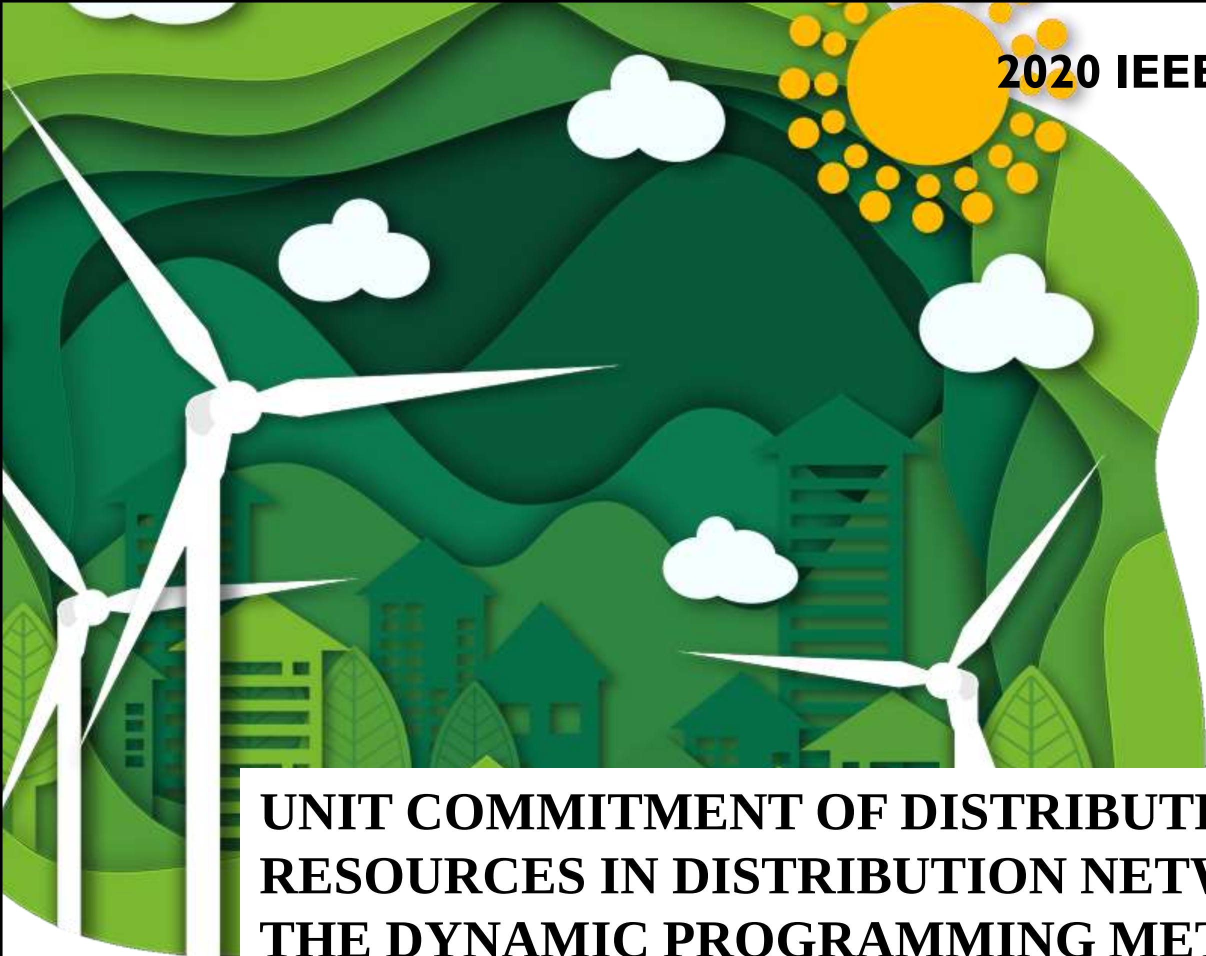

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UNIT COMMITMENT OF DISTRIBUTED ENERGY RESOURCES IN DISTRIBUTION NETWORKS USING THE DYNAMIC PROGRAMMING METHOD

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INTRODUCTION

- As the usage of the RES increases, the need for developing a method which optimizes the unit arrangement in the power network consisting of RES also increases.

- In this paper, a method based on dynamic programming is proposed for the unit commitment of DERs connected to the distribution power network.

- The case study: distribution network with photovoltaic (PV) generator, wind power plant and run-of-river (ROR) hydropower plant.

THE PROPOSED METHOD

- The proposed dynamic programming-based method analyses the availability and power generation capability of the DERs installed and proposes an optimal unit commitment solution minimising the costs and analysing their availability for satisfying the power demand.

