Analysis of Electricity Markets with Constraints

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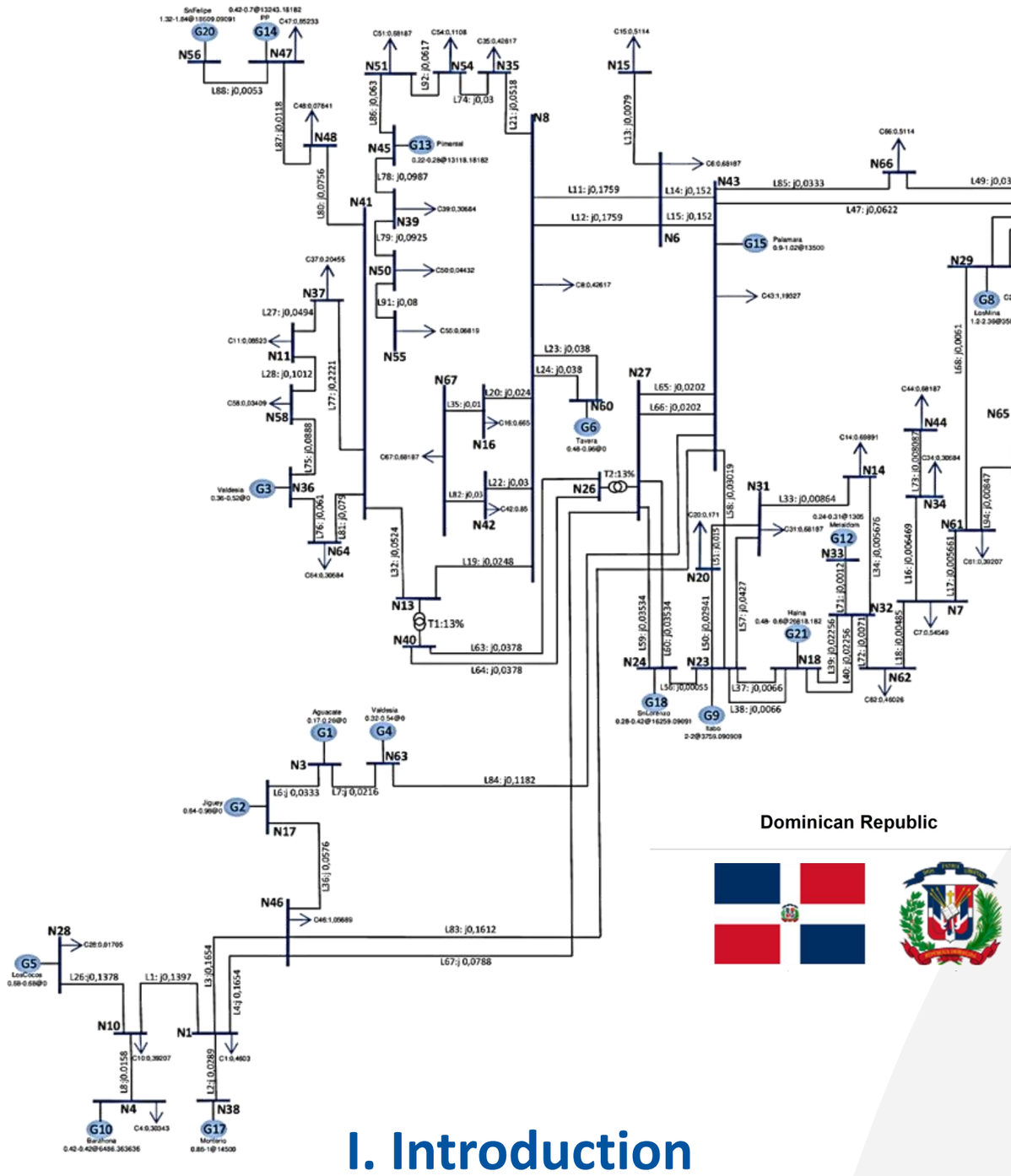
Abstract

Constraint satisfaction techniques are mechanisms that can be used to ensure that all transactions in a electricity market can be completed without violating any operating limits. This is an important issue in an electricity market, because an improper handling of the constraints can divide the system and have a significant impact on the ability of the individual players to exercise market power. The main purpose of this paper is to present a methodology to guarantee a safe unit commitment in normal operation and after contingencies, using re-dispatch techniques after a topological analysis.



