VIETNAM PRP

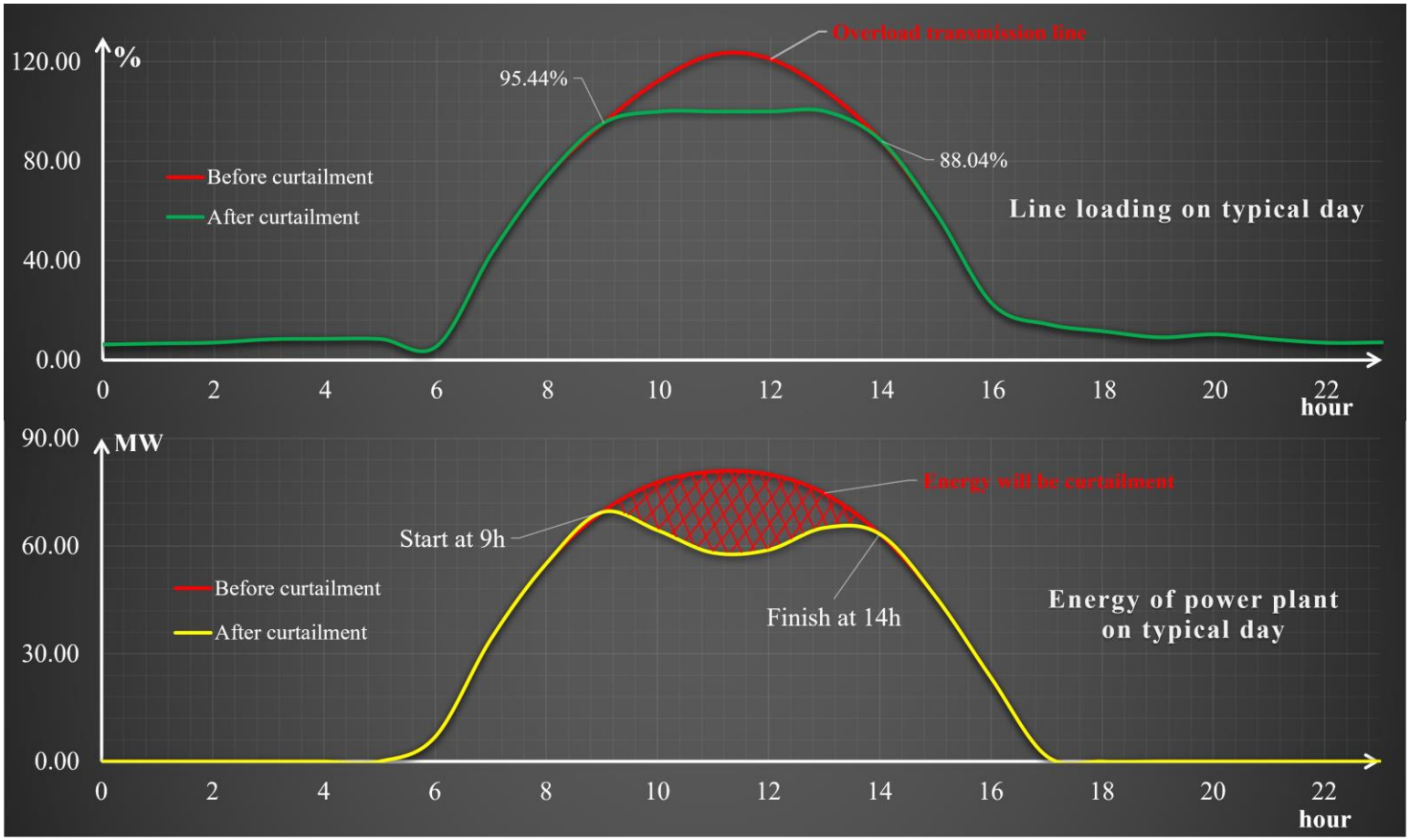
Grid Curtailment Study

Vietnam Power Resources Partner Corporation

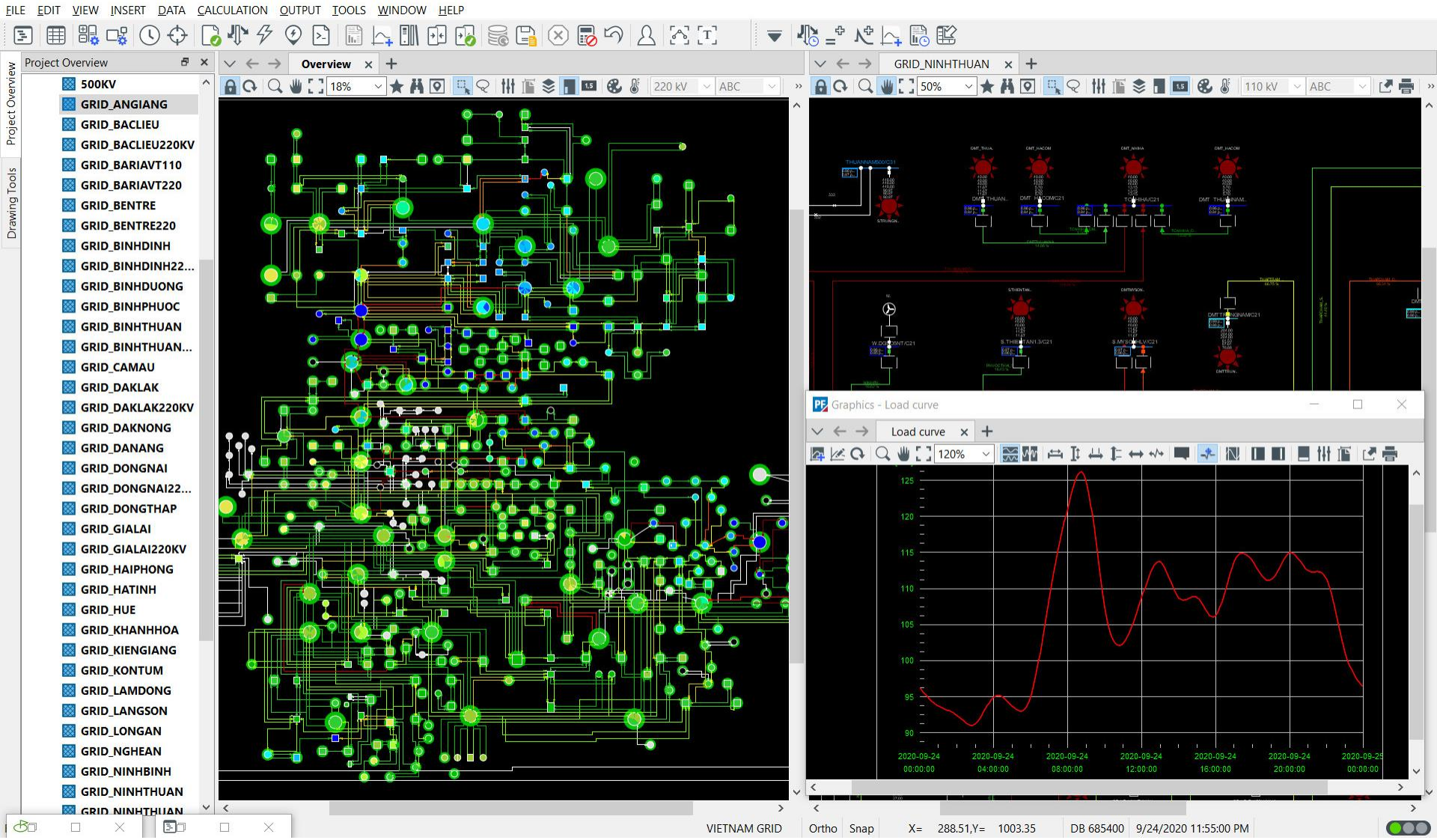
GRID CURTAILMENT STUDY

Grid Curtailment Study will help the Investors to calculate/determine:

The Energy Output of Power Plant Projects is curtailed in each day/month/year



Simulation of the entire Vietnam Grid



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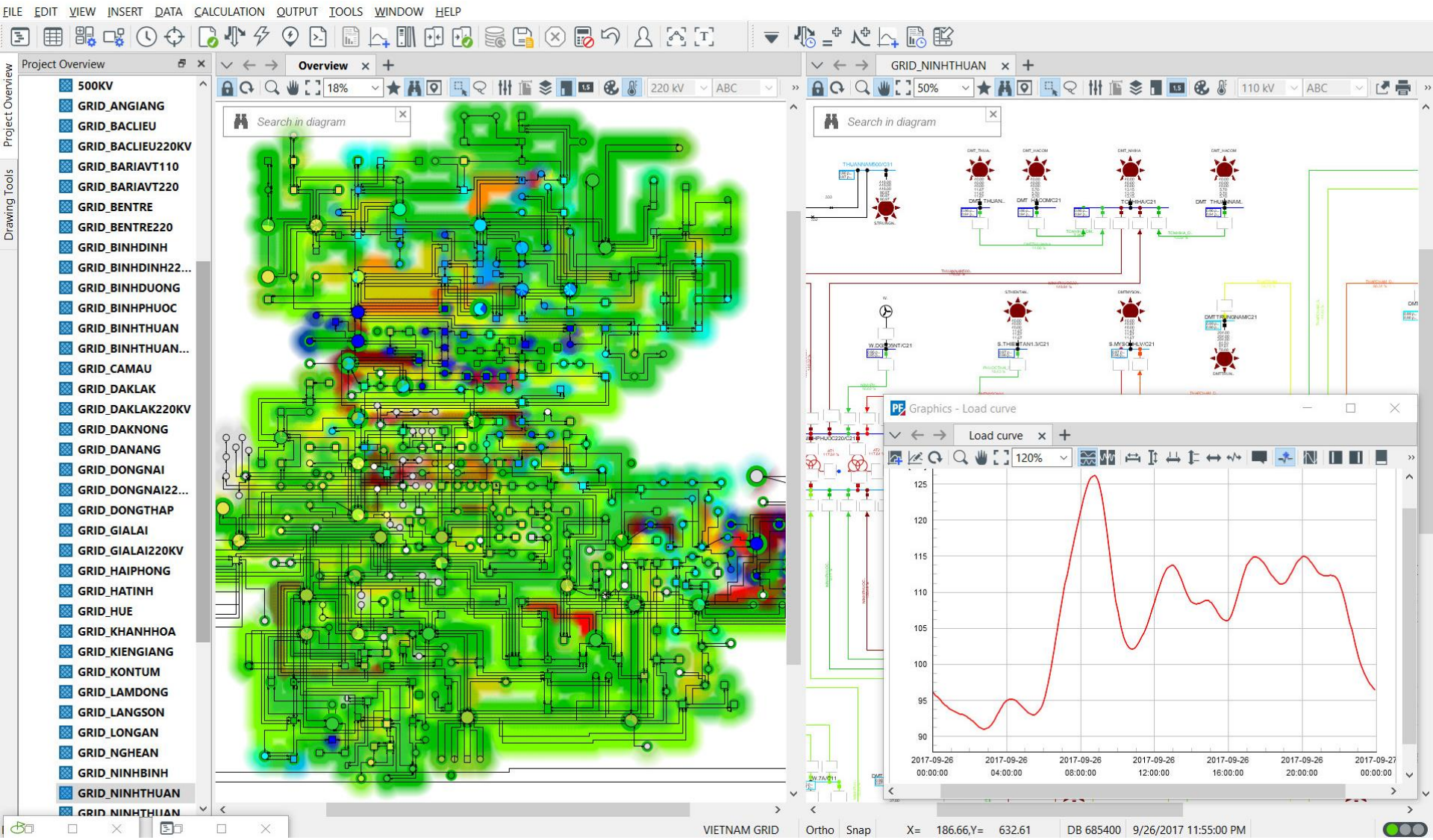
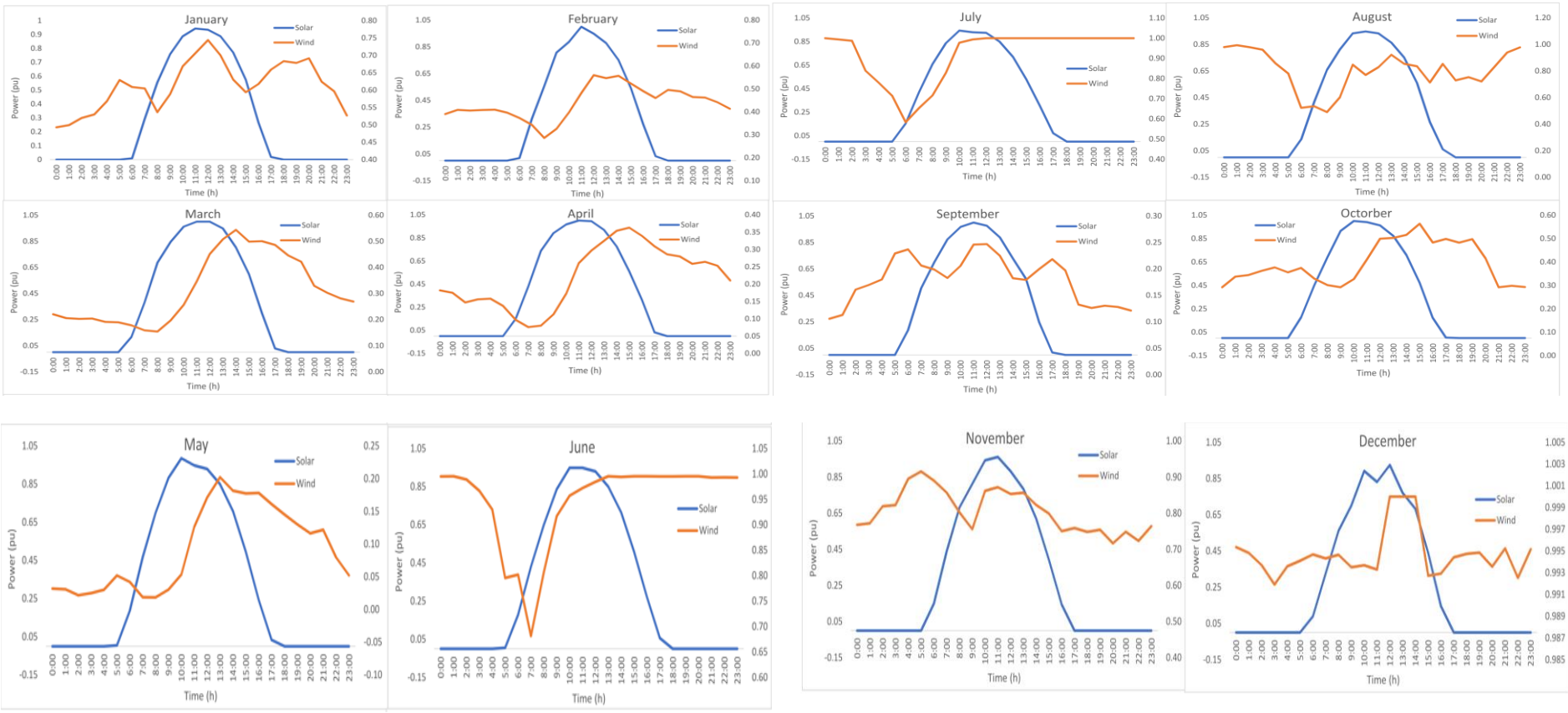