- Then, the availability defines in the following manner:

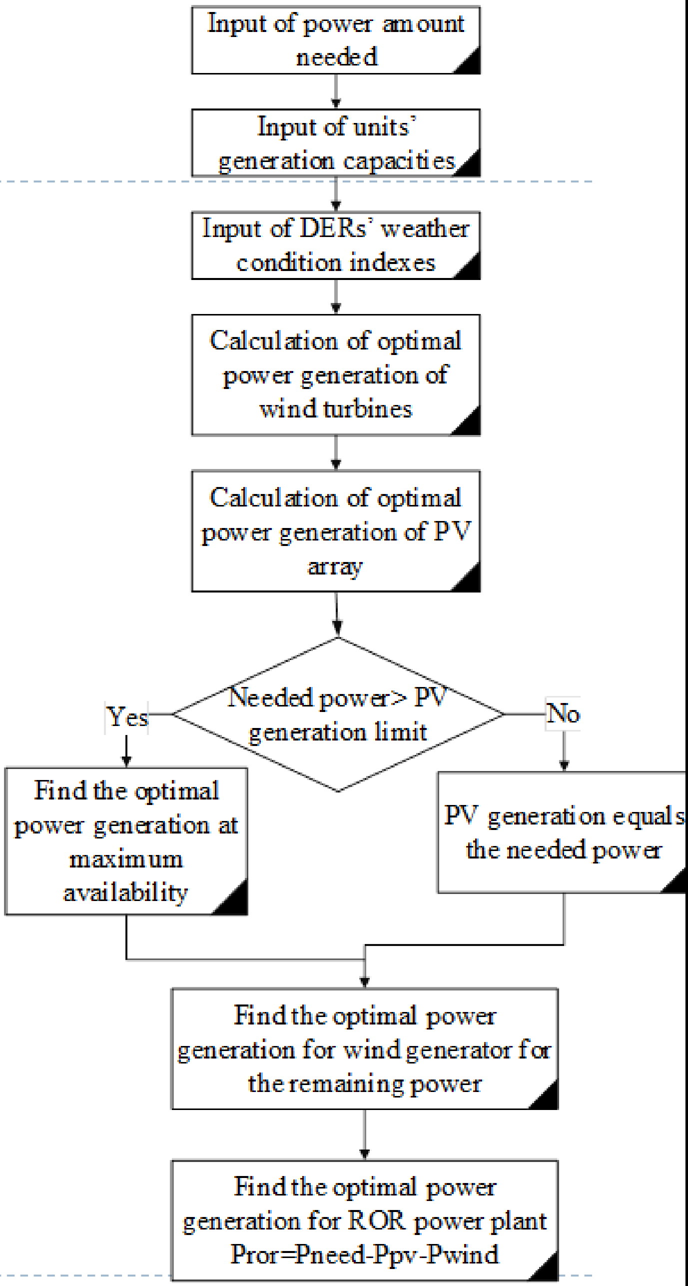
$$A_i(P_i) = f\big(W_i(P_i), C_i(P_i)\big)$$

THE PROPOSED METHOD

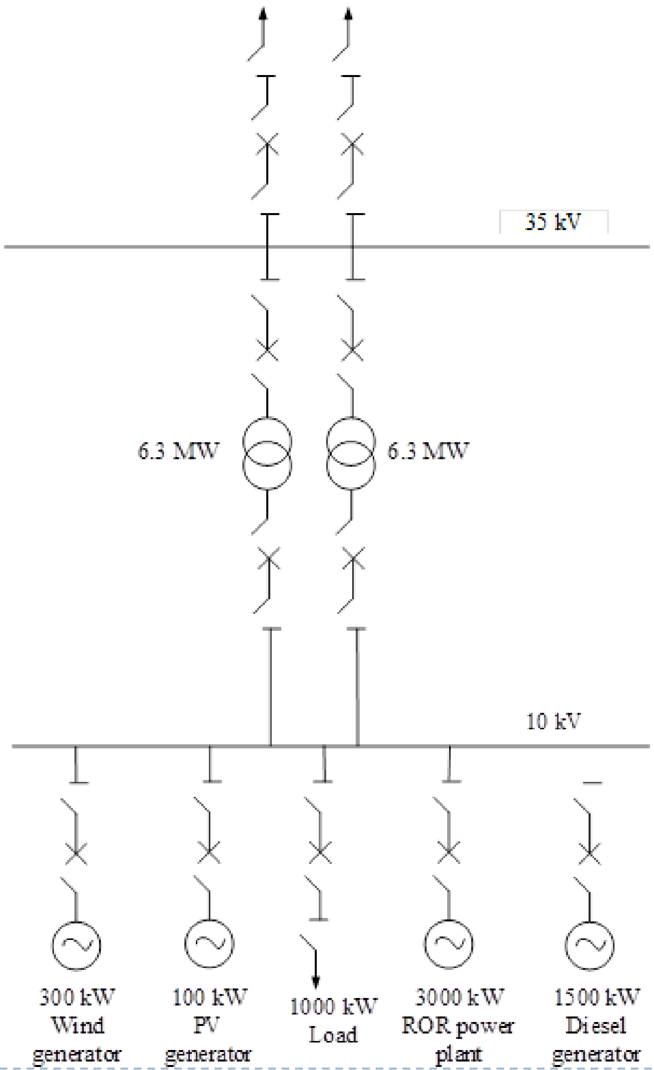
- The optimisation equation represents a multi-step continuous process. In the first step, the power needed is set. Then, the optimal combination of available units is selected, using the following form of the recurring relation:

$$A_i{}^e\left(P_i{}^e\right) = \max\left\{A_i(P_i) + A_{i-1}{}^e\left(P_j - P_i\right)\right\}$$

- Where,
  - $P_i{}^e$ indicates the power needed in the i-th sub-problem.



