A Distributed Scheduling Algorithm of Microgrid Cooperation

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Microgrid (MG)

Definition:

- Intelligent power distribution system
- Load and distributed resources (generator and stroage)
- Grid-connected and islanded

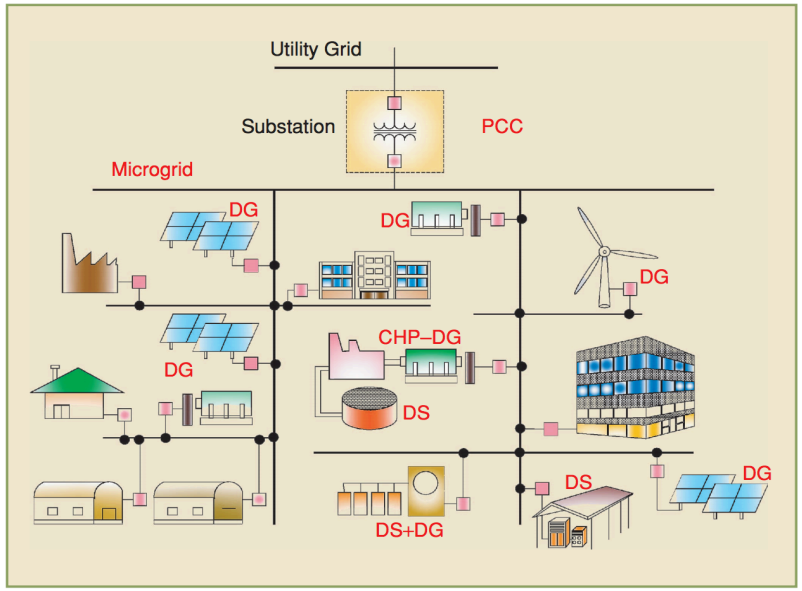


figure 1. A typical microgrid structure including loads and DER units serviced by a distribution system.

Characteristics of MG

- Localized control system:
  - Intelligent energy management
  - Distributed Grid intelligence: utilize communication network to coordinate with the other MGs and utility grid.
  - Work on both grid-connected and autonomous mode.
  - Seamless switch between two modes (plug-and-play)

Improve the flexibility, reliability, distributed intellgence and reduce power transmission loss.

MG Cooperation

Coordinated Operation of multiple MGs

- Power sharing
- Storage capacity sharing
- …

Advantages of MG cooperation:

- Exploit the renewable energy penetration [1][2]: exploit the diversity in energy production across geographically distributed areas
- Exploit power capacity[3][4]
- Reduce end user cost[4][5]
- Reduce power loss[5]
- ….

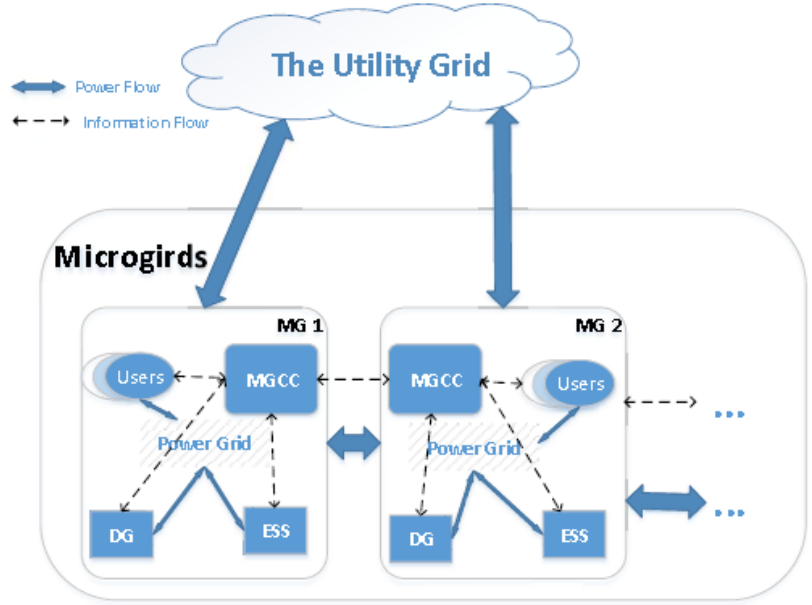


Figure 1: System Model.

[1] Ouammi, A.; Dagdougui, H.; Dessaint, L.; Sacile, R., "Coordinated Model Predictive-Based Power Flows Control in a Cooperative Network of Smart Microgrids," IEEE Transactions on Smart Grid , vol.PP, no.99, pp.1,1

[2] Y.-H. Wan, A primer on wind power for utility applications. National Renewable Energy Laboratory Golden, 2005.

