

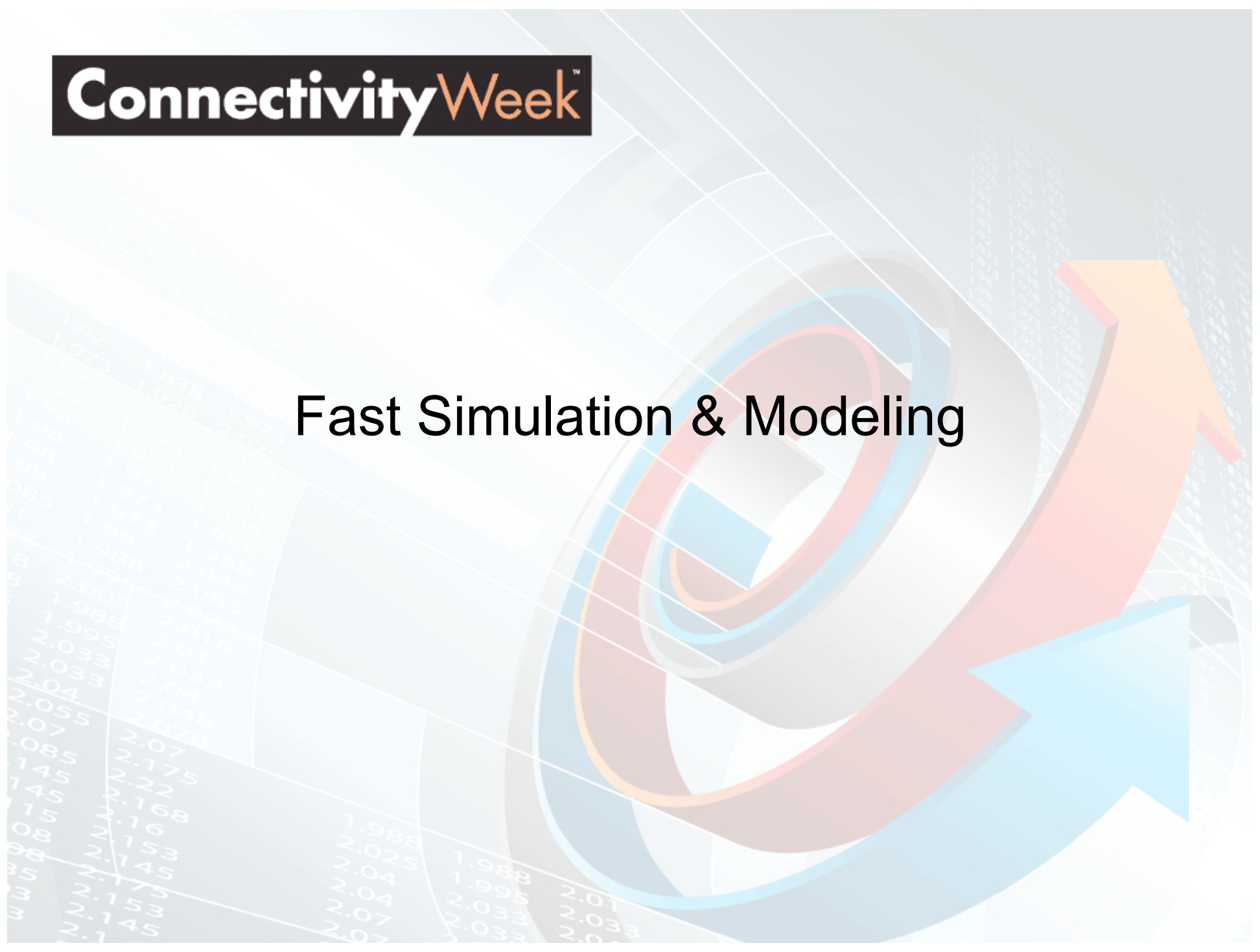
Smart Grid – Example of how it works

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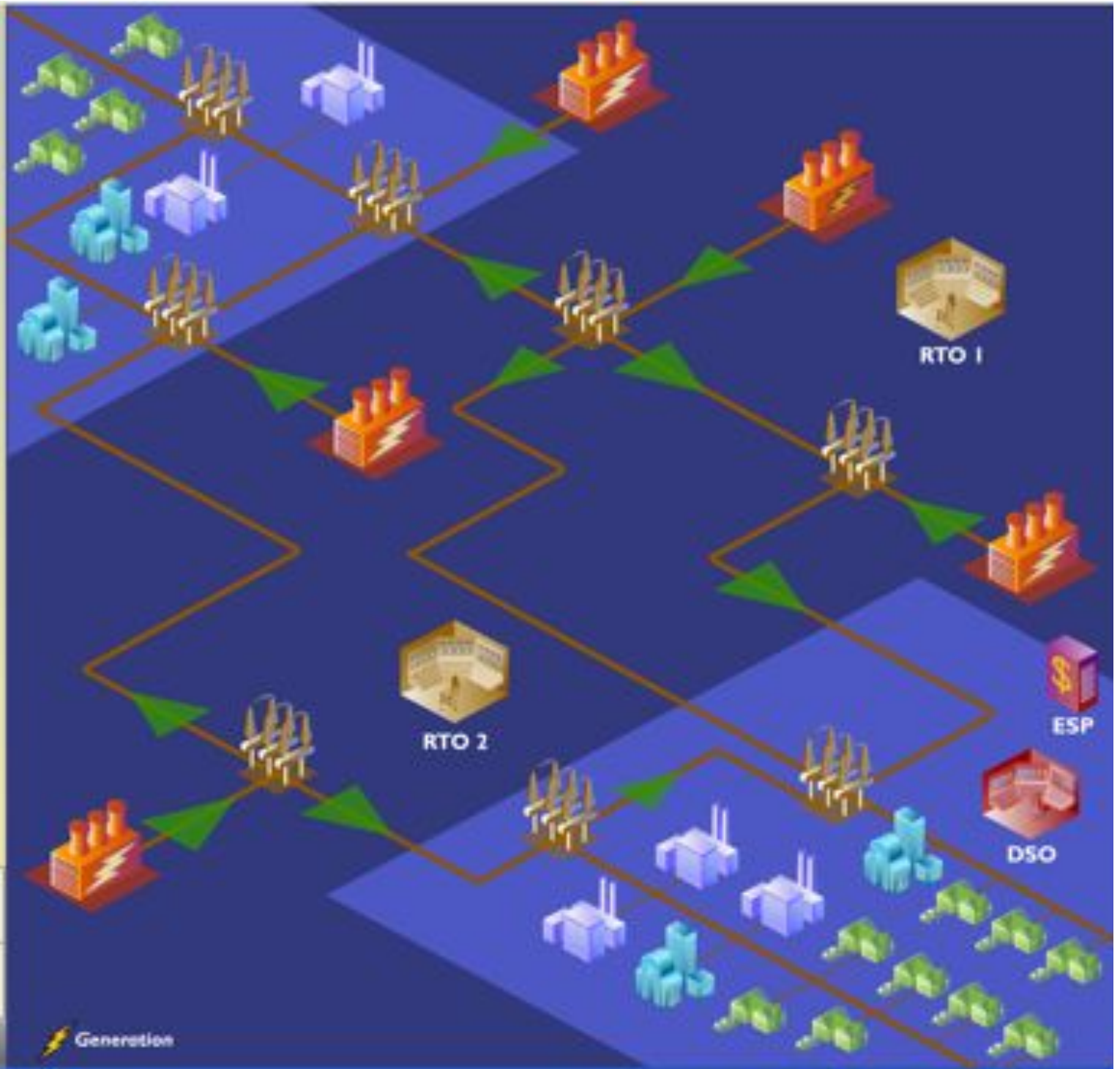
Vice Chairman GridWise Alliance

Fast Simulation & Modeling



Scenario: Peak Load/Blackout

I.
The transmission grid between two big cities is facing a peak load. It's a hot day and the air conditioners are consuming large amounts of energy.