No	Bus	Pmin (MW)	Pmax (MW)	USDólar/ MWh
G1	3	17	26	0
G2	17	64	98	0
G3	36	36	52	0
G4	63	32	54	0
G5	28	68	68	0
G6	60	48	96	0
G7	2	160	304	21,59
G8	29	120	236	35,86
G9	23	200	200	37,59
G10	4	42	42	64,86
G11	59	87	100	121,84
G12	33	24	31	130,5
G13	45	22	28	131,18
G14	47	42	70	132,43
G15	43	90	102	135
G16	30	16	24	138,06
G17	38	86	100	145
G18	24	28	42	162,59
G19	53	210	294	179,14
G20	56	132	184	186,1
G21	18	48	60	268,18

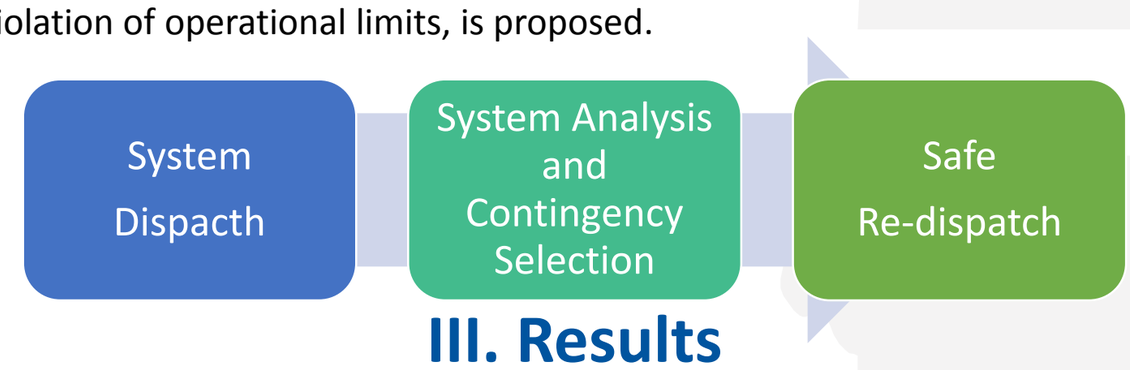
Typical generation at 20:00.
Dispacth and Re-dispacth Results.

I. Introduction

This poster presents a methodology to guarantee a safe unit commitment, and illustrates its application to the Dominican Republic power system. The aim is to fulfill demands of the market in terms of safety and economy, ensuring transparency among participants. For this purpose, the system is modeled under normal operation and with contingencies.

II. Methodology

Based on simple merit-order scheme, the market operator determines the commitment and the market clearing price. With the unit commitment, a topological analysis of the electrical system is performed to detect weaknesses under normal operation and with contingencies. Then a re-dispatch that takes into account the recommendations to guarantee safe operation of the system, so that transactions can be achieved without the violation of operational limits, is proposed.



III. Results

The Dominican Republic power system is used to test the methodology with a representative example, an insular system with a radial transmission network and a main link of 345 kV. For this system, the lines are classified according to how they are affected by a fault. An application was developed that classifies lines into four different types.

Type 1: Radial lines. Their fault causes isolation of generators and/or loads.

Type 2: Lines that, when in a fault, cause the division of the system into two unconnected parts.

Type 3: Lines whose shutdown does not affect the operation of the system or the market clearing price.

Type 4: Lines whose shutdown forces the re-dispatch of the system.

Line type	1	2	3	4
%	13	13	54	20

An analysis of the market clearing price using the traditional and the proposed methodologies shows that for peak demand using the traditional methodology the marginal price is 179.14 US$/MWh, generators 1 to 19 are dispatched. On the proposed methodology, the marginal price is 268.18 US$/MWh, generators 1 to 21 are dispatched.

IV. Conclusion

The proposed methodology avoids late entry to the unit commitment of generators out of merit, at high price, in case of contingency. The market operator evaluates the combination of the different prices, the probability of contingencies and its duration, and determines whether it is economically profitable for all participants in the market. This analysis allows the market operator and the system operator to establish policies to overcome the weaknesses identified. In addition, it allows to define a competitive electricity market to ensure equal participation and allows the transparent participation of the new members.

References

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