CASE STUDY- The analysed substation



CASE STUDY- The optimisation

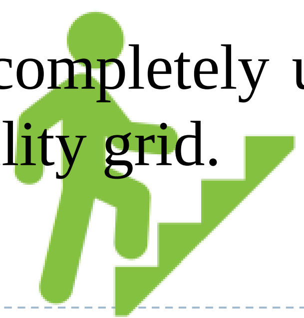
- The dynamic programming optimisation is done step by step.
- The algorithm optimises the system with a step of 1 kW
- In the first step no optimisation is done, and the data for the first DER is used.
- In this case, the data for the ROR power plant is used. That means that so far, only the ROR power plant will generate power.

CASE STUDY- The optimisation

- In the next step, the optimisation is done between the two DERs, ROR power plant and the wind generator.
- The calculations start with the power of 1 kW and continue until the power capacity limit of the wind generator is reached (300 kW).
- In the third step, the optimisation is done between the PV generator and the optimised values in the second step.
- The calculation is done until the power capacity limit of the PV is reached (100 kW).

CASE STUDY- Optimal unit commitment calculation

- First, the optimal power generation for the third DER is determined, according to the maximal availability.
- The remaining power that has to be provided is supplied by the two remaining DERs.
- The process continues until there is no power to be divided among the DERs.
- If the power generated from the DERs is not completely used by local load, the excess power is sold to the utility grid.



RESULTS- if there is not an outage in the substation

Distributed Generator	Power generation[kW]
PV generator	17
Wind generator	31
ROR power plant	952

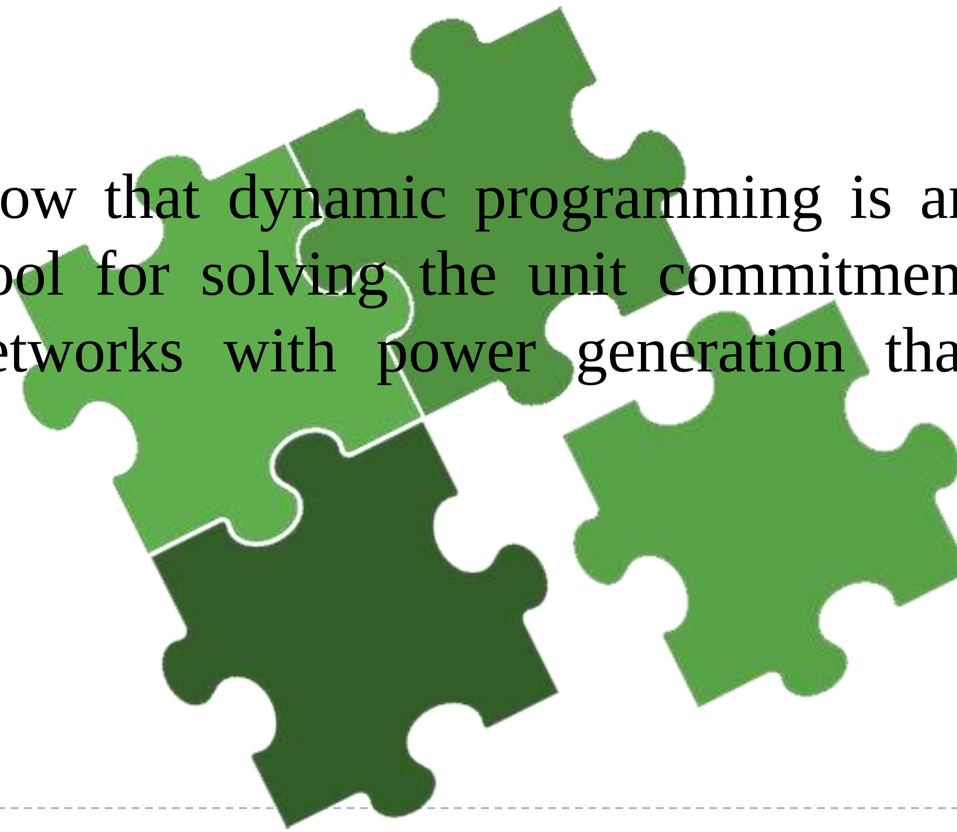
RESULTS- if there is an outage in the substation

Distributed Generator	Power generation[kW]
PV generator	38
Wind generator	18
ROR power plant	394

CONCLUSION

- The presented method responds to a real-life problem present in the contemporary smart grids. The method was developed in Matlab providing hour analysis if weather conditions are known.

- The presented results show that dynamic programming is an efficient mathematical tool for solving the unit commitment problem in complex networks with power generation that varies over time.



Thank you for your attention