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Provisional Micro grid For the Perfect Power System

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Abstract: With a new class of micro grids called provisional micro grids for perfect power system is introduced in this proposal. Provisional micro grids holds similar characteristics as micro grids however do not possess the islanding capability and are dependent on one or more electrically connected micr grids for islanding purposes. Removing the islanding requirements and relying on the available unused capacity of existing micro grids, characterizes provisional micro grids as enablers of rapidly deploying variable generation renewable energy resources in distribution network and further grids for preventing underutilization of capital-intensive distributed energy resources in a micro grids.

***Keywords*:** Distributed energy (DER), islanded operation, optimal scheduling, and provisional micro grids, robust optimization

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1 Introduction

The micro grid as defined by the U.S Department of energy is a group of interconnected loads and distributed energy resources (DERs) with clearly defined electrical boundaries that act as a single controllable entity with respect to grid and can connect and disconnect from the grid to enable it to operate in both grid connected or island modes. The DERs consist of distributed generators and energy storage which could be installed at electricity consumer's premise's to provide a local supply of loads. Based on this definition. the Der Deployments must have three distinct characteristics to be considered as a micro grid the electrical boundaries are clearly defined, a master controller is present to control and operate available resources as a single controllable entity and installed generation capacity exceeds the peak load for enabling islanded operation. The micro grid islanding capability enables the micro grids to be disconnected from the main grid in case of upstream disturbances or voltage fluctuation's. The Islanded operations of micro grid's provides significant social cost savings and load point reliability enhancements during major outage's which would justify the islanding design as part of micro grid planning decisions. This feature however may result in some drawbacks which are being identified as more micro grids are installed worldwide. First, islanded operation requires that the micro grid installed generation capacity exceeds the critical local loads. The micro grid master controller cannot rely on generation of non dispactahable units for this purpose. These units which primarily included renewable energy resources, such as solar and wind, produce a variable generation which cannot be controlled and there is always a possibility that the forecasted generation is not materialized. This issue is further boosted by the relatively higher capital cost of renewable energy resources compared to gas-fired plants. The second issue is the underutilization of the installed dispacthable capacity. The main power grids power benefits from economies of scale in generation, and even by accounting for transmission and distribution cost and associated losses, it is normally less expensive than the generation price of local dispacthable units. Local dispacthable units may be more economical than the main grid power when the transmission network is congested and the real-time market price is high. This case however mainly occurs in peak hours.

2) Provisional Micro grids

Provisional micro grids are similar to micro grids as their electrical boundaries are clearly defined and a master controller controls and operates available resources. Unlike micro grids however, provisional micro grids do not have the ability to be islanded on their own. Provisional micro grids as the name suggest are dependent on one or more electrically connected micro grids called coupled micro grids henceforth switching to an islanded mode. Provisional micro grids could utilize a high percentage of renewable energy resources without concerning islanding requirement. When islanding is needed, the provisional micro grid would be disconnected from the main grid distribution network. The provisional micro grids could be considered as viable solution to a more rapid deployment of variable generation renewable energy resources.in distribution networks and further prevent underutilization of capital – intensive DERs in micro grids.

2.1 Rationale

The idea behind the deployment of provisional micro grids is that by removing the islanding requirement there would be no need to deploy a high percentage of dispacthable units hence any generation mix could be deployed. Therefore, a high percentage of variable generation resources without concerning about islanding requirement could be installed. This deployment however, is contingent upon low critically and sensitivity of local loads. By deploying the variable generation resources it would be guaranteed that the installed capacity would not be underutilized as the generation of these resources will be used once it produced regardless of the main grid price.

2.2 Operation

The core operational actions of provisional micro grids are depicted and are defined as follows.

1) Provisional Micro grids generate energy by coordinating available resources and interact with the main grid and coupled micro grids for power transfer to supply local loads in normal (i.e. grid connected operation).
2) Provisional micro grids disconnect from the main grid distribution network and transfer power with the coupled micro grids for supplying locals loads in islanded operation .It is assumed that the connection between the provisional micro grids. It is assumed that the connection between the provisional micro grid and coupled micro grid will be maintained during islanding. The connection will ensure mutual benefit for both coupled micro grid and provisional micro grids, since the coupled micro grid would benefit by selling its unused capacity to the

eneration is not available to supply local loads, the islanding cut is represented in the provisional micro grids, and the provisional micro grids would purchase power in the islanded mode for increasing its reliability. It is assumed that the connection between the provisional micro grids and coupled micro grid will be maintained during islanding. The connection will ensure mutual benefit for both coupled micro grid and provisional micro grids. Since the coupled micro grid and provisional micro grid would purchase power in the islanded mode for increasing its reliability .The provisional micro grids and the provisional micro grids would purchase power in the islanded mode for increasing its reliability. The provisional micro grid would further rely on the coupled micro grid for frequency regulation and voltage control in case dispacthable unit deployment is limited in the provisional micro grid.