Simulation of Renewable energy sources

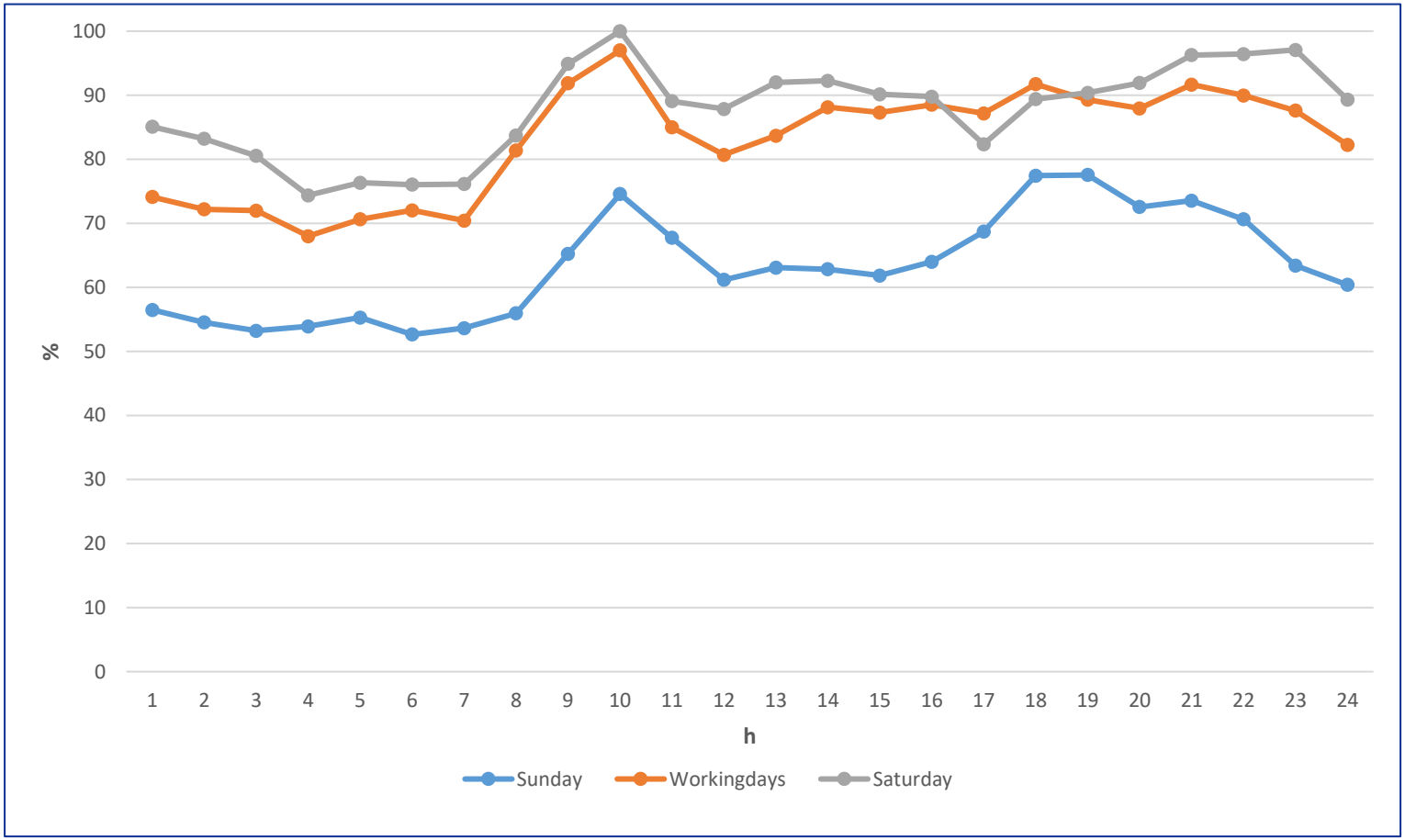
Due to renewable energy projects fluctuate their generation capacity during a day, hence, all renewable energy generators in the project area will be modelled using resource time series with modelled hourly output.



Example: Power generation curves of typical Solar Plant and Windfarm in the project area province during 12 months (in relative unit)

Simulation of Load Demand

Loads will be modelled at each node based on 3 load profiles: working days (from Monday to Friday); Saturday and Sunday.



