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PROTECTION & AUTOMATION FOR ELECTRIC POWER SYSTEMS 2021

Hybridization with Floating Solar, Offshore Wind Farm and Batteries in Hydroelectric Power Plant Reservoirs

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Brazil

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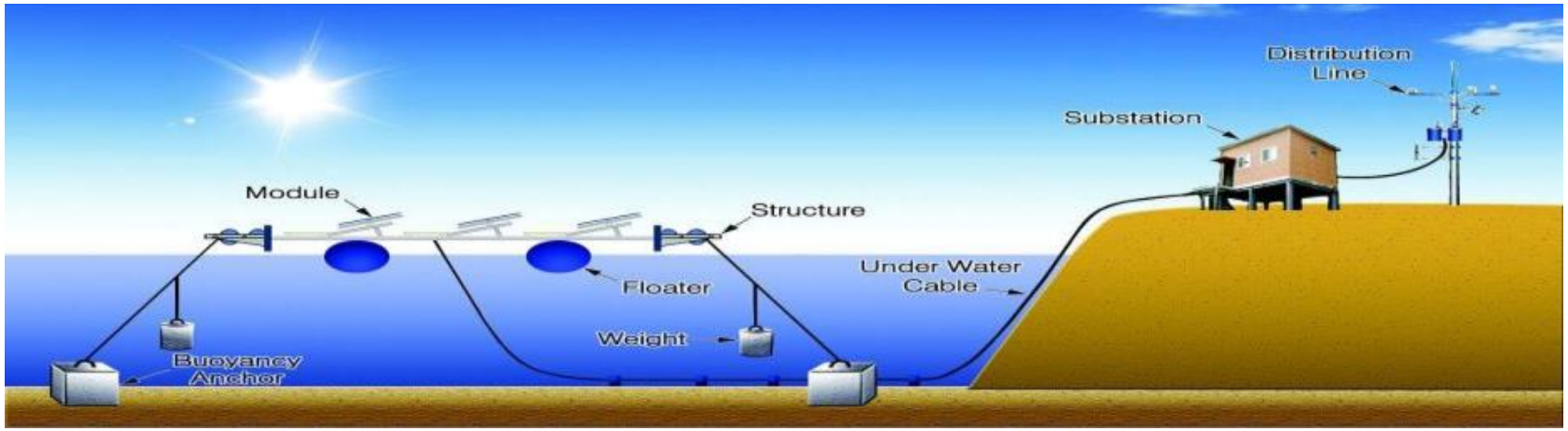
CONTEXTUALIZATION

- Reduction in costs of photovoltaic modules → exponential growth in the world.

- Alternative to assist the production of electricity
  - Integrating hydroelectric power plants → positioned in the dams (floating panels)

- Paper aims:
  - Relevant issues to the technology of floating photovoltaic plants
  - Possible benefits
  - Limitations and challenges
  - Protection and technical approach.

TECHNOLOGY DESCRIPTION



Basically, a floating photovoltaic plant consists of:

1) Photovoltaic modules

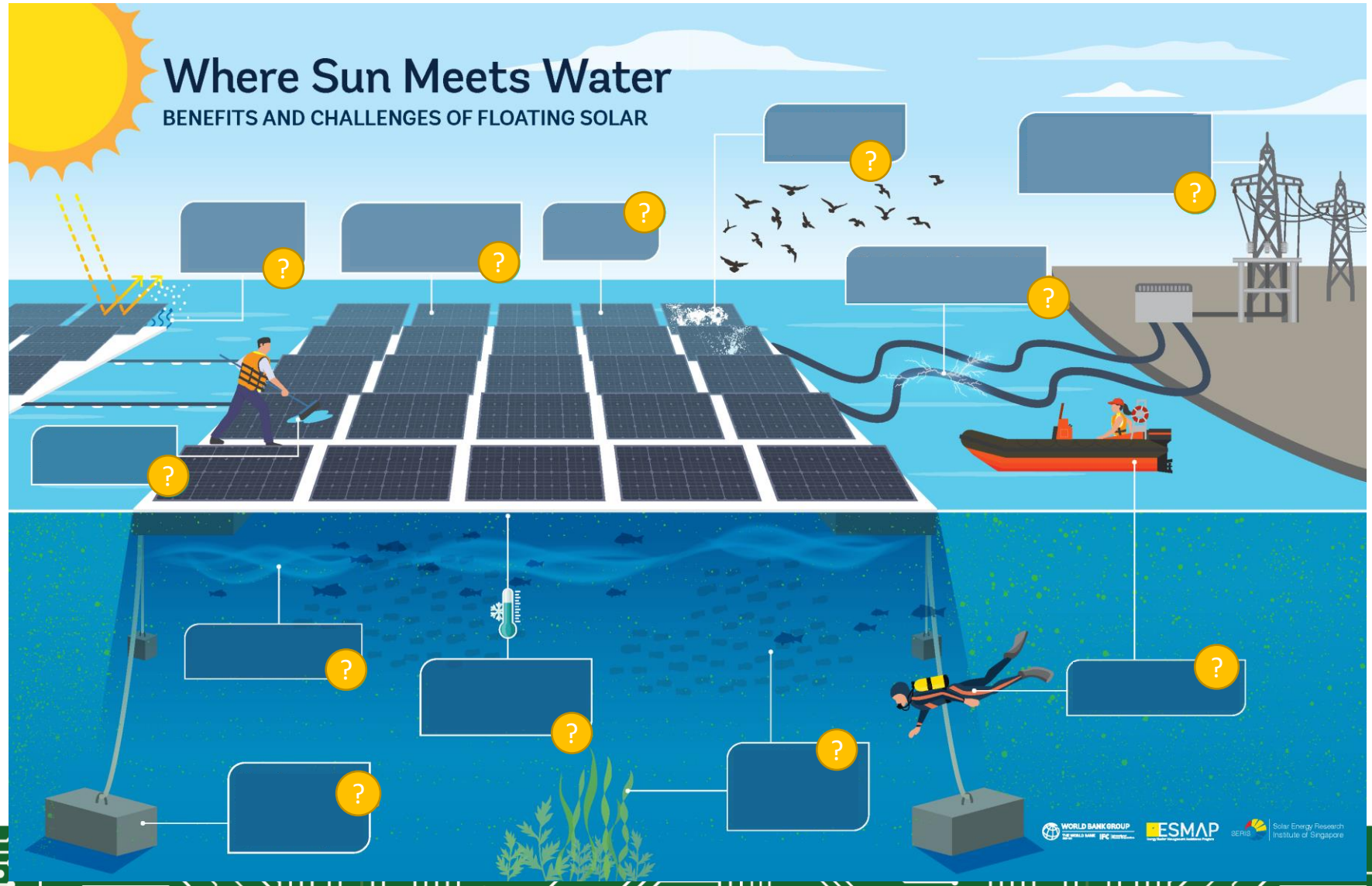
2) Floating platforms

3) Anchoring and Mooring

4) Electric cables

support structure for the installation of
for fixing the floating platform on the
photovoltaic modules, in addition to
banks and/or the bottom of the water
wind

PROS AND CONS

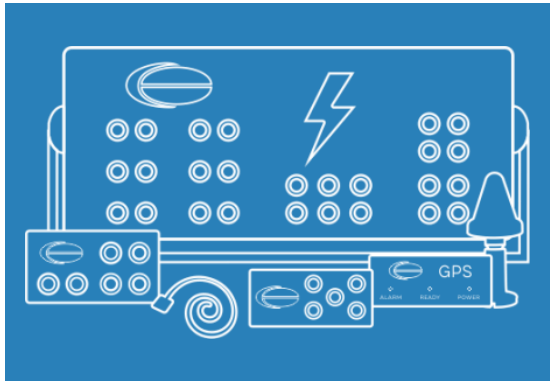


STUDY CASE

- Pilot plant: 1 MWp (solar plant)
- Second stage
  - 1 MWp (solar plant)
  - 1 MW (offshore wind farm)
  - 1 MW (battery banks)
- Simulate and analyze solar plant → short circuits
- Use software developed in Brazil by CONPROVE
- PS Simul

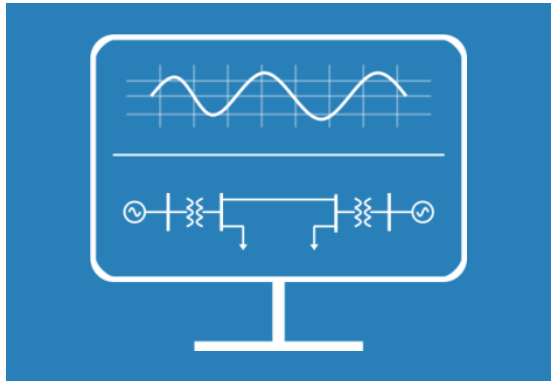
CONPROVE

- Brazilian company engaged in research, development and production of technology for the electric power.