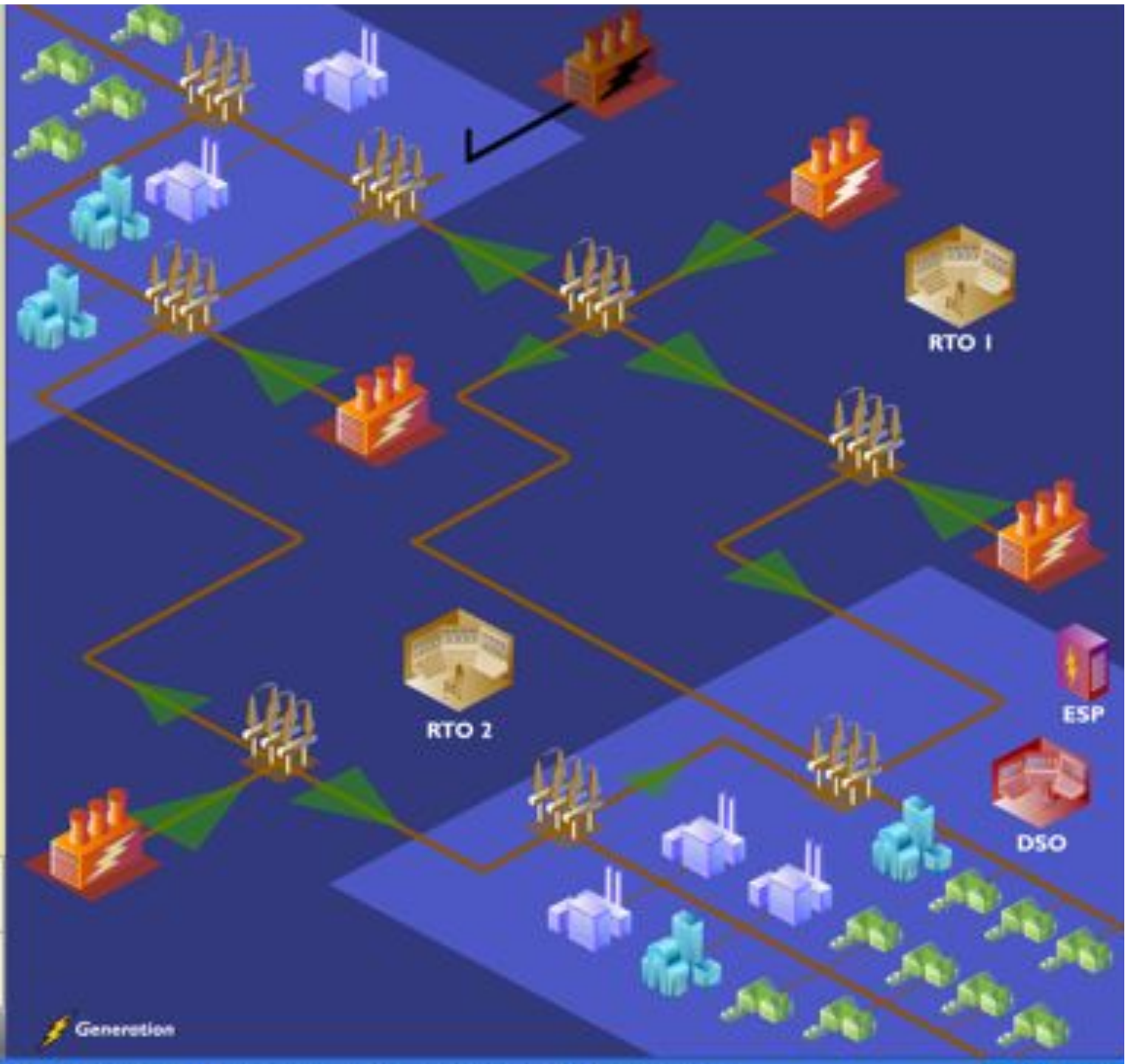


Scenario: Peak Load/Blackout

2.

A plant is turned off for planned maintenance. The other power plants have been warned that they will have to produce more.

Today there is less overall generating capacity compared to a day when all plants are producing.