Example: Load profiles of the project area (in %)

Curtailment method

The method for curtailing the capacity of a power plant *i* is formulated as below:

$$\mathbf{P\_Curtailment\ i} = \frac{\mathbf{Pi}}{\sum \mathbf{Pi}}\ \mathbf{\Delta MW}$$

Where:

P_Curtailment i is the power of plant i needs to be curtailed,

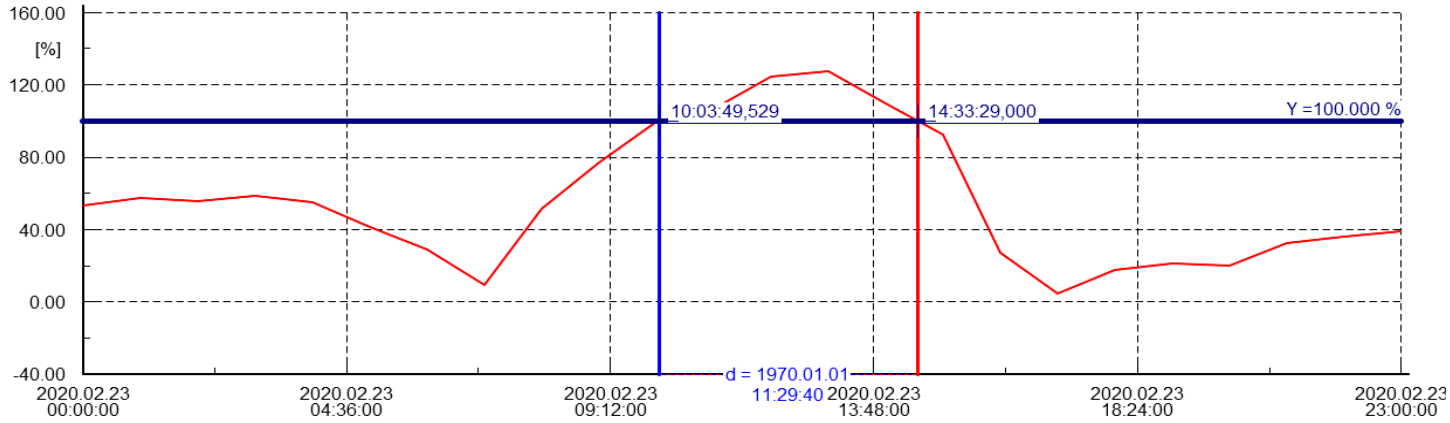
Pi is the power generation of plant i

$\sum Pi$ is the total power generation of all plants that cause directly overload the grid

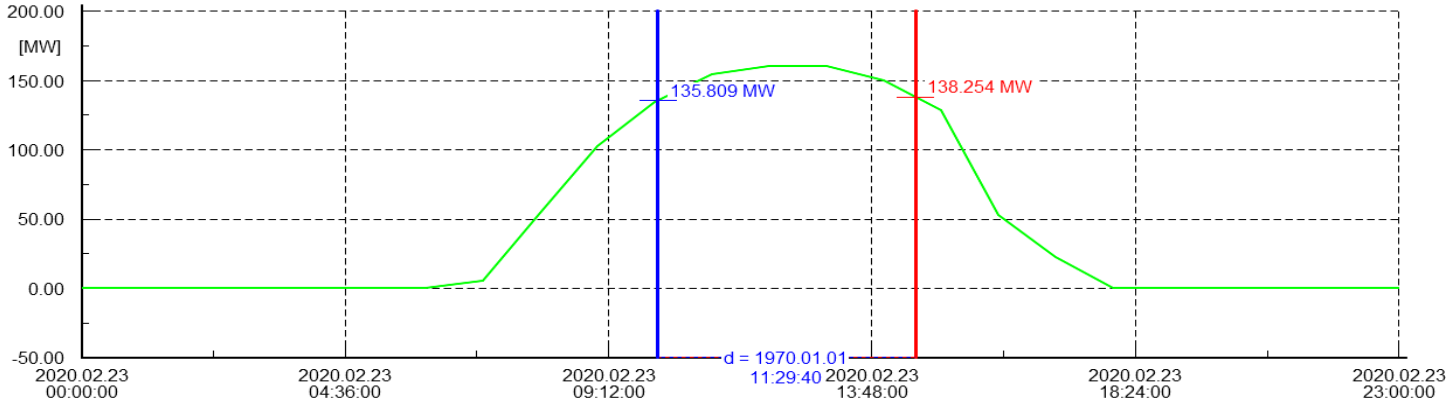
ΔMW is the total power needs to be curtailed to avoid grid overload

- ✓ The calculations of regional grid's capacity evacuation possibility for renewable energy sources are significantly related to the provincial load demand, maximum generation intervals of the renewable energy sources. At an interval of minimum provincial load demand but maximum renewable energy source's generation, the regional grid shall carry a heavily load due to a large residual power proportion injected to the transmission lines (T/Ls). Therefore, it is necessary to assess the intervals suitably selected for the calculations that based on the recording of load curve's fluctuation, as well as generation models of renewable energy sources.
- ✓ According to the power system operation methods, the grid-integrated Plants shall be allowed the order from the Load Dispatch Center to curtail the Plant's generation power in order to ensure the operation conditions, avoiding overloads to the power grid.
- ✓ Perform hourly resolution time-step load flow calculations for each time period with a total of 8760 steps on each time period.

