Valuation of Distributed Predictive Information in Robust Economic Dispatch

Prof. Yue CHEN
The Chinese University of Hong Kong
yuechen@mae.cuhk.edu.hk

Valuation of Distributed Predictive Information in Robust Economic Dispatch

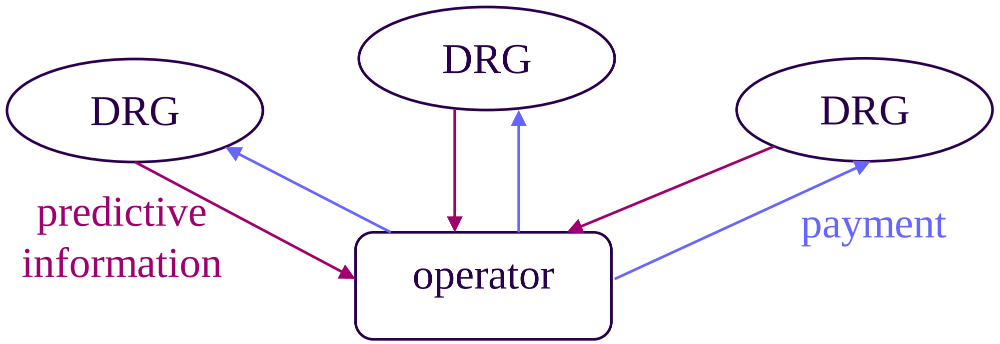
- Background
- Scope of the work
- Work methodology
- Results and achievements
- Conclusion

Background

- Uncertainty arises
  - Distributed renewable generators (DRGs) grow rapidly
  - DRG fluctuates & intermits
  - Operator may not have enough data
  - More information is owned by DRGs
- Robust economic dispatch is a typical way to hedge against uncertainty, but it often ignores distributed predictive information.
- The choice of uncertainty set has a crucial impact on the dispatch strategy

Question: What if the oprerator can buy predictive information from DRGs?

Scope of the Work



System operator:

- **Decides whether to buy information from DRGs**
- **Constructs better uncertainty set based on the information**
- **Conducts robust economic dispatch using the uncertainty set**

Decision-dependent uncertainty (DDU) exists: Information purchase decision (first-stage decision) affects the uncertainty set

Two-stage robust optimization with DDU

Work Methodology

Construct uncertainty set

- Combine operator data and purchased information
- Use estimated expectation and variance.

Develop robust economic dispatch model

- Two-stage robust optimization with decision-dependent uncertainty (DDU)
- Pre-dispatch stage: Decide the reference power and whether to buy predictive information
- Re-dispatch stage: Adjust power for balance

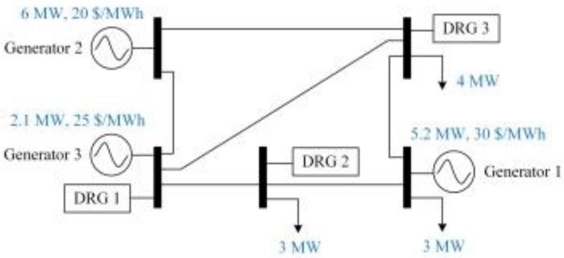
$$\min_{z,p,r} \sum_i C_i z_i + f(p,r) + \max_{u \in \mathcal{U}(z)} \min_{y \in \mathcal{Y}(p,r,u)} g(y)$$

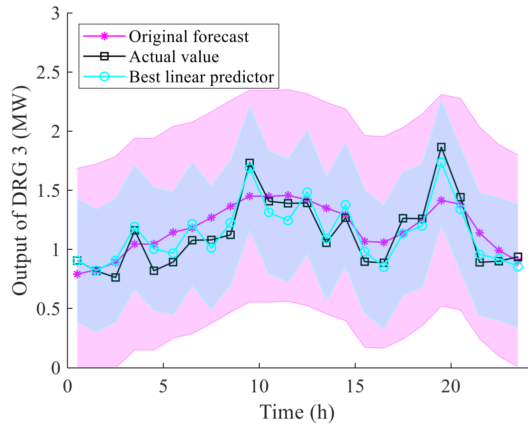
Solve the model

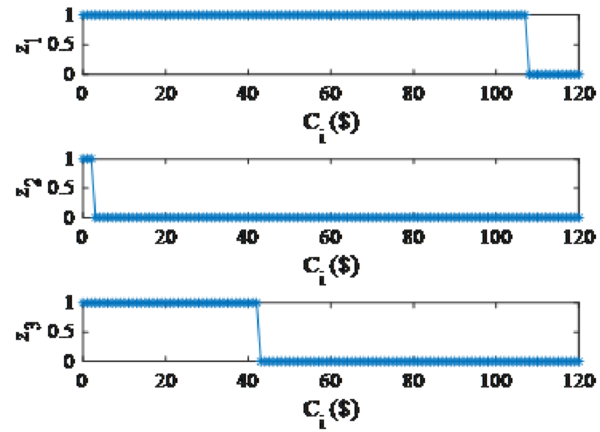
- Transform DDU into decision-independent uncertainty (DIU)
- Solve the problem by C&CG algorithm

Results and Achievements

Case study: A 5-bus system with 3 DRGs







With predictive information, the uncertainty set becomes smaller and still maintains robustness

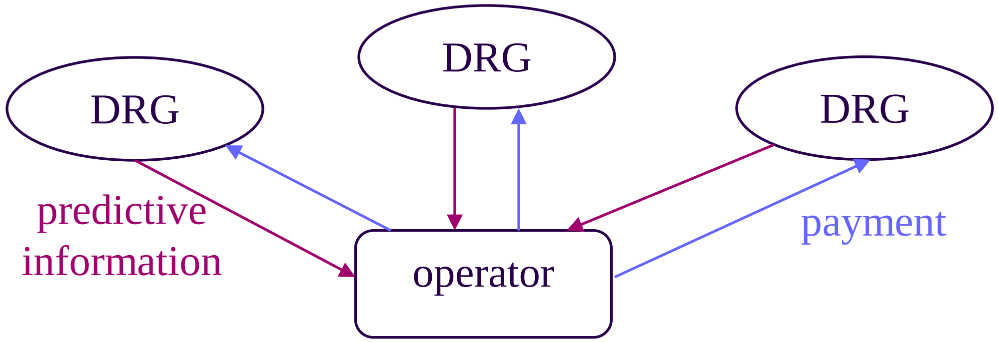
Distributed predictive information helps to reduce the operational cost

Purchase decisions change as the payments change. The critical point reflects the value of information.

Direct application of C&CG algorithm fails to find the optimum

Conclusions

Proposed Framework:



Improve uncertainty estimation and dispatch efficiency

Findings:

Distributed predictive information can help to decrease the operation cost

The transformation of decision-dependent uncertainty (DDU) into decision-independent uncertainty (DIU) is necessary before applying the C&CG algorithm

The distributed predictive information of the DRG with a larger variance tends to be more valuable

Thank You