

# Paris Session 2022



## RES Generation Network Topology Optimization Based on an Adapted Genetic Algorithm

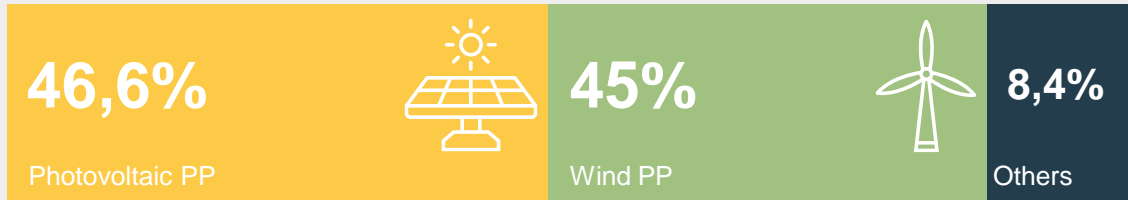
*SC C2 – PS 2  
30 August 2022*

ANDREY BRAMM  
RUSSIA

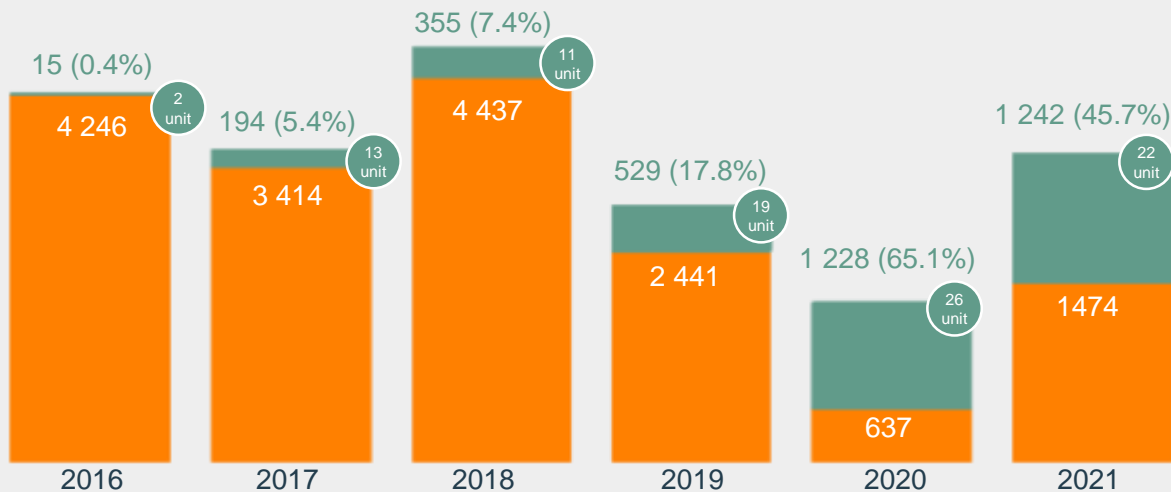


CIGRE Paris Session 2022

# Problem statement



Share of different types of RES worldwide

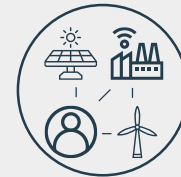