Curtailment method

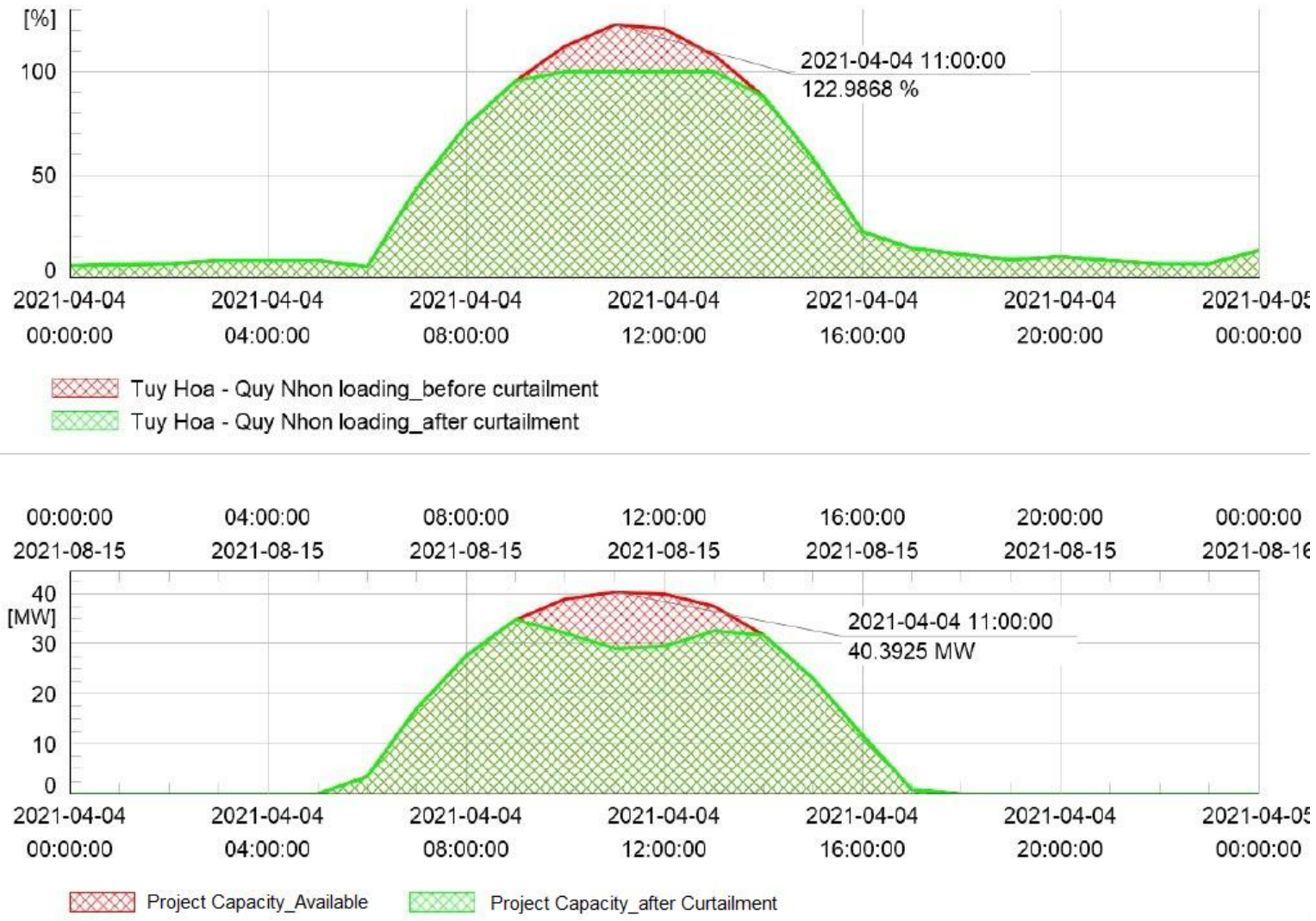


<u>Example</u>: Daily load carrying diagram of the transmission line monitored on 23/02/2020, At the time 10h03AM, the T/L starts to be overloaded, which is the time that need to curtail the generation power from the concerned Plants



<u>Example</u>: Daily power generation diagram of the solar plant on 23/02/2020 with the time at 10h03AM when the T/L starts to be overloaded and needs to curtail the generation power from the concerned Plants.

Curtailment Result



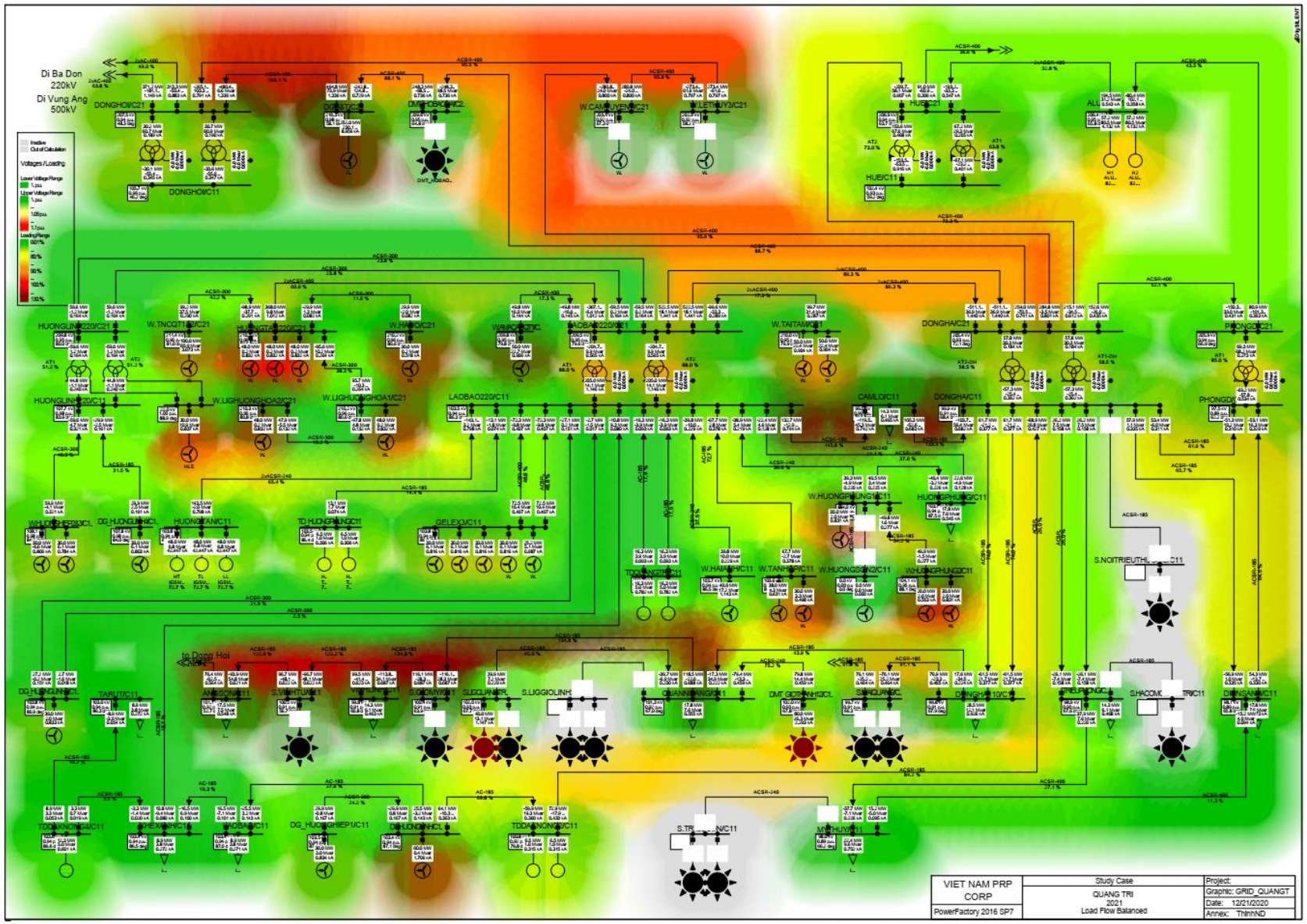
<u>Example</u>: Maximum capacity of a solar project (before and after Curtailment)