3 Optimum Constrained Scheduling Algorithm:

The optimum model for provisional micro grids is developed and shown the flowchart in Fig. 2, how to optimize the model of it.The problem is decomposed into master problem and sub problems. The master problem determines the optimal scheduled of available disptachable DER”s as well as adjustable loads. The obtained binary solutions will be used in sub problem 1 islanded operation to examine power mismatches when islanded. If mismatches are not zero i.e. sufficient generation is not available to supply local loads, the islanding cut is generated and added to the master problem for revising the current scheduled ,which is an iterative manner between the master problem subproblem1, will be used in sub problem 1, i.e. islanded operation to examine power mismatches when islanded. If mismatches are not zero i.e sufficient

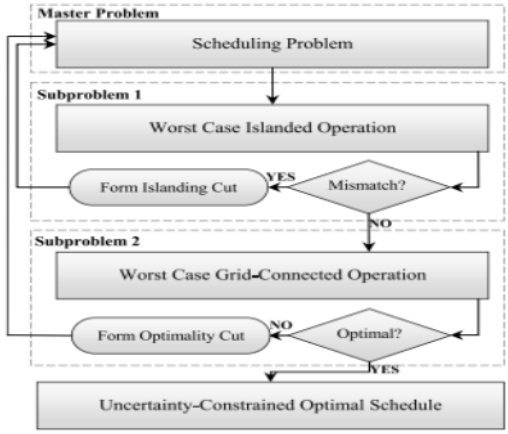

Fig.2 Flowchart for Proposed Optimum Scheduling Agent

form of an inequality constraints which provides a lower estimates of the total mismatch in the sub problem as a function of scheduling variables in the master problem. The islanding capable schedule, which is obtained in an iterative manner between the master problem and subproblem1, will be used in subproblem2 i.e. grid connected operation to determine the optimal dispatch of local DERs and also interconnections with main grid and coupled micro grid. If the solution does not satisfy a predefined optimally criterion, the optimality cut is formed and sent back to master problem for revising the current schedule. The optimality cut is represented in the form of inequality constraints which provides a lower estimate of the total operation cost as a function of scheduling variables in the master problem. The iterative procedure will continue until the final schedule which means both islanding and optimality criteria is obtained.

3.1 Component Modelling

Dispatch' able units, energy storage and adjustable loads are scheduled by the micro grid master controller. A mixed integer programming representation of these components is required as a primary step tomodel micro grid scheduling problem. The components models are found however these are used in problem formulation. On dispatch able generations as well fixed loads are obtained based on forecast, hence treated as constants in problem formulation. As well as fixed loads are non dispacthable generations as well as fixed loads are obtained based on forecast, hence treated as constant in the problem formulation. The dispatch'able unit generation is subjected to minimum and maximum generation capacity limits.

1) Ramp up and ramp down rate limits.
2) Minimum up and down time.
3) A dispacthable unit can be further to fuel emission limits based on the unit type.
4) A dispatch able unit can be further subject to emission limit based on the unit type.
5) The energy storage power is subjected to charging and discharging minimum and maximum limits .energy storage charging power is consider as negative. Hourly studies are performed where the time period is considered to be 1h.

3.2 Problem Formulation

1) Scheduling (Master Problem):The master problem is proposed as follows:

$$\min\sum\sum[\, c^{io}Iit+SUi+SDi] + \sum KdΔd +Λ \text{-------(1)}$$

The master problem comprises three terms associated with disptachable units, adjustable loads and grid connected operation cost. The no-load startup and shut down cost of dispatch able units are calculated in the master problem since all are dependent only on binary commitment variables. The operation costs of energy storage and adjustable loads are zero. The master problem formulation includes only binary scheduling variables associated with

dispatch able units, energy storage and adjustable loads.

2) Islanded operation. The objective of the islanded operation problem is to minimize power mismatches when islanded.
Max min w=∑(SL1,t +SL2,t)----------
---------- (2)
The power balance equation ensures that the sum of power generated by DERs, power from the main grid≤ and power from the coupled micro grid matches the hourly load. The energy storage power can be positive, negative, or zero. The main grid power can be positive, negative or zero. The coupled micro grid power can be positive (import), negative (export) or zero. Slack variables which are both non negative, characterizes virtual generation and load in the provisional micro grid and represents the mismatch between the variable generation and load.

3) Grid Connected Operation ---The objective of the grid connected operation problem is to minimize the micro grid total operation cost.
Max minQ=∑∑ ciPit+∑Pm,t PM,t+ ∑PCM,tPcm,t
∑Pit + PM,t+ PCM,T=∑Ddt-LSt
-PM max≤ P M,t ≤ PM min
PCM,t min≤ PCM,t≤PCm,t max

The first term in the objective is the operation cost of dispatch able units in the provisional micro grids, which includes generation cost over the entire scheduling horizon. The no-loads startup, and shut down cost are excluded as these cost are already considered in the master problem objective. The generation cost is approximated by a single –step linear model. The second term is the cost of power transfer from the main grids based on the market price at the point of common coupling. When the provisional micro grids excess power is sold back to the main grid PM, t would be negative, so this term would represents a benefit rather than a cost. The last term is the cost of power transfer from the coupled micro grid. When the excess power is sold back to main grid Pm,t would be negative ,so this term would represents a benefit rather than a cost. The last term is the cost of power transfer from the coupled microgrid. When the provisional micro grid excess power is sold back to the coupled micro grid Pcm,t would be negative ,so this term would benefit rather than a cost. Achieve
In this the concept of provisional micro grids was introduced and optimal scheduling was developed for demonstrating the merits of this new class of micro grids. An extensive discussion of provisional micro grids will be studied .In this concept of provisional micro grids however is needed. Further the studies which will be built upon the provisional micro grid concept and short term operation included but are not limited to optimal planning of provisional micro grid with the objective of economically justifying the provisional micro grids with the objective of economically justifying the provisional micro grid deployments, control studies for ensuring the frequency and voltage within limits during grid connected and islanded mode.

CONCULSION

A new class of micro grids called provisional micro grids was proposed in the paper to address prevailing challenges in micro grids deployment associated with islanding requirement .An uncertainty constrained optimal scheduling model was to proposed to efficiently model the day ahead operation of provisional considering prevailing operational uncertainties .The robust optimization was employed where the original problem was decomposed into

smaller and coordinated problems for uncertainty consideration. In this paper the concept of provisional micro grids was used and optimal scheduling model was developed. Which demonstrates the provisional micro grids merits and extensive discussion on the provisional micro grid

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