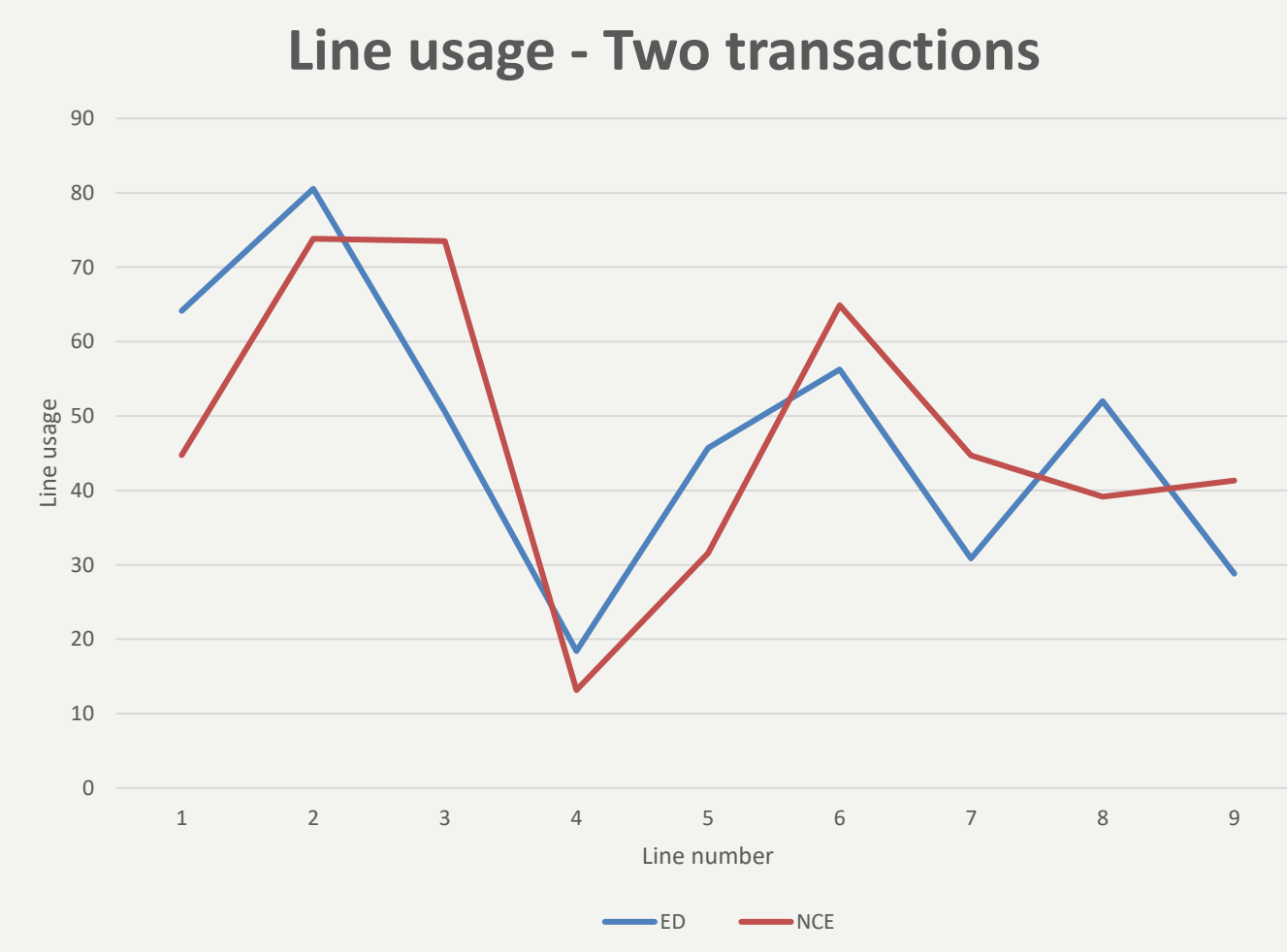