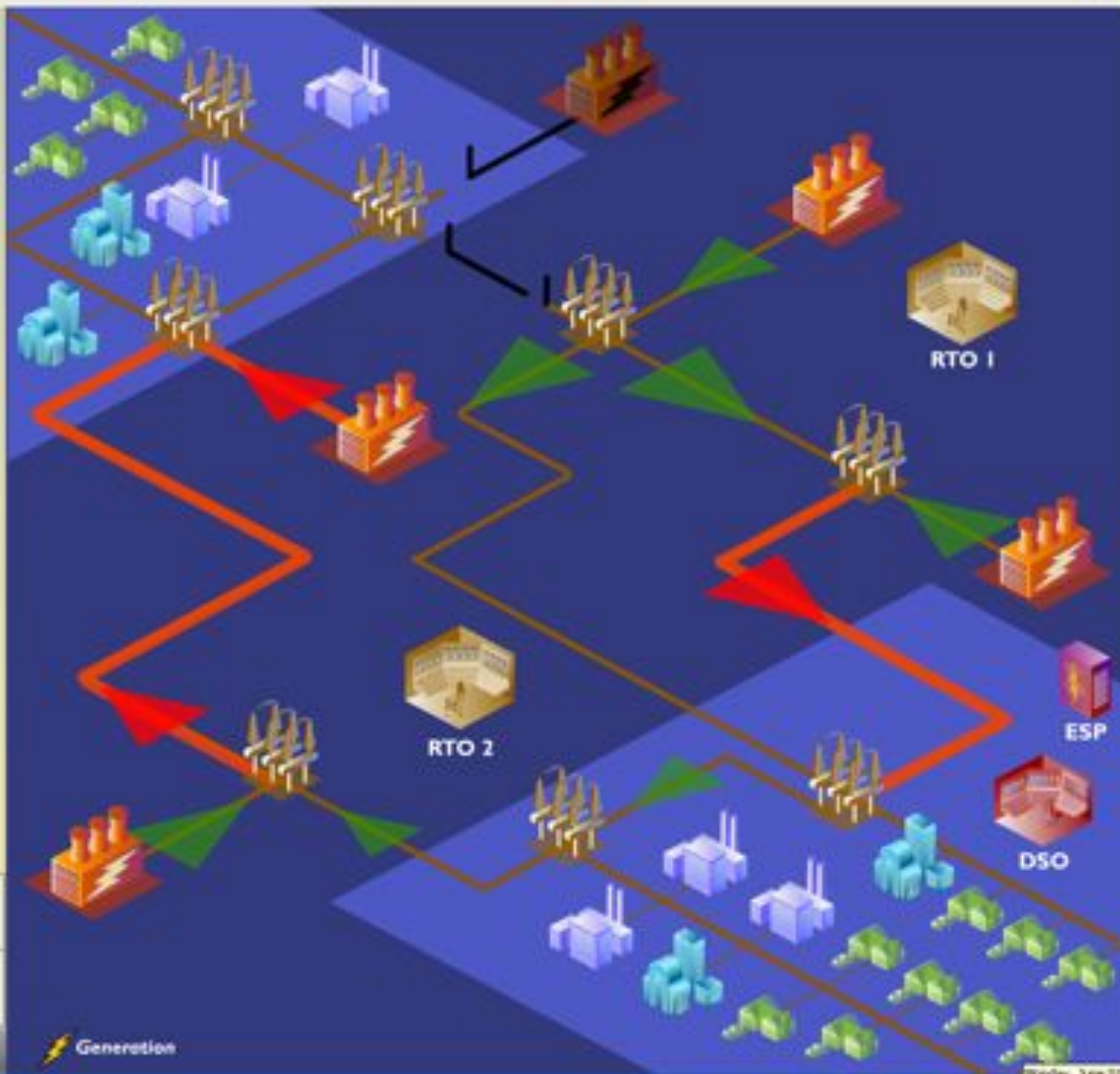
Scenario: Peak Load/Blackout

3.

A storm hits the area. Lighting strikes the line, destroying a piece of equipment on a tower.

This creates a default, the protections open the circuit breakers.

The topology of the grid is modified. The changes in the power flows create some overloads.