Curtailment Result

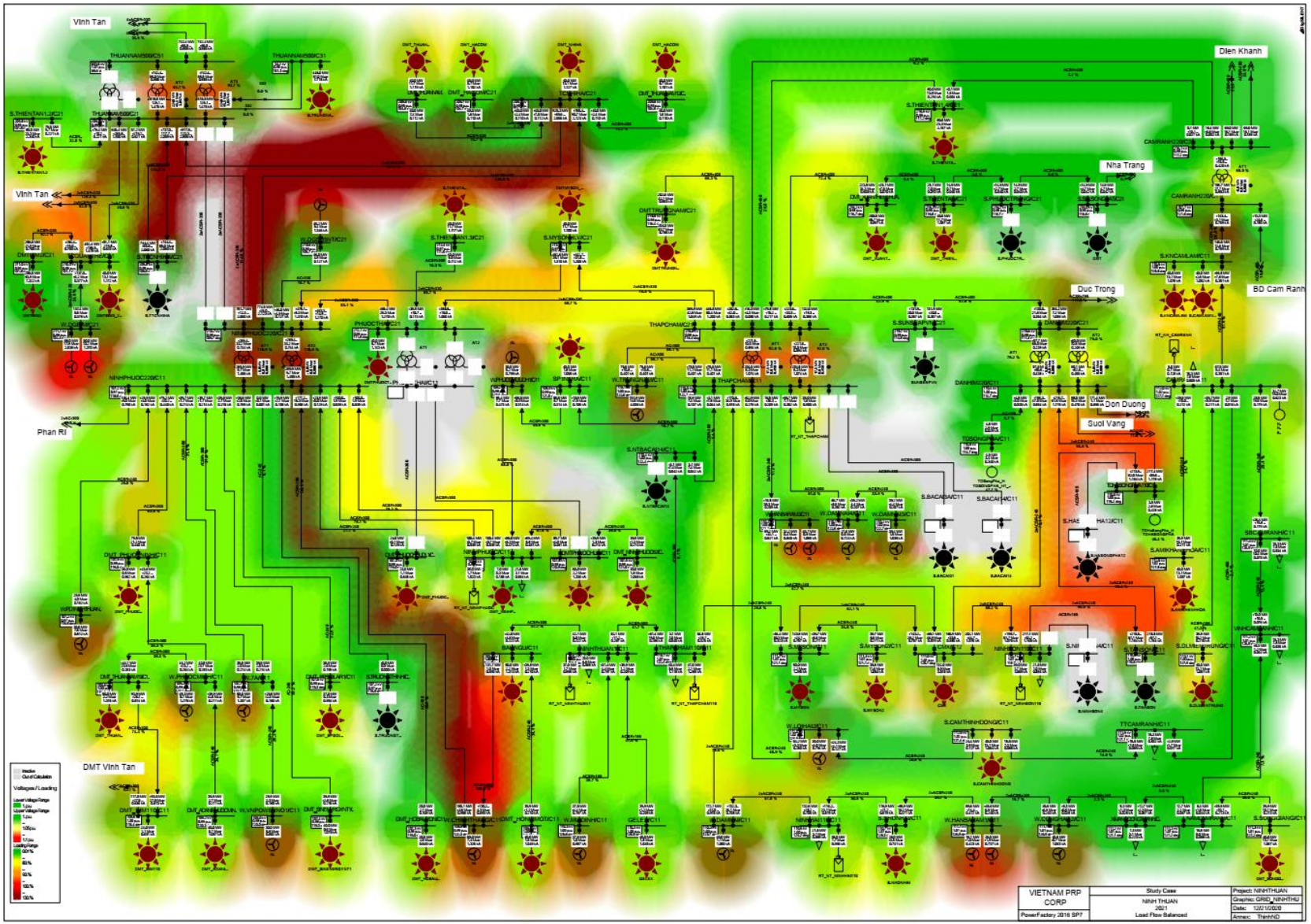
Month	Power Plant generation (MWh)	Power Plant Curtailment (MWh)	Maximum Curtailment (MW)	Curtailment time (hours)
01	19,358.30	175.63	18.51	38
02	19,537.64	276.38	20.30	53
03	19,802.14	247.58	19.43	53
04	20,298.04	174.69	18.31	42
05	20,390.61	118.20	15.46	19
06	16,433.65	67.28	13.38	9
07	17,141.63	50.62	13.52	7
08	18,974.40	97.48	16.23	13
09	19,700.42	127.66	16.93	27
10	18,850.74	151.72	16.13	28
11	16,520.81	112.36	17.09	29
12	21,986.64	208.40	17.08	45
Year	**228,995.02**	**1,807.99**	**20.30**	**363**

Example: The total energy output of a solar project is curtailed

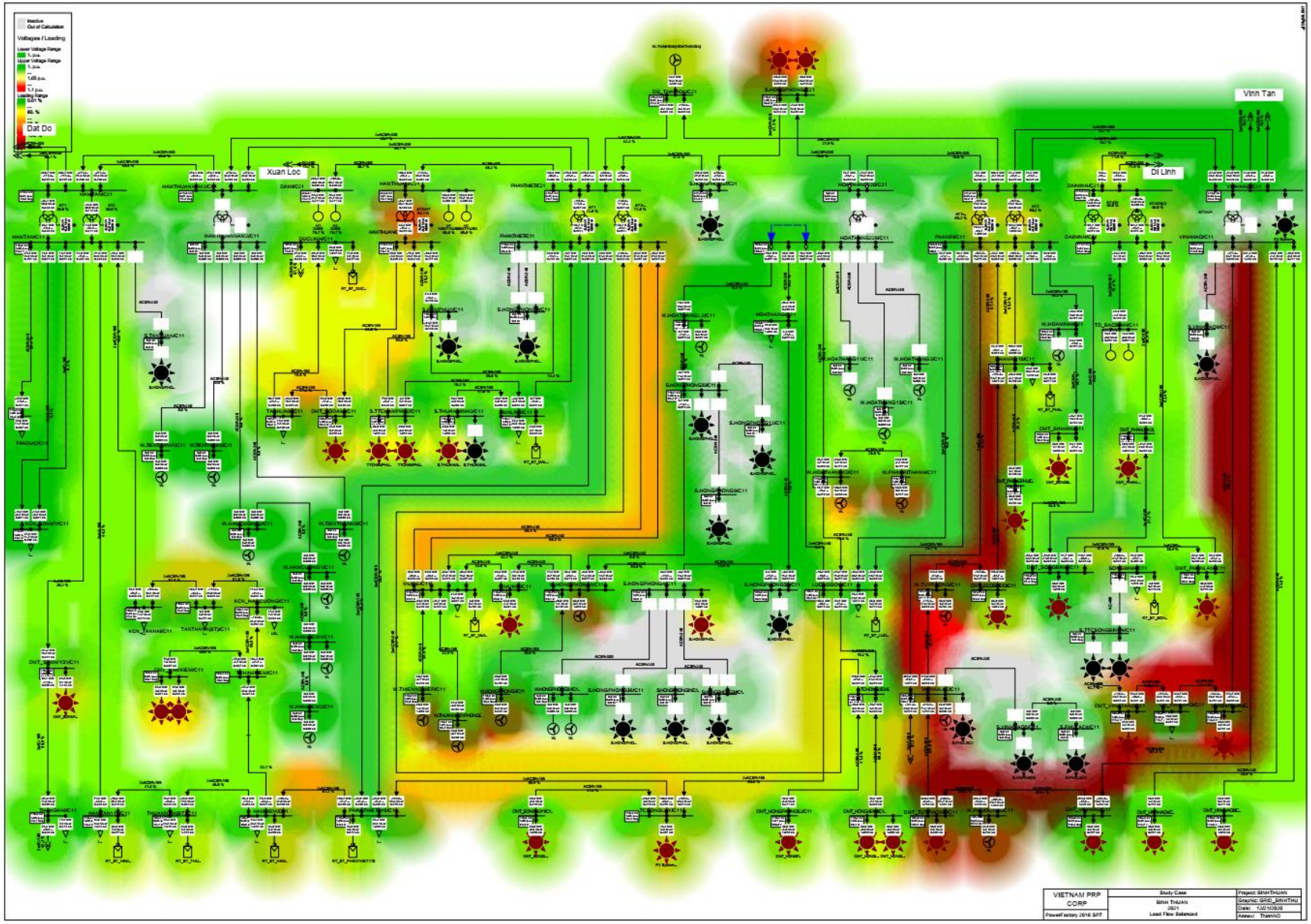
The overview of grid status in Quang Tri province