Increasing of the share of the RES in the new PP building in Russia

CIGRE Paris Session 2022



Raise of the share of RES



Intellectualization of distribution grids



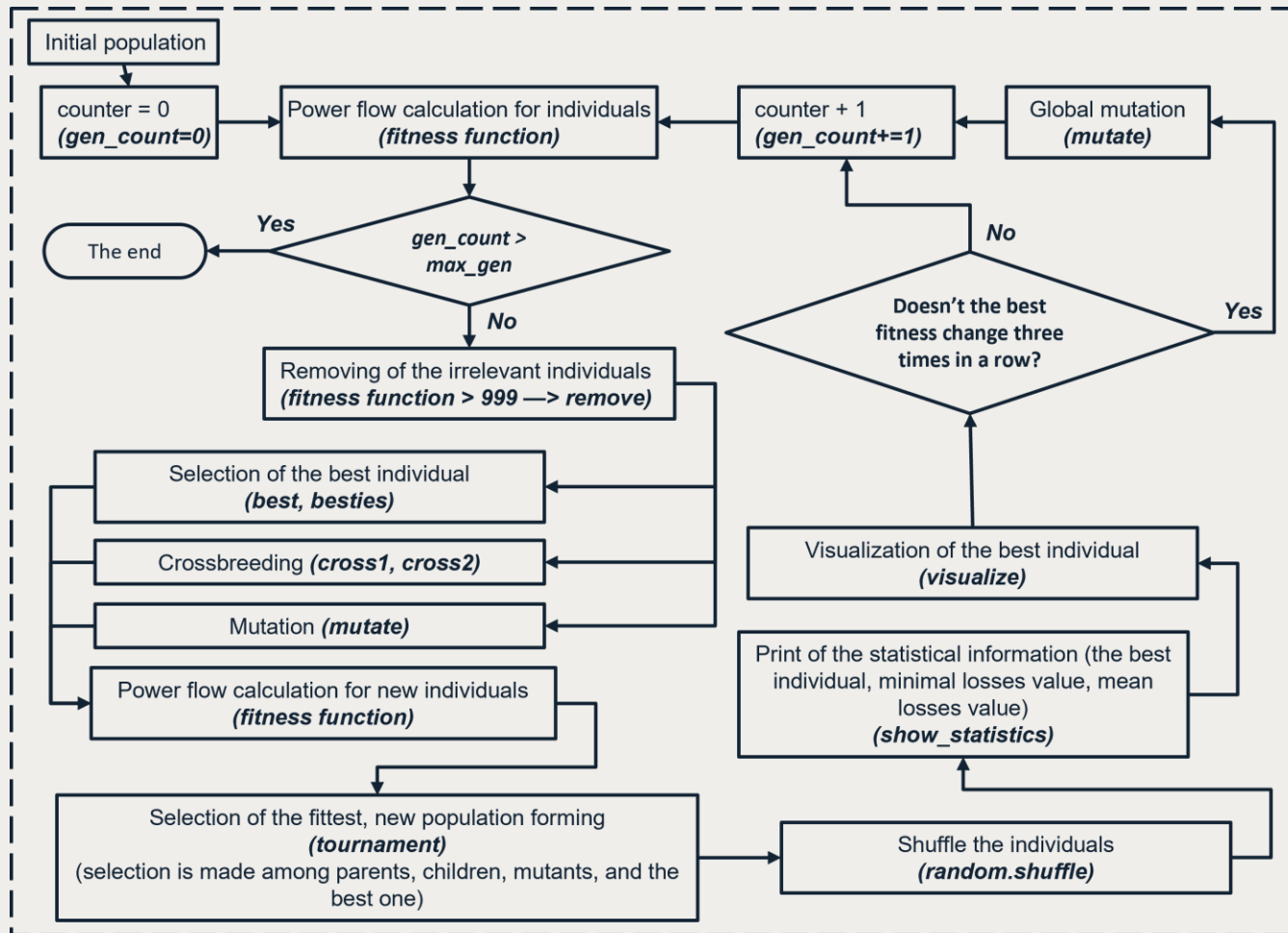
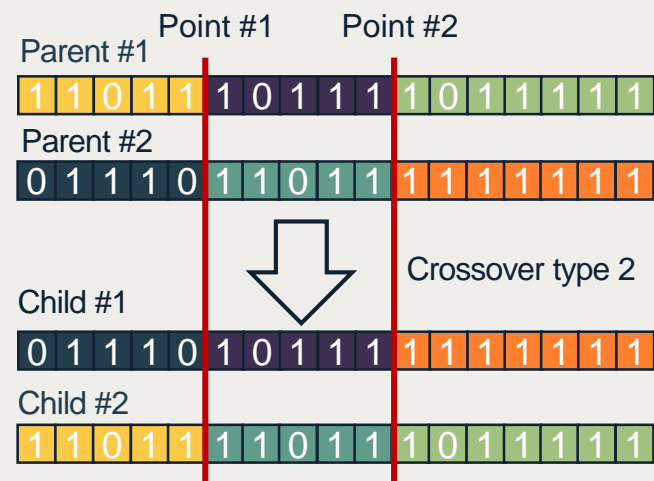
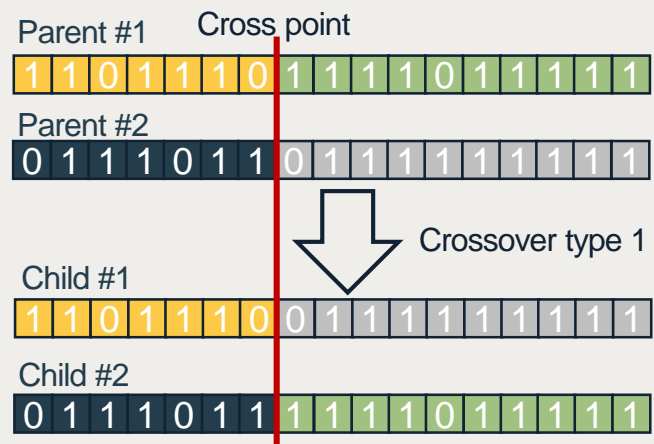
Generation dependence on weather changes and day cycle