Electrical Tests

Equipment for **secondary level** injection (IED's and PMU's) and **primary level** (CT, VT, Transformer and Circuit Breaker)



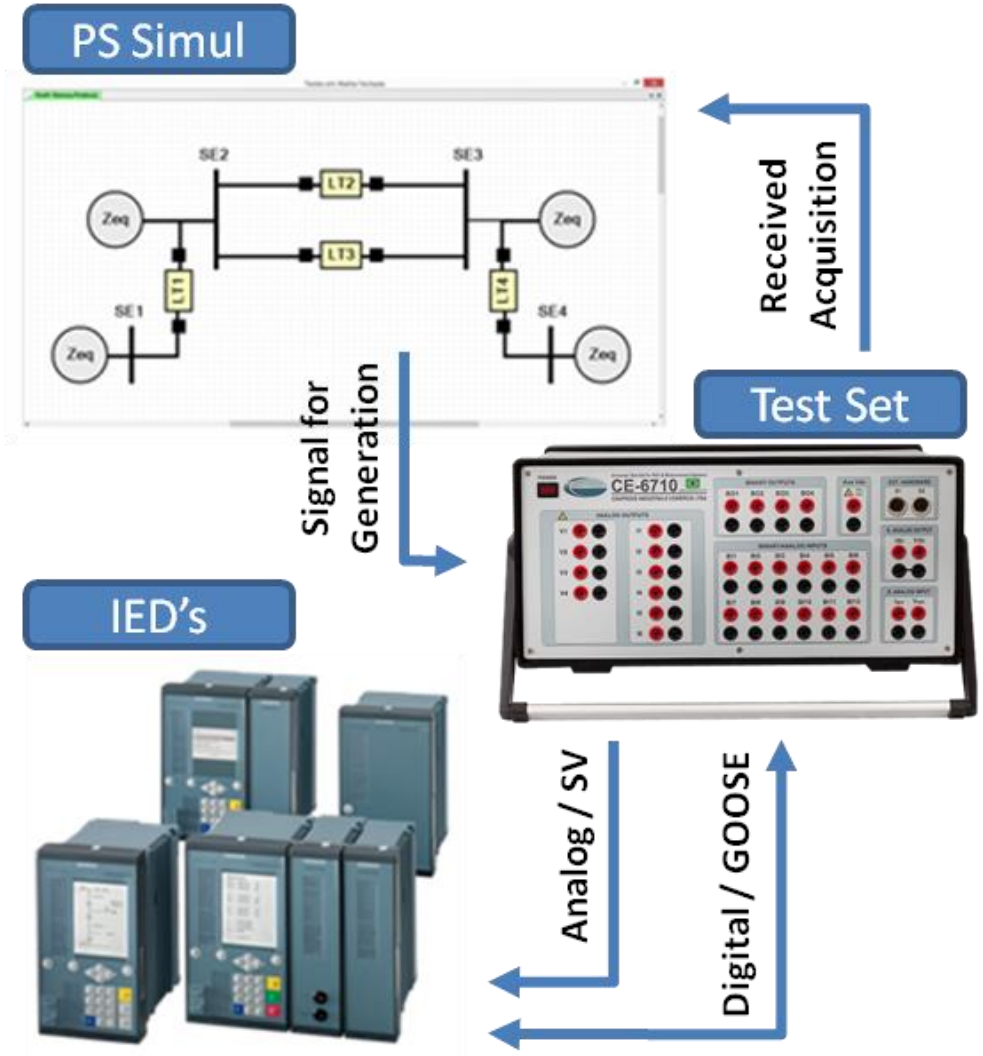
Softwares

IEC-61850 Environment: **SimulGOOSE** and **MultimSV**
For system modeling and study of electrical transients: **PS Simul**