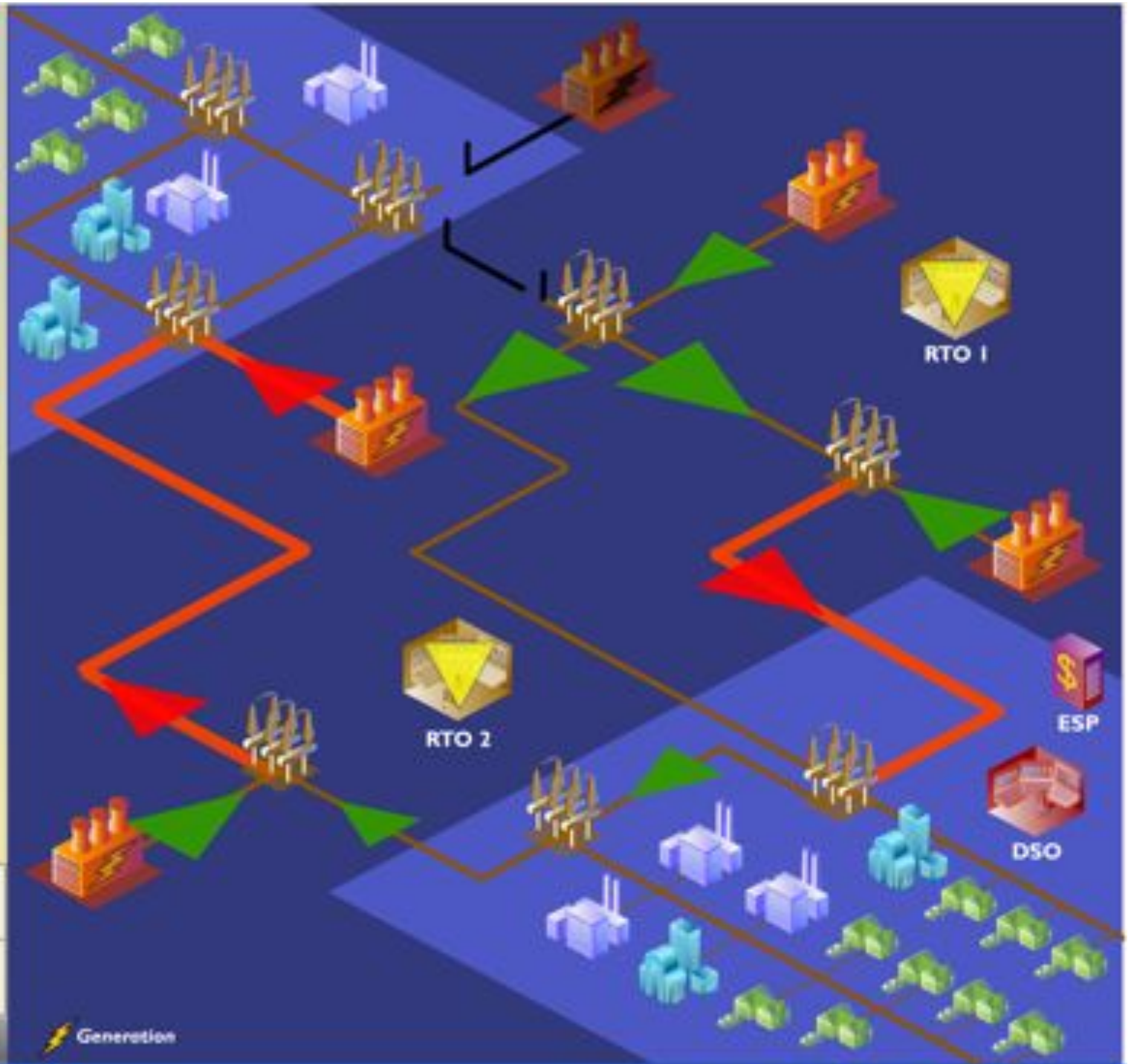


 Generation

Scenario: Peak Load/Blackout

4.

The 2 RTOs don't communicate between each other. RTO #2 doesn't know why it is facing overloads, and hasn't foreseen it.

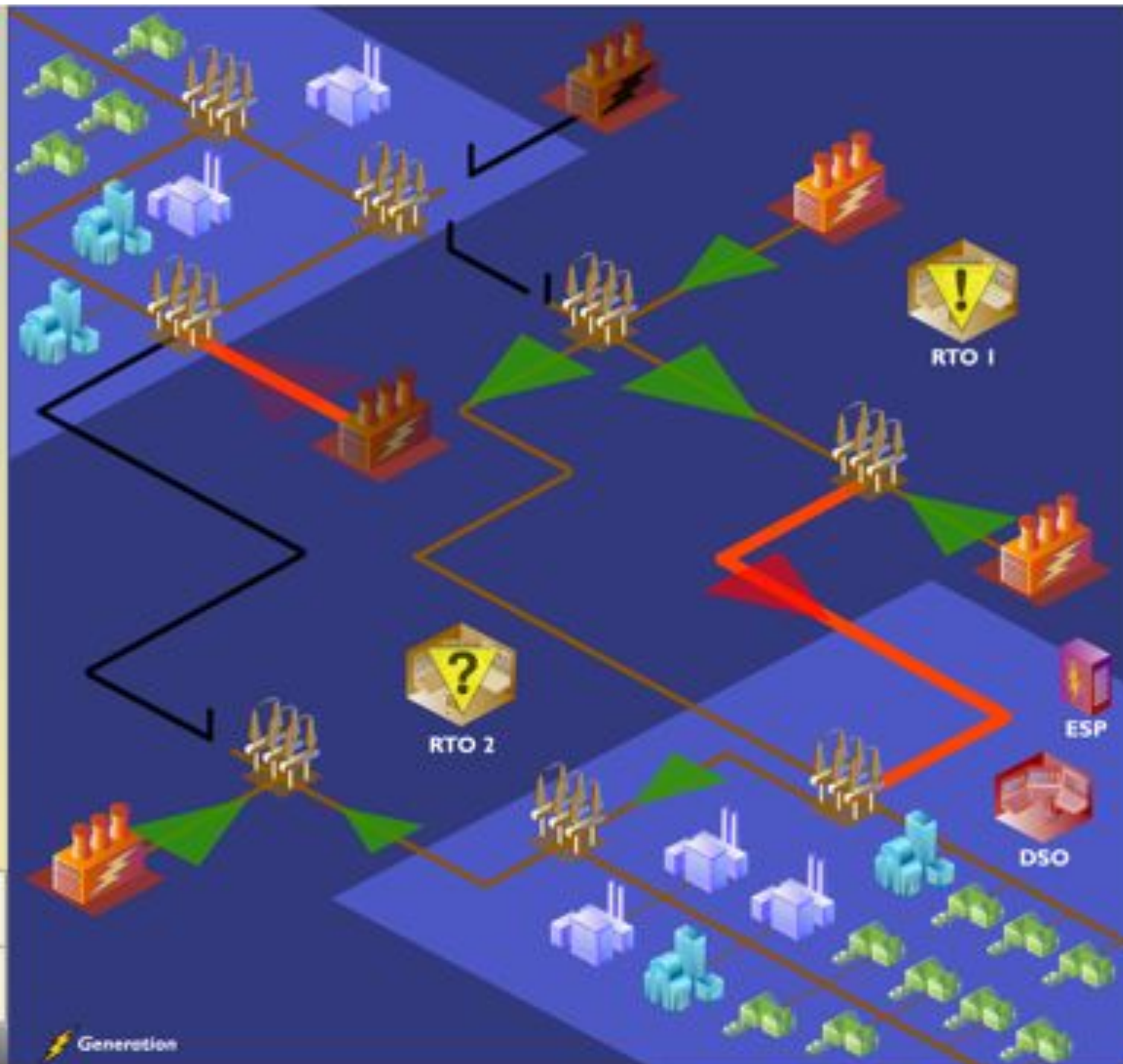


Scenario: Peak Load/Blackout

5.