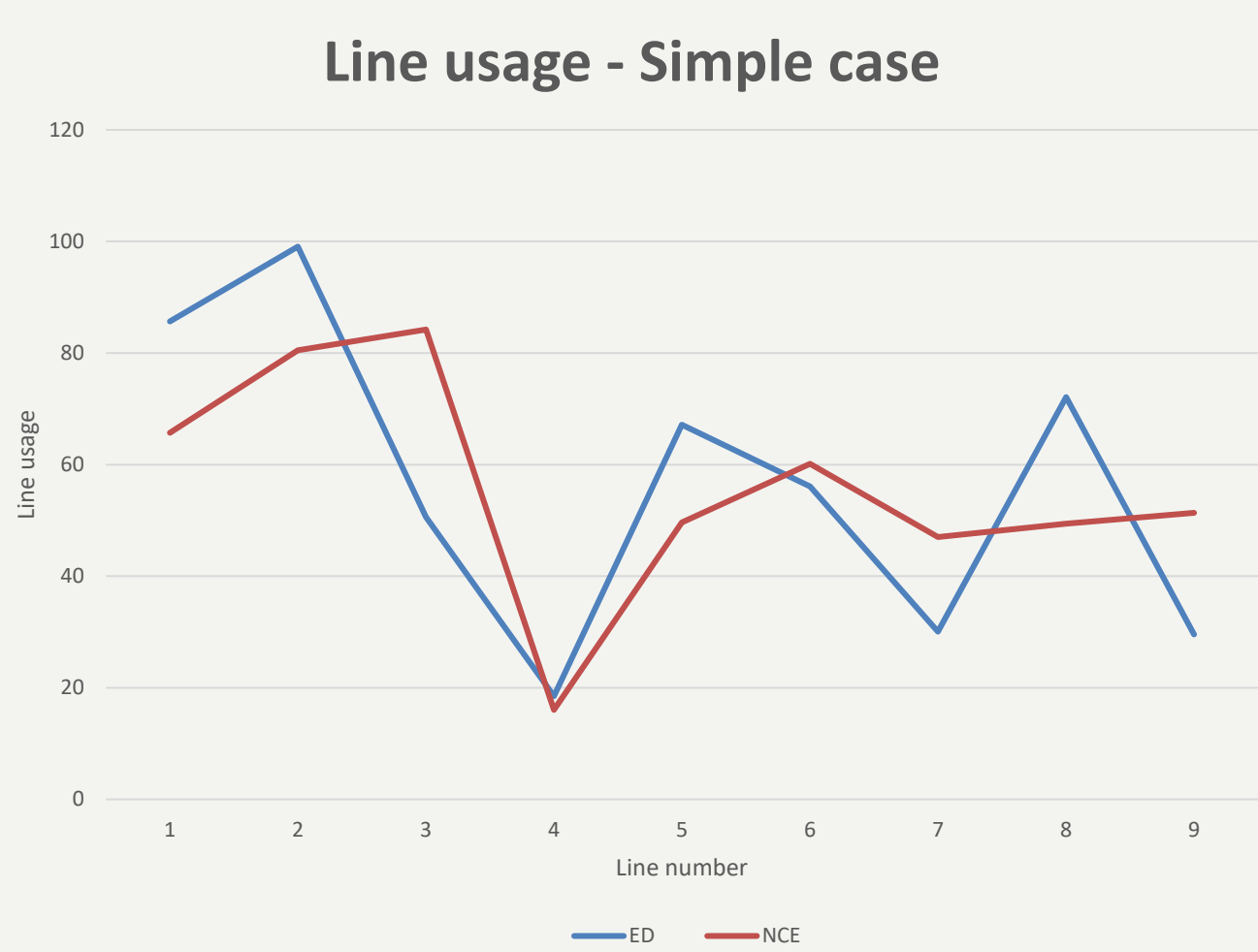
Subject to