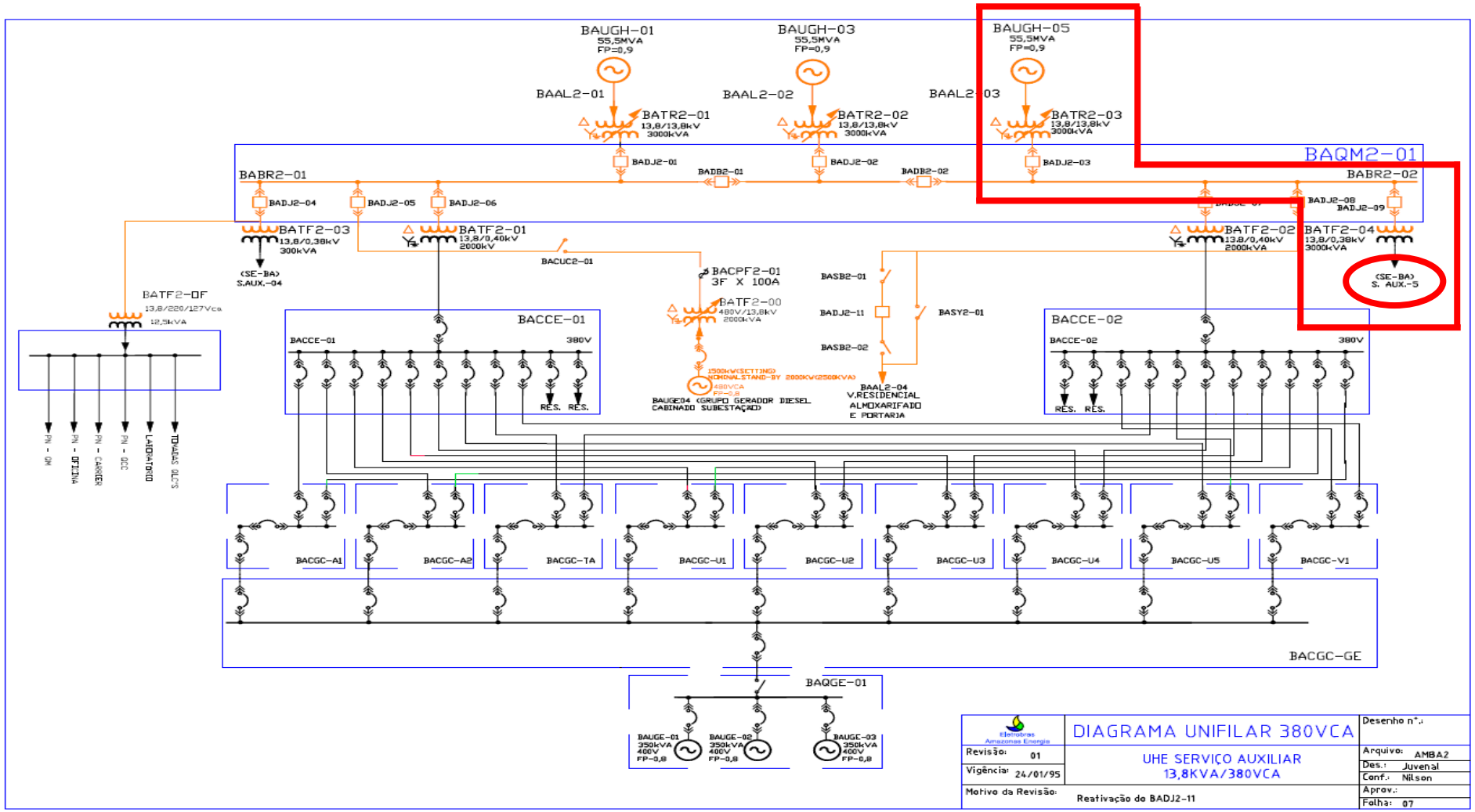
SOFTWARE USED

- Developed in Brazil over a decade ago by the company CONPROVE.
- PS SIMUL has the most advanced features in simulating.
- User-friendly and intuitive interface that facilitates the projects and analysis of results.
- Vast library with more than 400 components.
- It uses trapezoidal integration. Euler method to avoid numerical oscillations.
- Enables the export of waveforms in COMTRADE and CSV format.
- Complete user manual.
- Specialized technical support available.
- Available in languages: Portuguese, English and Spanish.