Soon another line trips off due to overload, disconnecting the north area from the grid.

The only plant left can't supply the loads, the plant disconnects for stability reasons.



Scenario: Peak Load/Blackout

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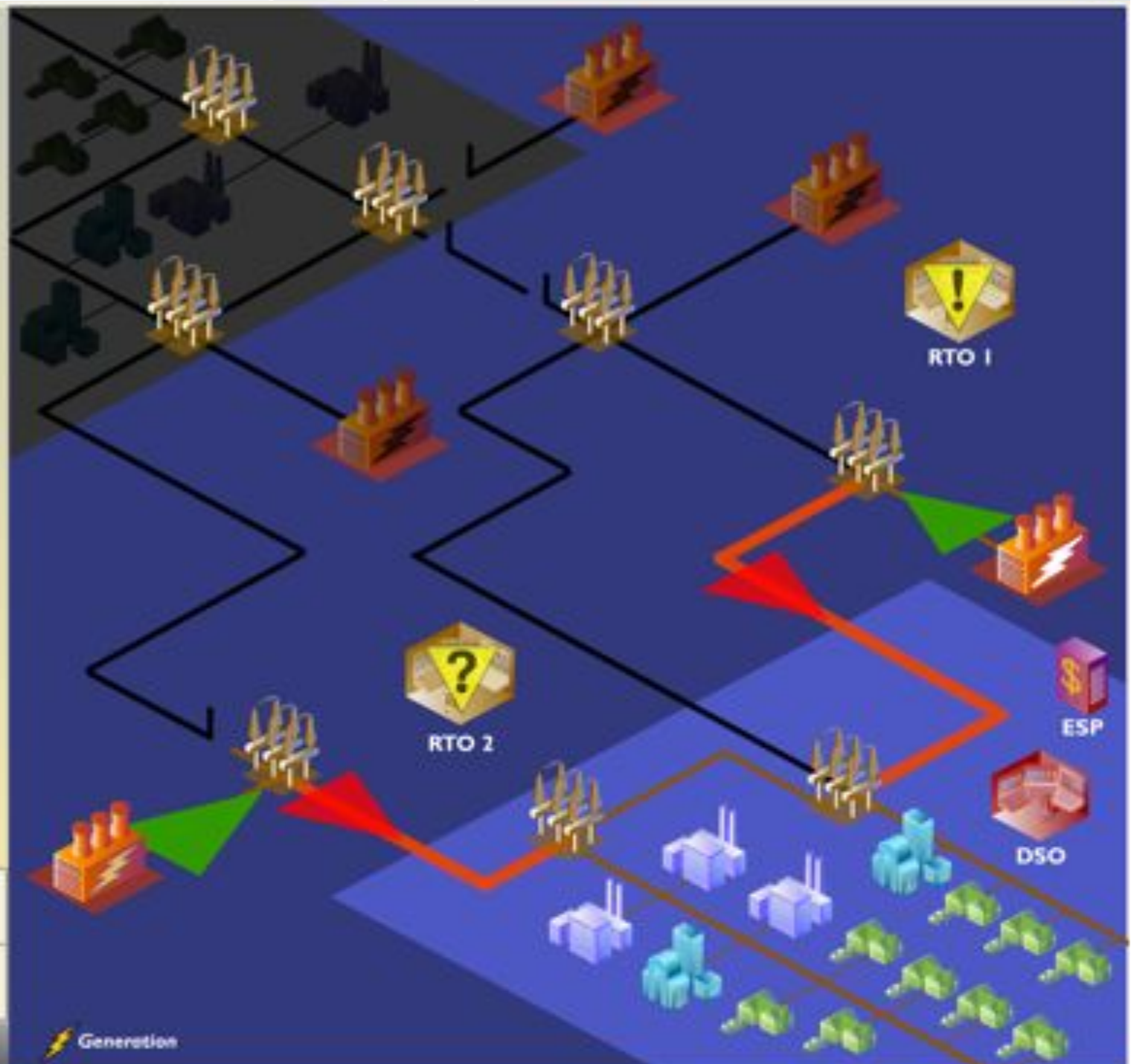
The only plant left can't supply the loads, the plant disconnects for stability reasons.

Instantaneously, the whole north area is in Black out.

Supply



Demand



Scenario: Peak Load/Blackout

6.

On the part of the grid still on, there is a huge unbalance between load and generation.

The power plants oscillate and disconnect to ensure stability.

The cascade of events has plunged the whole grid into Black out.

Supply



Demand



Reset – Using Smart Grid FSM



Scenario: Peak Load/Blackout

7.

Replay of the scenario, but with the assumption that the Grid has been designed using Intelligrid Architecture and that FSM has been implemented.