$$\delta_i = 0$$

$$\sum_{j \in \mathcal{N}} B_{ij}(\delta_i - \delta_j) + q_i = d_i, \forall i$$

$$q_i^{min} \leq q_i \leq q_i^{max}$$

$$-F_{ij}^{max} \leq B_{ij}(\delta_i - \delta_j) \leq F_{ij}^{max}$$



PRESENT

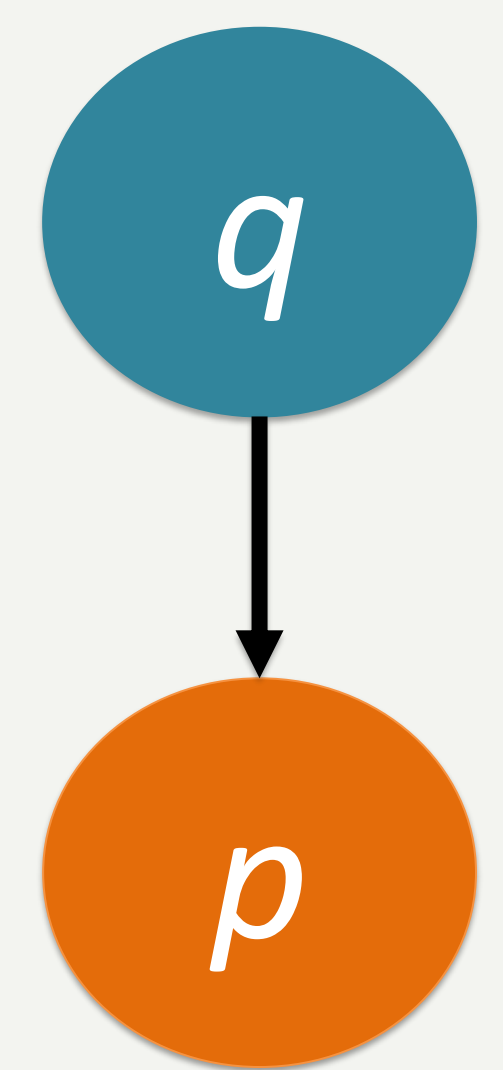
Reactive Power Cost as an Ancillary Service

An MPEC/EPEC formulation for strategic participation in voltage support

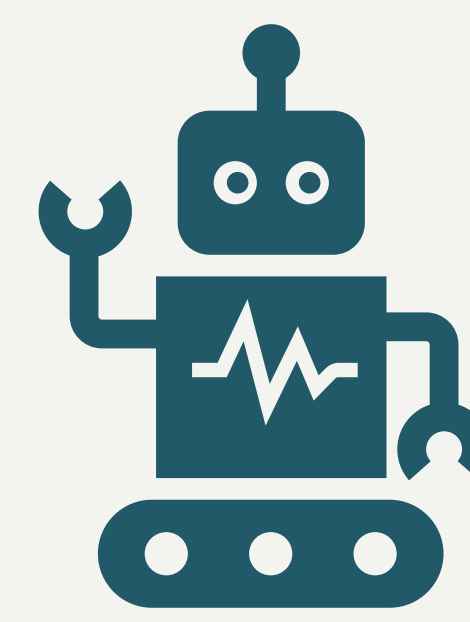
Formulated reactive power payment schemes with a bi-level structure and competition