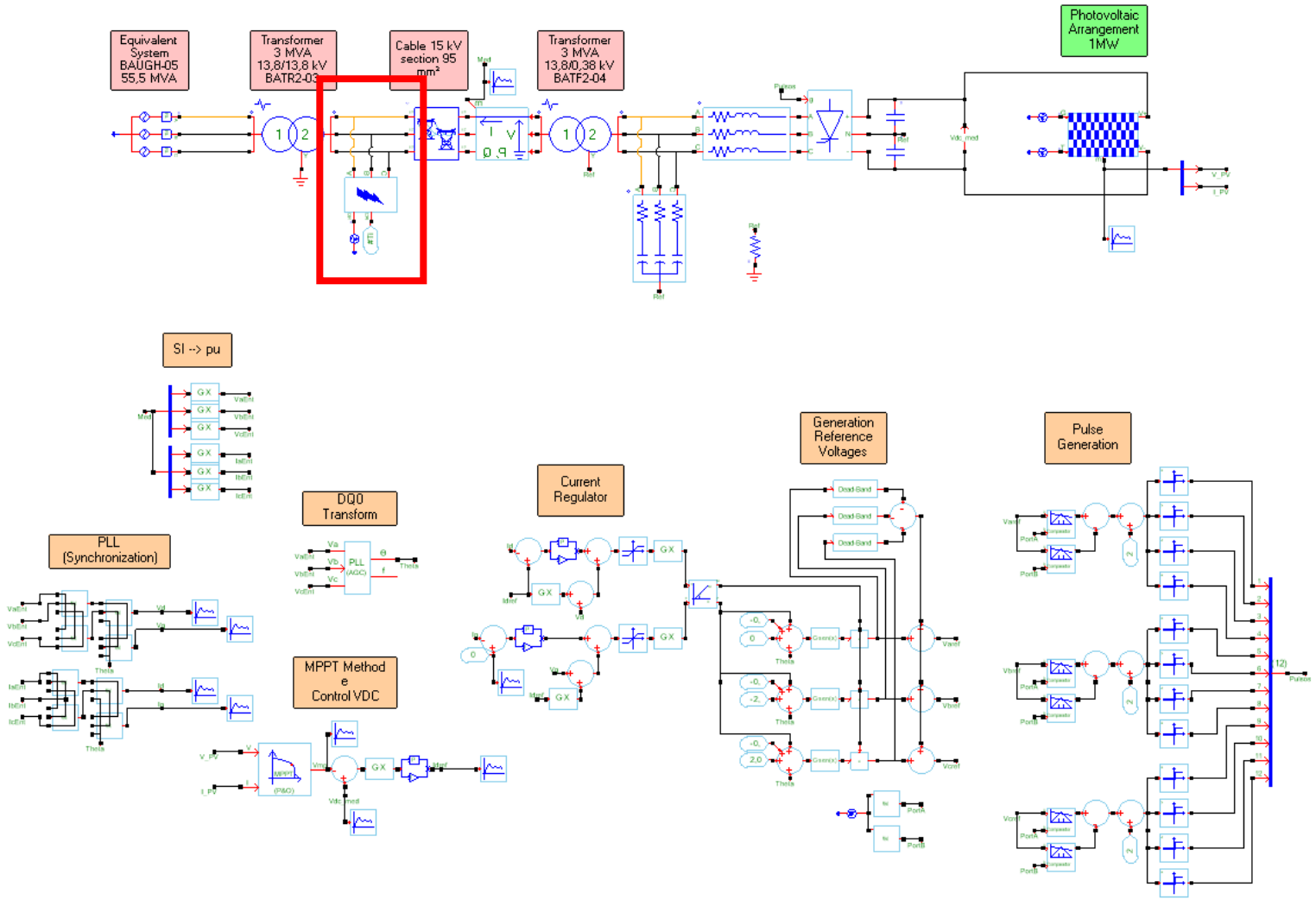
ITERATIVE METHOD



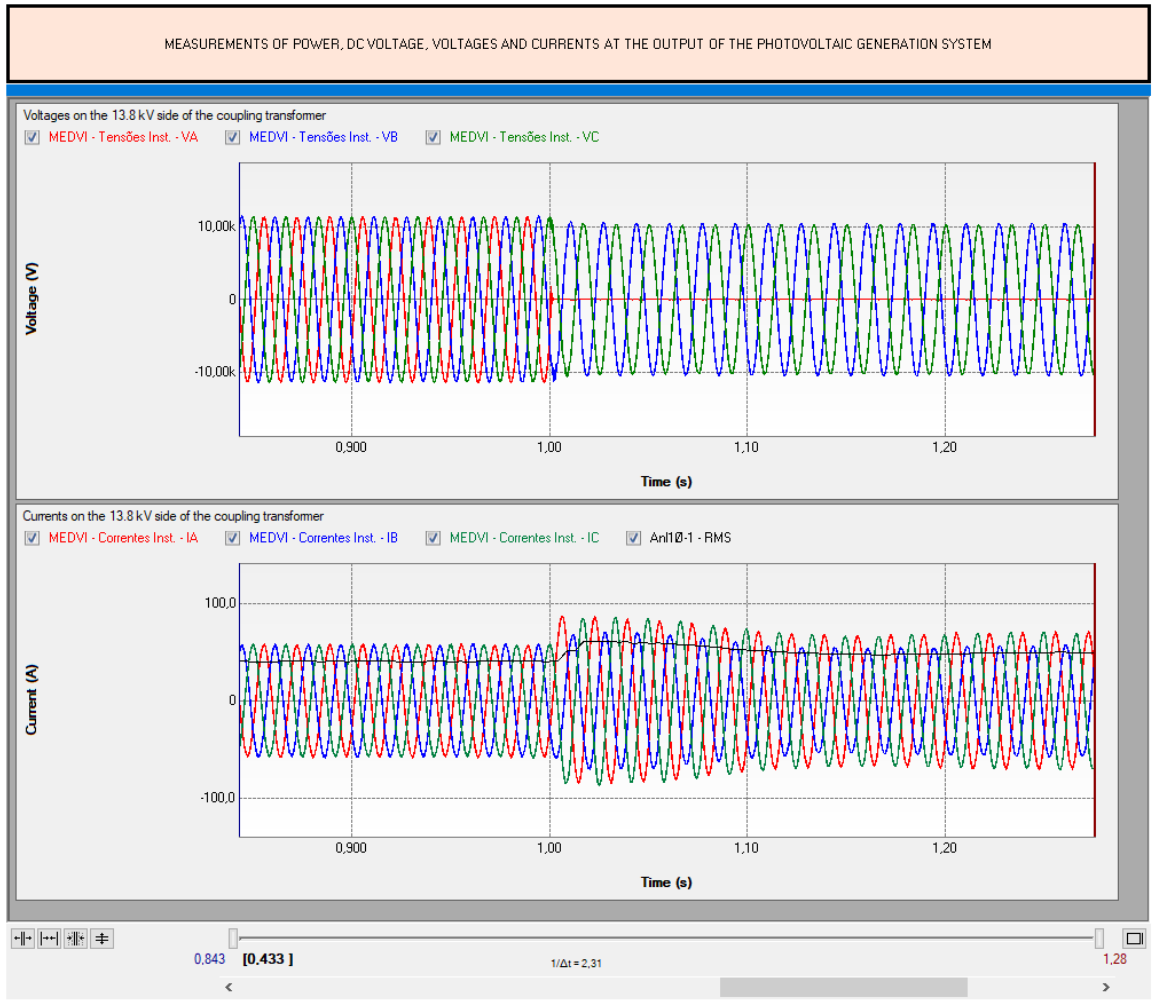
ON LINE DIAGRAM

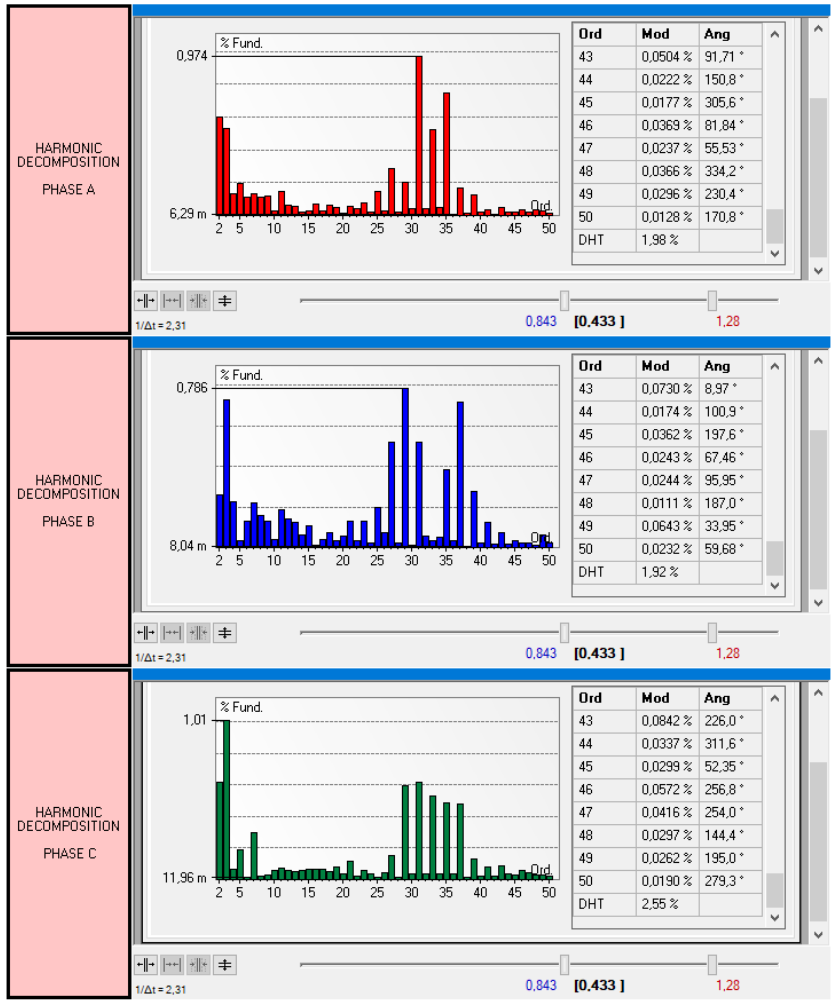


MODELED SYSTEM IN PS SIMUL