Hourly changing of the optimal configuration

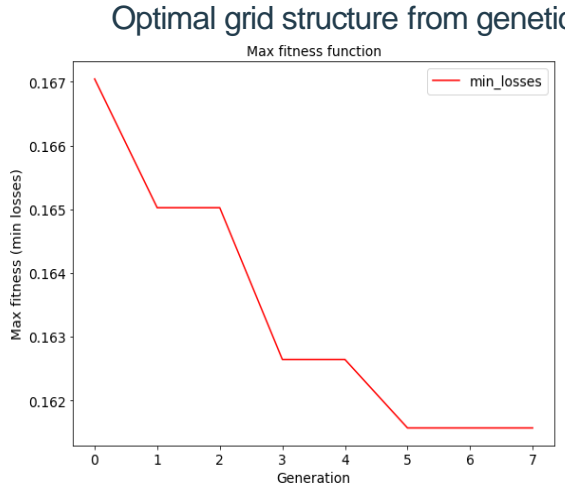
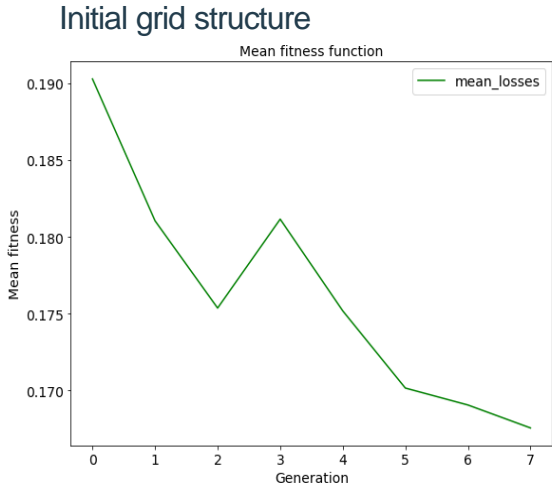
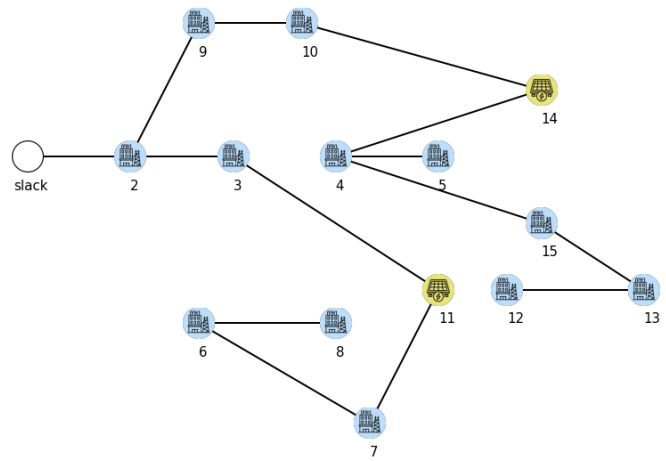
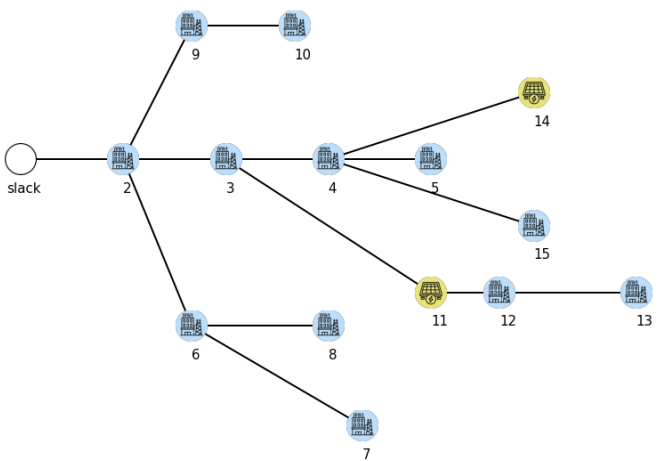
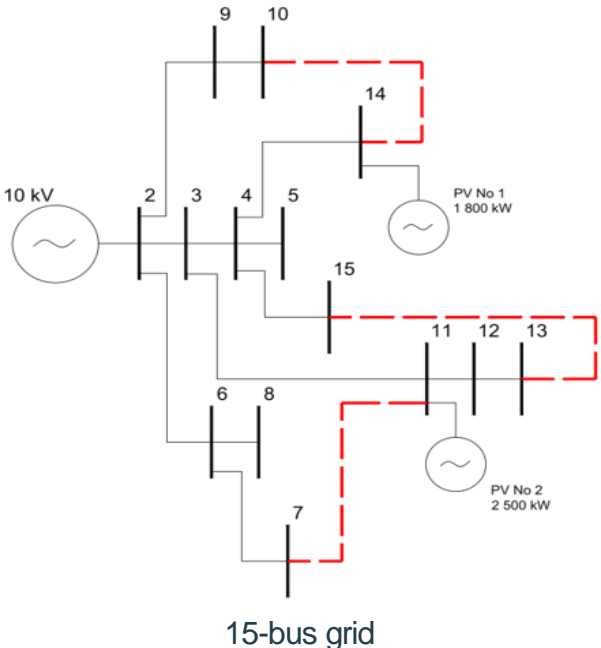