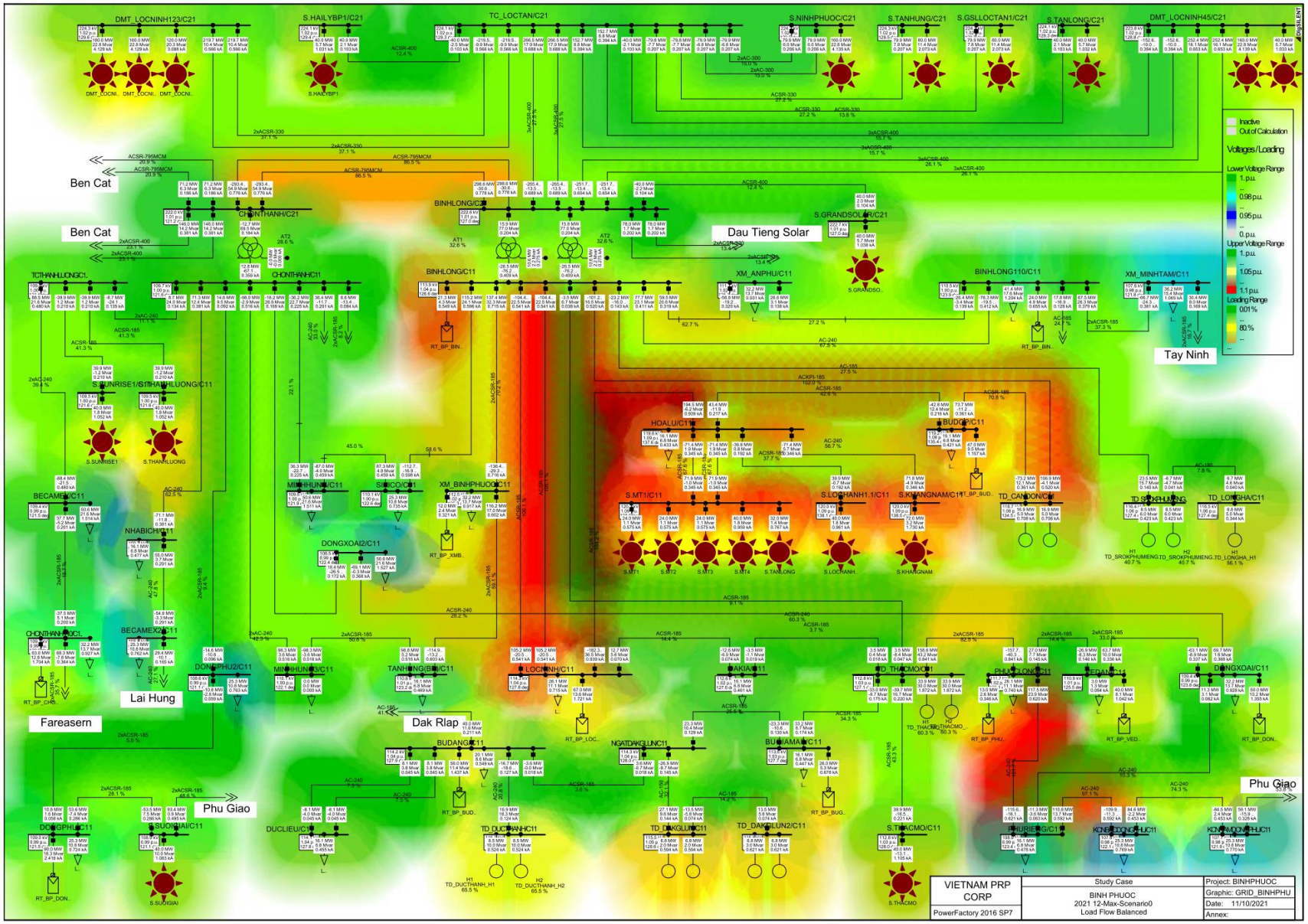
The overview of grid status in Ninh Thuan province