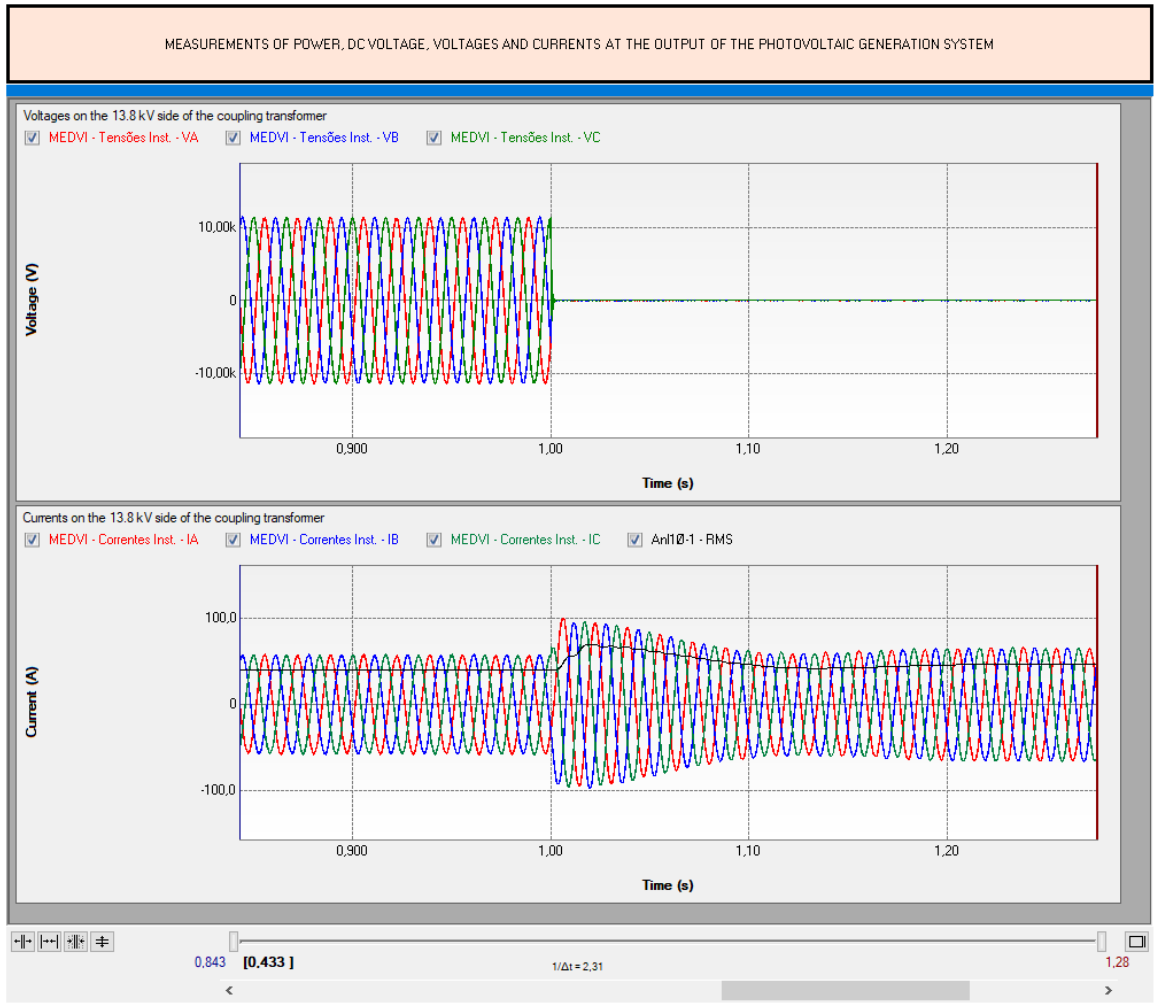


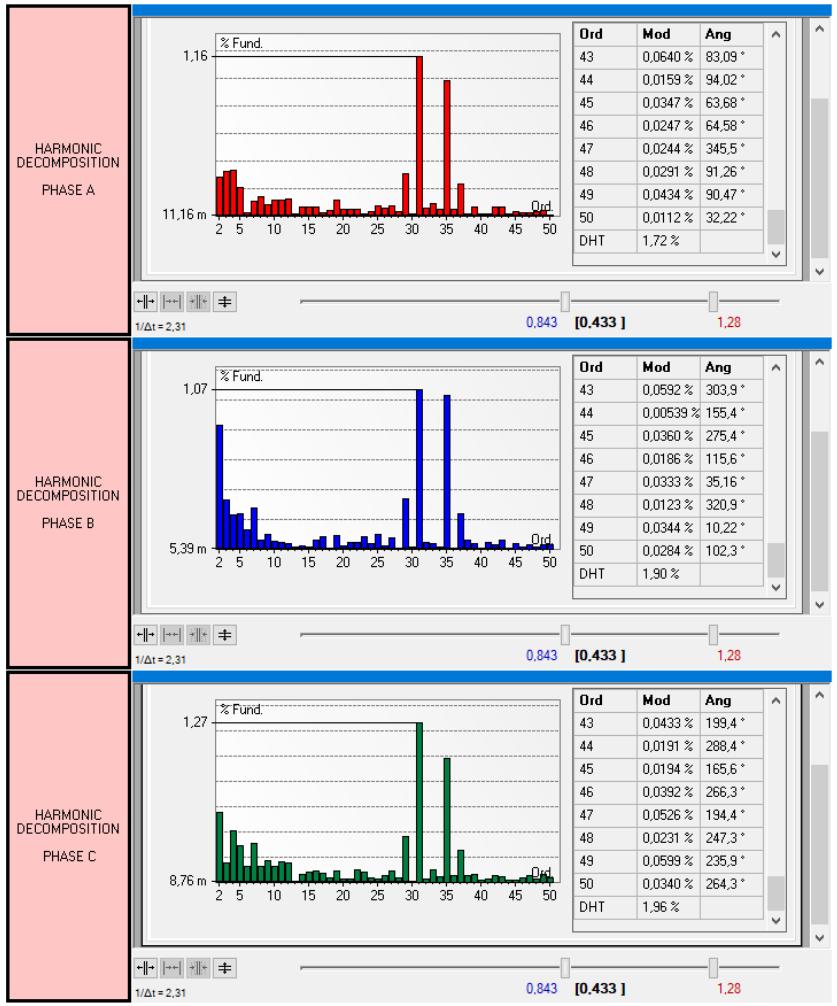
FAULT SCENARIO AND ANALYSIS OF WAVEFORMS – AT FAULT





FAULT SCENARIO AND ANALYSIS OF WAVEFORMS – ABCT FAULT





CONCLUSION

- Importance of studies that involve the modeling and simulation of energy systems.
- New sources behave under fault conditions X Traditional Grid Protection.
- Land X Water Mirrors.
- The adoption of floating due to space limitations or to avoid land acquisition costs.
- Installation cost does not seem competitive at this time in Brazil.

Thank you for your attention!

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