# Impact of Grid Reconfiguration in Distribution Market Clearing and Settlement

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# Introduction

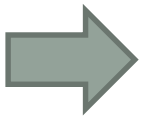
**Distributed energy resources (DERs) advantages:**

- Increasing the distribution system reliability and resiliency
- Allowing consumers to partially or fully supply their demand

**DERs disadvantages:**

- Adding technical complexity to grid management

As a result, distribution grid management becomes a concern of upstream grid operators when DERs deployment in distribution system increases.



The necessity of DSO to manage the distribution grid and solve this added complexity in a local manner.

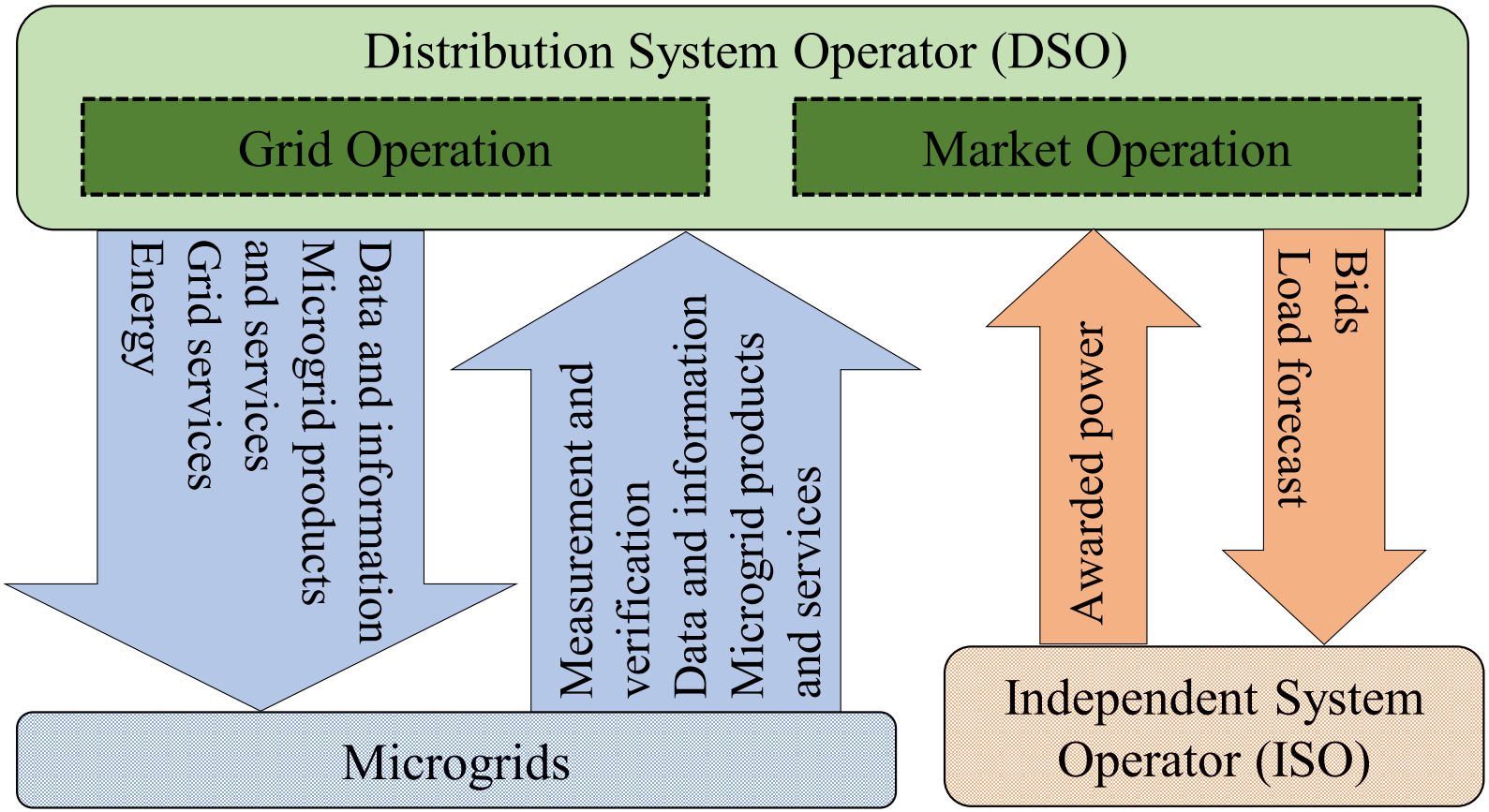
# Introduction

**The DSO advantages for the distribution system:**

- Managing the grid and market operation of the distribution system
- Allowing participation of the proactive customers in energy market within distribution system
- Removing the uncertainty of flexible loads (microgrids net load)