[3] J. Matamoros, D. Gregoratti, and M. Dohler, "Microgrids energy trading in is-landing mode," 2012 IEEE Third International Conference on Communications in Smartgrid (SmartGridComm),, Nov 2012, pp. 49–54.

[4] Rahbar, Katayoun, Rui Zhang, and Chin Choy Chai. "Privacy constrained energy management for self-interested microgrids." Acoustics, Speech and Signal Processing (ICASSP), 2015 IEEE International Conference on. IEEE, 2015.

[5] J. Vasiljevska, J. P. Lopes, and M. Matos, "Evaluating the impacts of the multi-microgrid concept using multicriteria decision aid," Electric Power Systems Research, vol. 91, pp. 44–51, 2012.

An Adaptive Distributed Scheduling Algorithm of MG Cooperation

Objective: Improve the long-term utility function of MG Network (MG) by MG cooperation.

- Power Scheduling among MGs
- Charging/discharging of ESS
- Power transactions between MG and the utility Grid

Method

- Lypunov Optimization
- Virtual Queue Technology

Theorem 2. *Given $X_i(0) = 0$ and $0 \le V \le V_{max}$. Applying* ***DOPS*** *ensures the following performances:*

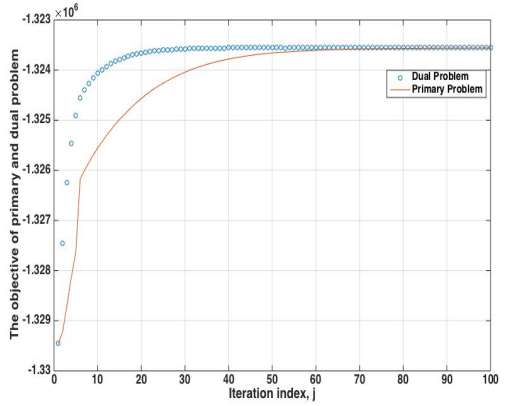
$$1.\ \lim_{t\to\infty} \frac{1}{t}\sum_{\tau=0}^{t-1} X_i(\tau) \le B * V \tag{24}$$

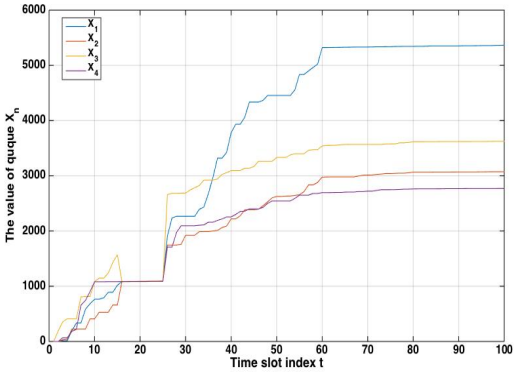
$$2.\ f^{DOCPS} - f^* \le \frac{B}{V} \tag{25}$$

where B is a positive constant independent of V and its expression can be found in the proof below, f^{DOCPS} and f^* denotes the value of objective function achieved by DOPS and the optimal performance in theory, respectively.

Algorithm 1 Distributed Online Cooperative Power Scheduling for MGs Cooperation (DOCPS)

procedure DOCPS OF MG i IN TIMESLOT t
  $\lambda_i(0) \leftarrow \lambda_i^0$ *and broadcast them to all the connected MGs of MG* i.
  $k = 1$.
loop:
  if $\lambda_i(k) - \lambda_i(k-1) \le \sigma$, where σ is the stop criterion. **then**
    Receive all $\lambda_j(k)$.
    Calculate $S_{i,j}^*, C_i^*,$ *and* H_i^* *by solving the problem of* (17).
    Broadcast $S_{i,j}^*$ *to all the connected MGs.*
    Receive all $S_{j,i}^*$ *and update* $\lambda(k+1) = \lambda(k) + \alpha\{L_i + H_i^* - \sum_{j\neq i} S_{j,i}^* A_{j,i}\eta_{j,i} - G_i\}$, *where* α *is the constant step size of* λ_i *loop.*
    Broadcast $\lambda_i(k+1)$ *to all the connected MGs.*
    $k = k + 1$.
    close;
  $i \leftarrow i + \max(delta_1(string(i)), delta_2(j))$.
  goto *top.*





FUTURE WORK

1. Reliability assessment of MGN
2. Improve the system reliability by MG cooperation