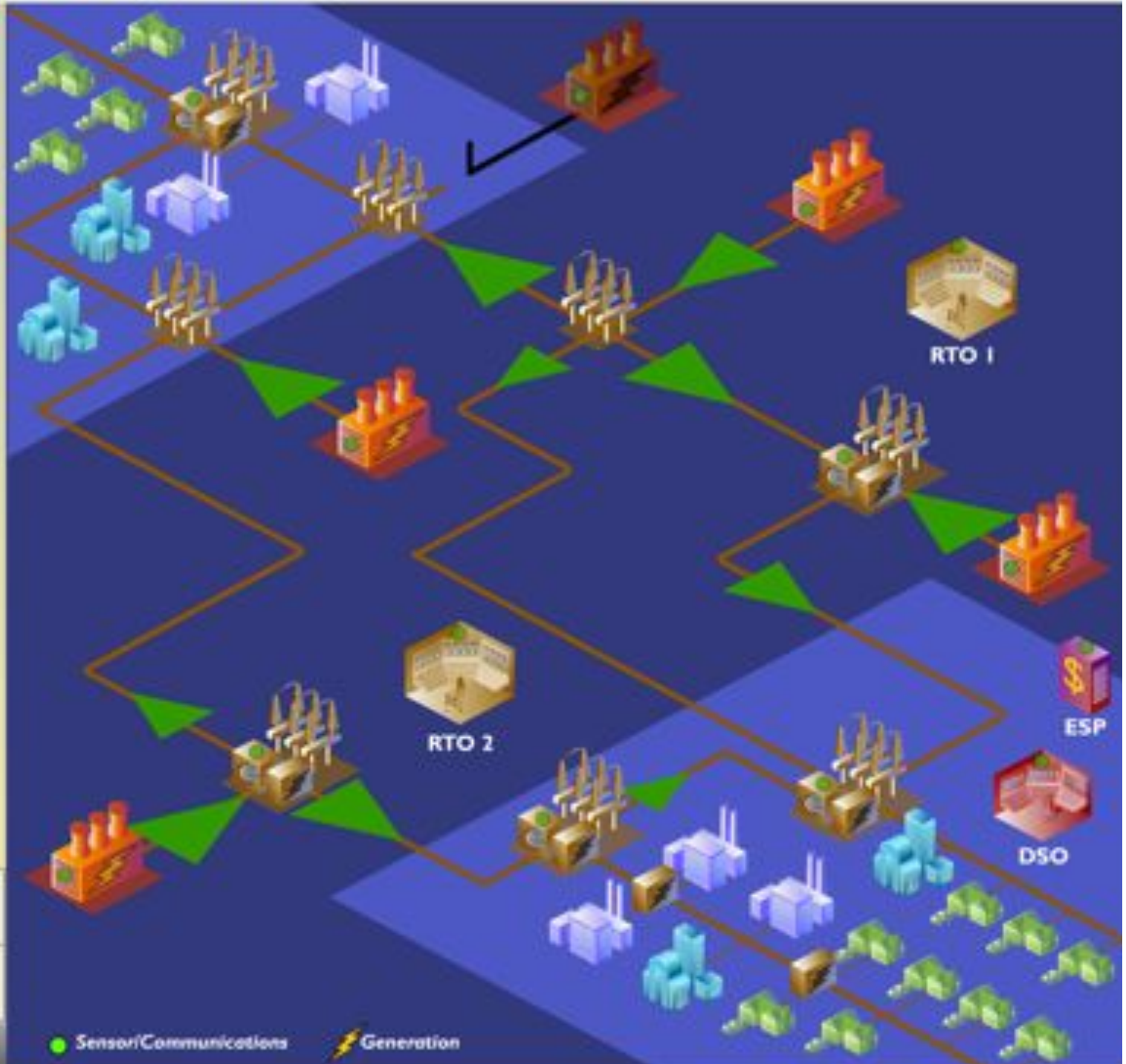


Scenario: Peak Load/Blackout

8.

Let's have a close look at what's going on in the RTOs at that moment.

The FSM suite of tools is connected to the grid. FSM collects data from sensors and intelligent agents, and runs analysis. The real-time information is presented to the operator, in a user-friendly way.



Scenario: Peak Load/Blackout

8.

Let have a close look at what's going on in the RTOs at that moment

The FSM suite of tools is connected to the grid. FSM collects data from sensors and intelligent agents, and runs analysis. The real time information is presented to the operator, in a user friendly way.

Capabilities:

Forecasting - FSM foresees the peak load, the capacity and the prices in the next minutes, hours, days.

Real time state estimator - models the state of the grid at that exact moment.

Predictive capabilities - FSM simulates what would happen to the grid if an event was to occur, according to historical data, statistical analysis and systematic schemes. (what if the line is lost?)