# Developed algorithm main points



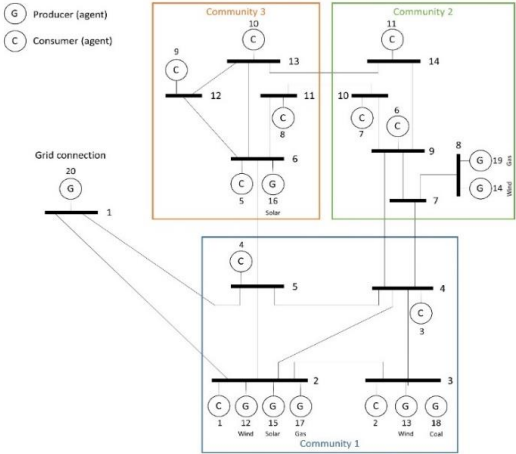
Flowchart of the genetic algorithm

# Algorithm results for 15-bus grid with only SPP

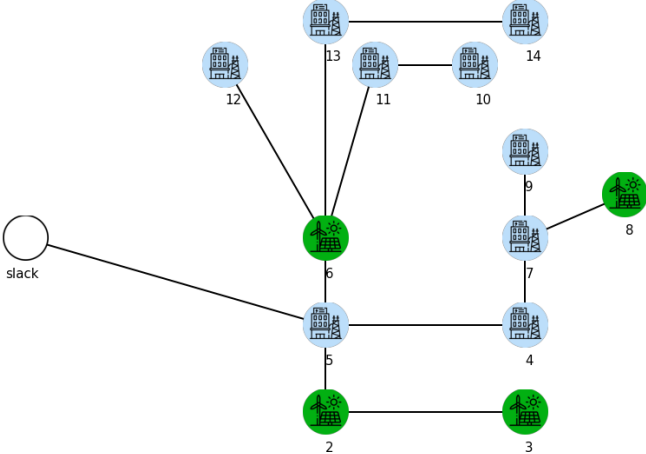


Results of genetic algorithm

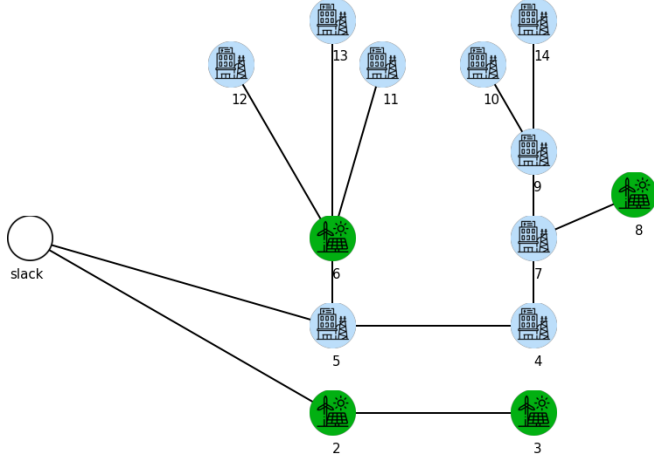
# Algorithm results for 14-bus grid with different RES