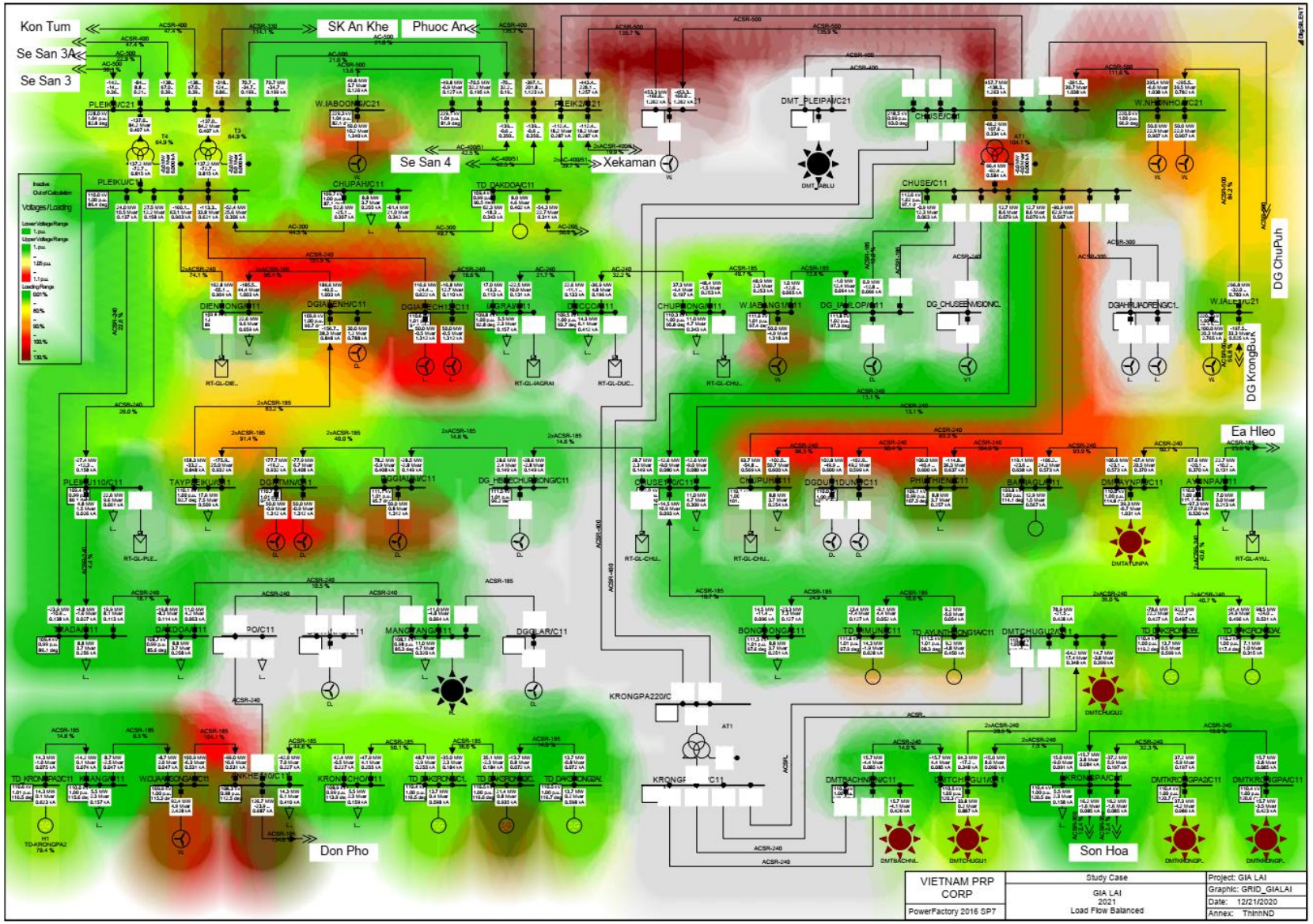
The overview of grid status in Binh Thuan province



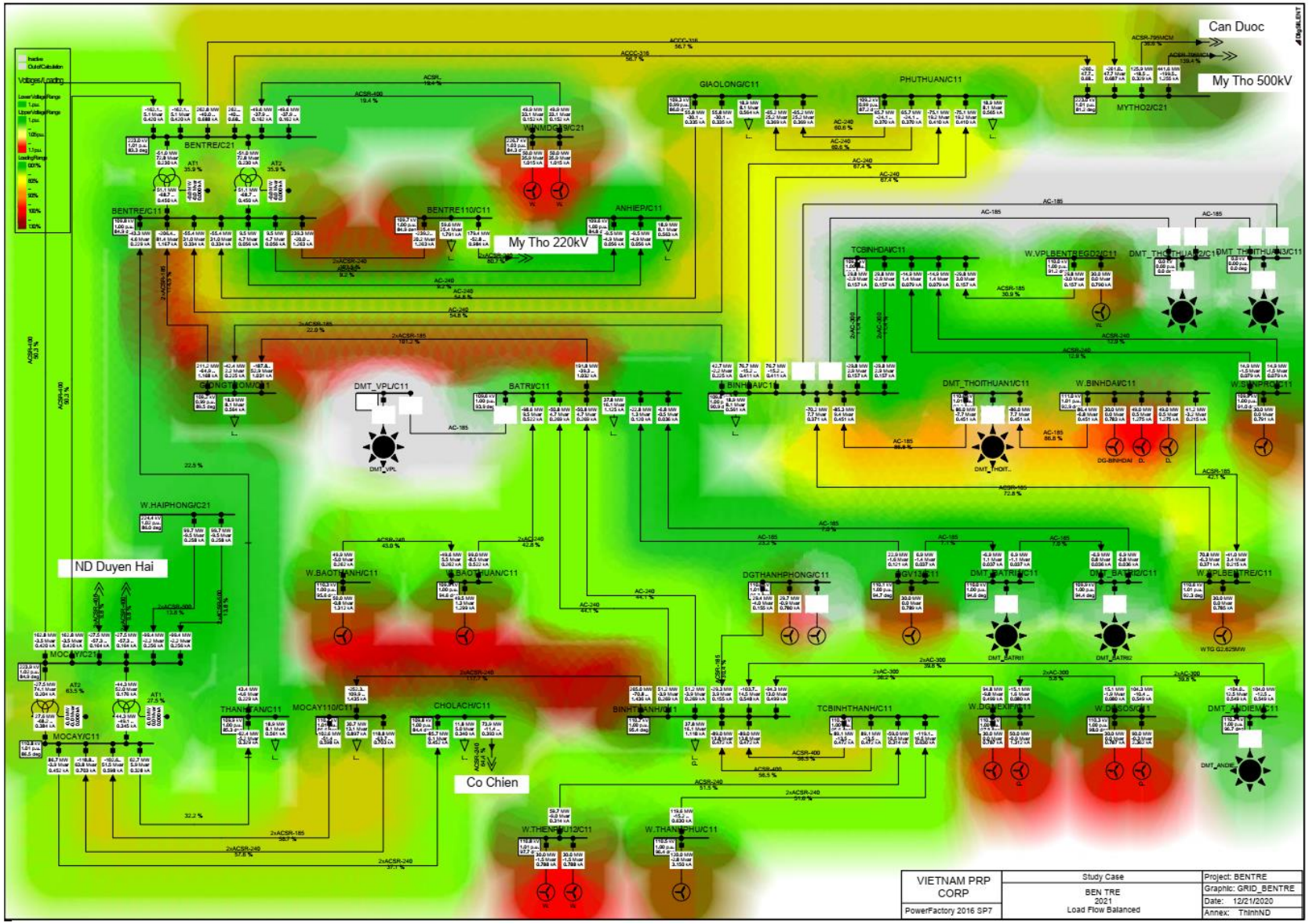
The overview of grid status in Binh Phuoc province



The overview of grid status in Gia Lai p



The overview of grid status in Ben Tre province



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