- Reducing the required two-way communications between the ISO and proactive customers

# Introduction

The market structural in presence of the DSO:



# Problem Statement

**Grid reconfiguration can help with:**

- Maximizing the social welfare in the distribution market
- Providing a level of flexibility in distribution markets
- Better utilization of distributed resources
- Increasing participation of proactive customers in grid operation and market

# Distribution System Clearing Model

**The objective function of the proposed model:**

- Maximizing the system social welfare
- Simultaneously finding the optimal reconfiguration of the grid
  - The system social welfare is defined as the load benefit of flexible loads (microgrids) minus the cost of purchasing energy from the upstream grid.

**The objective function is subject to the following constraints:**

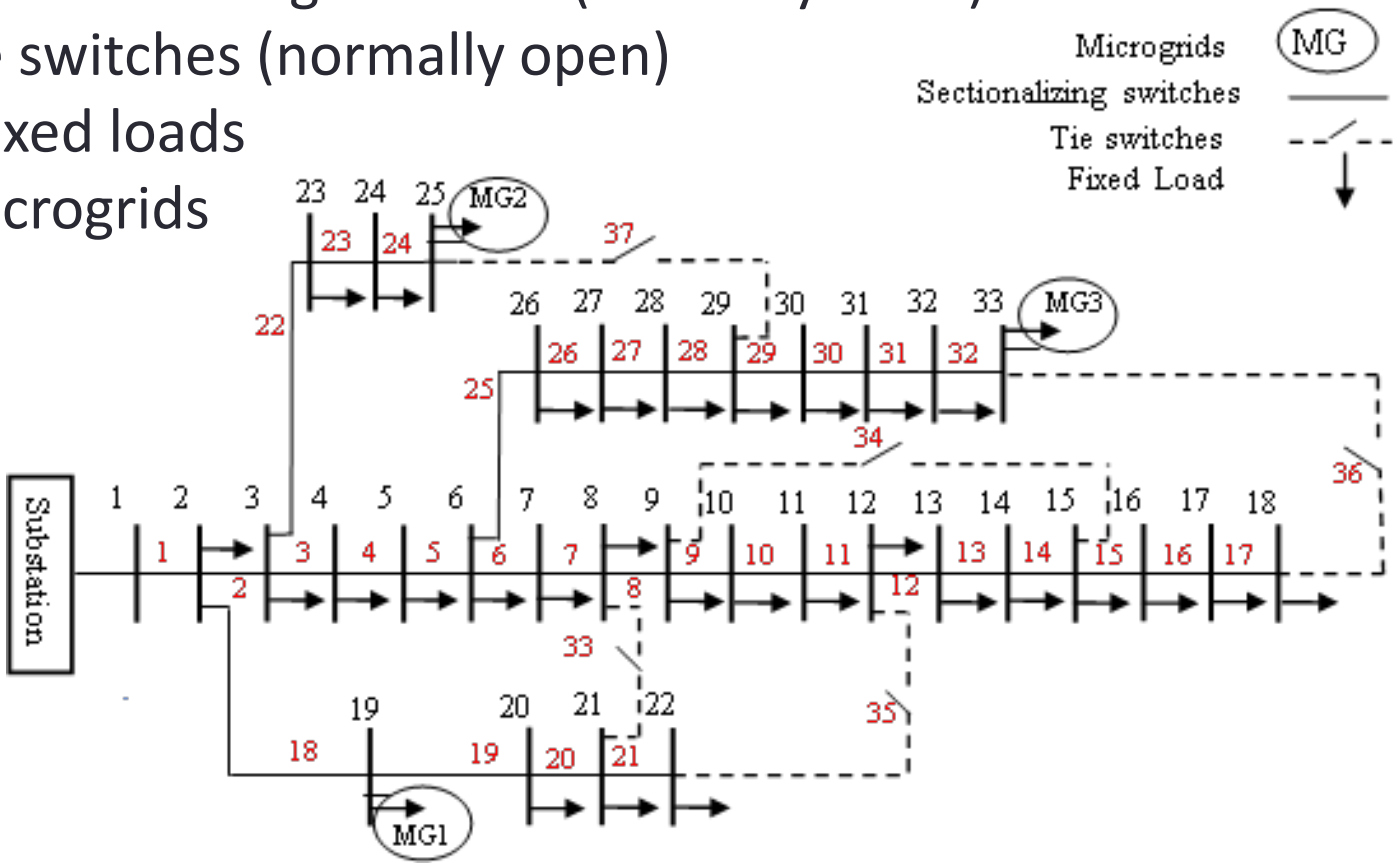
- Operation and power flow constraints
- Nodal balance constraint
- The radiality constraint: Keep the grid radial without forming loops.

