**RESEARCH MOTIVATION**

- Effective coordination of distributed energy resources (DERs) in the presence of operational uncertainties is critical to harvesting their potential benefits.

- Variability and uncertainty associated with renewable generation (RG) present challenges to system operation.

- Loss of life of the battery energy storage system (BESS) needs to be explicitly modeled.

- Approximate dynamic programming (ADP) is a broad umbrella of techniques and algorithms for solving large and complex stochastic sequential decision-making problems.

- Central to ADP is making decisions based on value function approximation to provide a scalable and effective approximation to exact value functions.

- Two iteration strategies: value iteration and policy iteration.

- When problem states and actions become large, existing ADP methods may become less efficient.

**VALUE ITERATION METHOD**

- An innovative deep deterministic policy gradient (DDPG) approach is proposed for optimal DER dispatch with BESS loss of life explicitly modeled.

- DDPG is in the category of action-dependent heuristic dynamic programming, a type of ADP.

**POLICY ITERATION METHOD**

- Objective Function

  \[
  \min (\text{BESS operation and maintenance cost} + \text{energy cost})
  \]

- **Models & Constraints**
  - BESS power and energy limits
  - BESS energy state dynamics
  - BESS power output limits
  - BESS startup and shutdown time
  - Microgrid power balancing
  - Microgrid load from forecast and forecast error

**CONCLUSIONS**

- ADP methods are promising for power system scheduling and dispatch under uncertainties.

- Utilizing the underlying properties of the problem in control design can help enhance exploration capability and thereby learn the dispatch policy more efficiently.

- The proposed ADP methods were validated and evaluated through case studies in both deterministic and stochastic environments.

- The results showed that the proposed approach outperforms the existing ADP approaches in terms of both optimization gap and solution time.

- Case studies also substantiate that incorporating the BESS life loss model into control design can maximize benefits while expanding the BESS service life.

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**References**