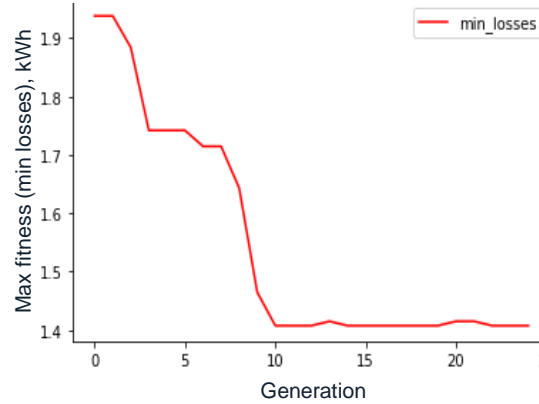
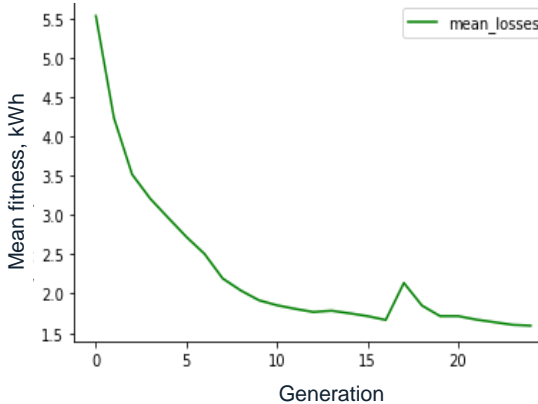
14-bus grid



Initial grid structure



Optimal grid structure from genetic algorithm



Results of genetic algorithm



# Comparison

Results of the genetic algorithm for 15-bus grid

Parameters	Hours												
	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00
$\sum P_{load}$ , kW	448.9	354.1	306.3	272.5	256.2	258.4	287.8	421.1	430.9	483.9	392.5	333.6	262.4
$\sum \Delta P_{default}$ , kW	10.67	9.93	49.4	144.7	222.1	220	228	255.6	182.5	84.6	26.9	9.37	7.05
$\sum \Delta P_{opt}$ , kW	11.9	9.85	46.04	133.8	195.2	192.9	207.2	225.6	161.6	75.2	23.3	8.84	7.05
$\Delta \sum \Delta P$ , %	11.5	-0.8	-6.8	-7.5	-12.1	-12.3	-9.1	-11.7	-11.5	-11.1	-13.4	-5.7	0

$\sum P_{load}$  – total system active load at considered hour;

$\sum \Delta P_{default}$  – total losses of active power in the grid (initial configuration);

$\sum \Delta P_{opt}$  – total losses of active power in the grid (best configuration);

$\Delta \sum \Delta P$  – change in total losses of active power (in relation to total losses in initial configuration).

Hour	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00
Algorithm solution (losses), kWh	1 029	1 055	982	1 099	873	877	1 239	1 036
Exhaustive search (losses), kWh	706	661	568	539	501	546	1 139	1 031
Hour	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00
Algorithm solution (losses), kWh	1 399	950	588	927	942	985	1 060	1 000
Exhaustive search (losses), kWh	1 399	686	410	444	614	640	802	735
Hour	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00
Algorithm solution (losses), kWh	916	694	835	1 353	1 295	1 338	1 345	1 369
Exhaustive search (losses), kWh	485	458	624	998	1 019	1 047	1 345	1 204

$$Err = \frac{\Delta P_{Alg} - \Delta P_{brute}}{\Delta P_{brute}}$$



**Mean error: 44,6%**

**Matches with brute-force: 2**

# Conclusion

---

- The developed genetic algorithm has fast convergence
- The developed algorithm performs correctly for various network schemes, generation and load structures
- The created set of configurations may be used for the reclosers' switches schedules or the commutations plan (in the case of the manual commutations)
- The algorithm can be applied jointly with systems for the RES generation day ahead forecasting when planning the distribution grid operating modes
- The algorithm and can be applied as the tool for the grid schemes comparison at the project stage



Thank you for your attention!