*** Detailed mathematical formulation is available in the paper.**

# Numerical Simulation

**Using modified IEEE 33-bus test system with:**

- 33 buses
- 32 sectionalizing switches (normally close)
- 5 tie switches (normally open)
- 29 fixed loads
- 3 microgrids




The IEEE 33-bus distribution test system

# Numerical Simulation

The potential loops

| Loop No. | Lines in the loop |
|---|---|
| **1** | 2, 3, 4, 5, 6, 7, 18, 19, 20, 33 |
| **2** | 9, 10, 11, 12, 13, 14, 34 |
| **3** | 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 18, 19, 20, 21, 35 |
| **4** | 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 25, 26, 27, 28, 29, 30, 31, 32, 36 |
| **5** | 3, 4, 5, 22, 23, 24, 25, 26, 27, 28, 37 |

Microgrids' Characteristics

| **Segments** | **1** | | **2** | | **3** | |
|---|---|---|---|---|---|---|
| | Quantity (kW) | Price ($/kW) | Quantity (kW) | Price ($/kW) | Quantity (kW) | Price ($/kW) |
| **MG 1** | 500 | 0.065 | 300 | 0.039 | 200 | 0.027 |
| **MG 2** | 450 | 0.072 | 350 | 0.065 | 200 | 0.029 |
| **MG 3** | 400 | 0.085 | 400 | 0.064 | 200 | 0.035 |