Addressing challenges of incorporating non-convexities and competition

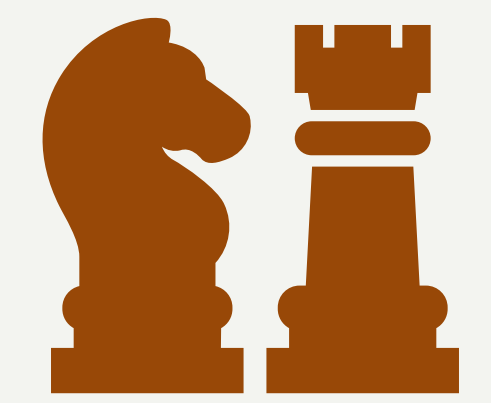
Upper level: Competitor



Lower level: ISO



MARL: Multi – Agent Reinforcement Learning



Game Theory

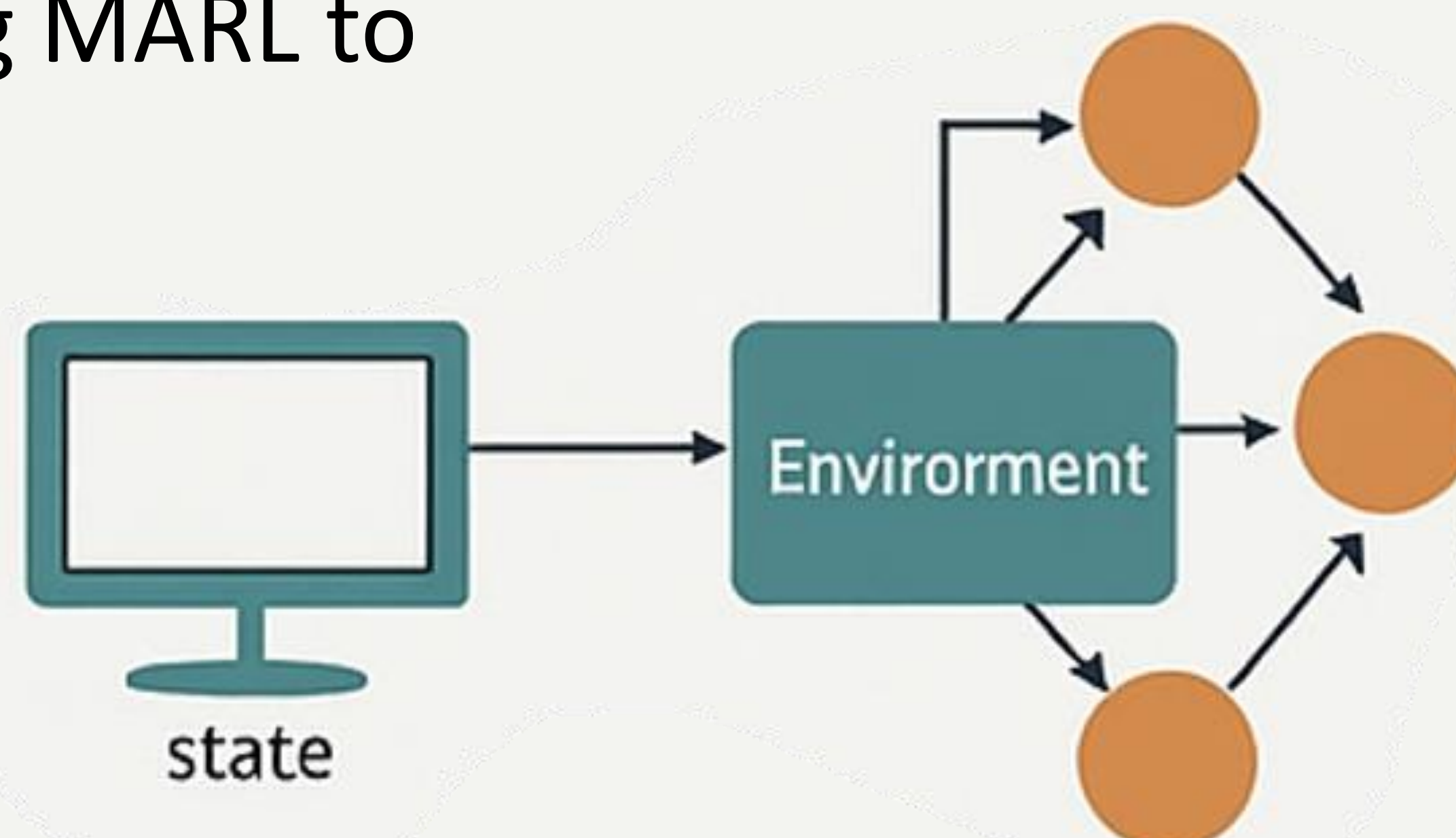
FUTURE

Multi-Agent Reinforcement Learning in Ancillary Services

Towards intelligent agents for dynamic electricity markets

Current interest in applying MARL to learn strategic behavior

Conceptual schematic



Agents can learn when and where to offer reactive power to ensure ancillary service coverage

Past

Present

Future

Understanding strategic behavior in power markets from analytic models to intelligent models