# Numerical Simulation

**The model is solved for the following cases:**

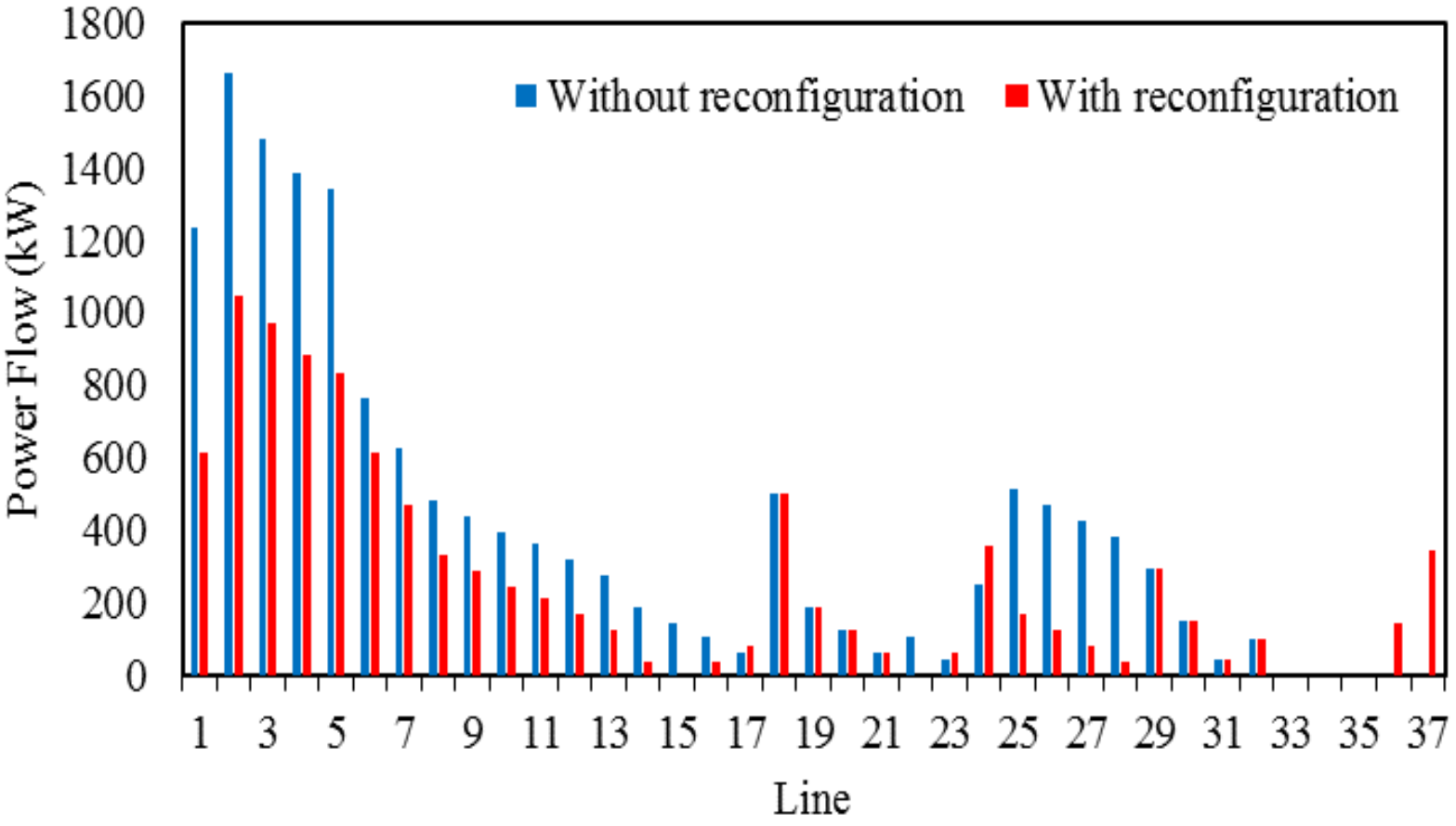
- Without grid reconfiguration (forcing all tie switches to stay open)
- With grid reconfiguration (allowing switches to be closed or open, considering radiality constraint)

**Comparison between results of Cases 1 and 2:**

| | | Without Reconfiguration | With Reconfiguration | Change |
|---|---|---|---|---|
| **Social Welfare ($)** | | 150.54 | 153.56 | 2% |
| **Upstream power purchase (kW)** | | 1233.09 | 616.76 | -49.98% |
| **Microgrids power (kW)** | MG1 | 703.949 | 753.949 | 7.1% |
| | MG2 | 600 | 1000 | 66.67% |
| | MG3 | 142.418 | 290.765 | 104.16% |
| **Power Loss (kW)** | | 59.46 | 41.47 | -30.26% |
| **Upstream grid payment ($)** | | 86.32 | 43.17 | -49.98% |

# Numerical Simulation

**Power flow comparison between cases 1 and 2**



# Conclusion

- **The model advocated that the reconfiguration can provide:**
  - A level of flexibility in distribution markets to improve the system social welfare
  - Better utilization of distributed resources within radial distribution grids
  - Capability to serve as a congestion relief and loss reduction method by revising the power flow within the grid

Thank you

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