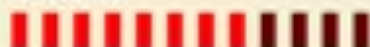
Analyses of the risks and alarms to the operators

Analyses of solutions - statistical, and systematic schemes to find solutions and propose some emergency action plan that can be taken -automatically and with human actions-using new functions of the grid -Power electronics to control power flows, demand-response to reduce the loads or start DER, Islanding and microgrids.

Supply



Demand



Scenario: Peak Load/Blackout

9.

Based on information about the coming storm and the plant maintenance, the FSM suite of tools asks for additional capacity. A few DER are requested to start.



Scenario: Peak Load/Blackout

10.

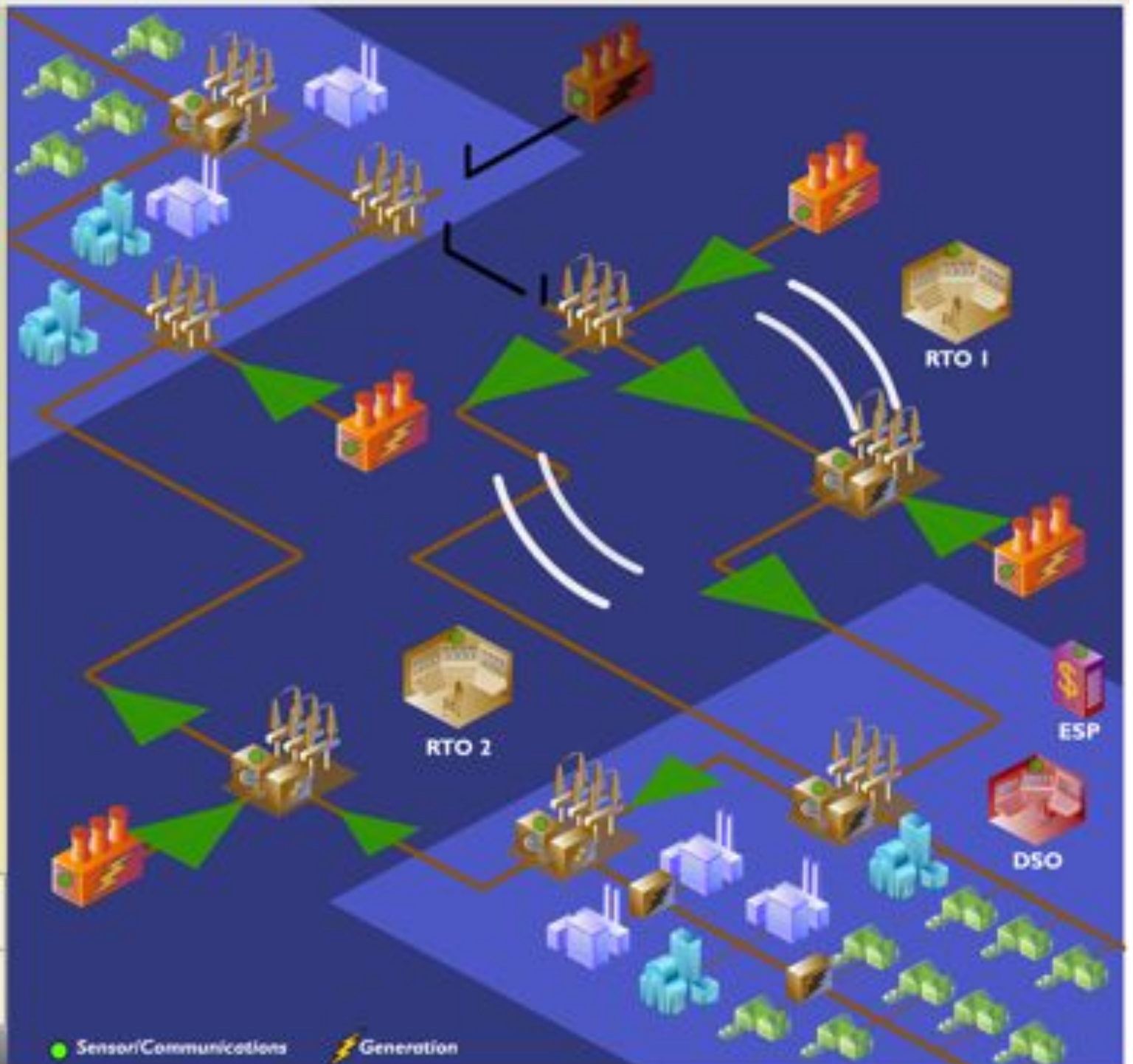
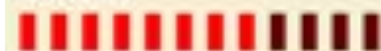
Lightning strikes the line that trips off. Instantaneously, the RTOs that are now coordinating follow the emergency action plan determined by FSM suite of tool. First the RTOs start a demand and response action in order to reduce the loads. The consumers are encouraged to reduce their consumption and start DER.

At the same time, the power electronics devices (FACTS) control the power flows to avoid the overload.

Supply



Demand

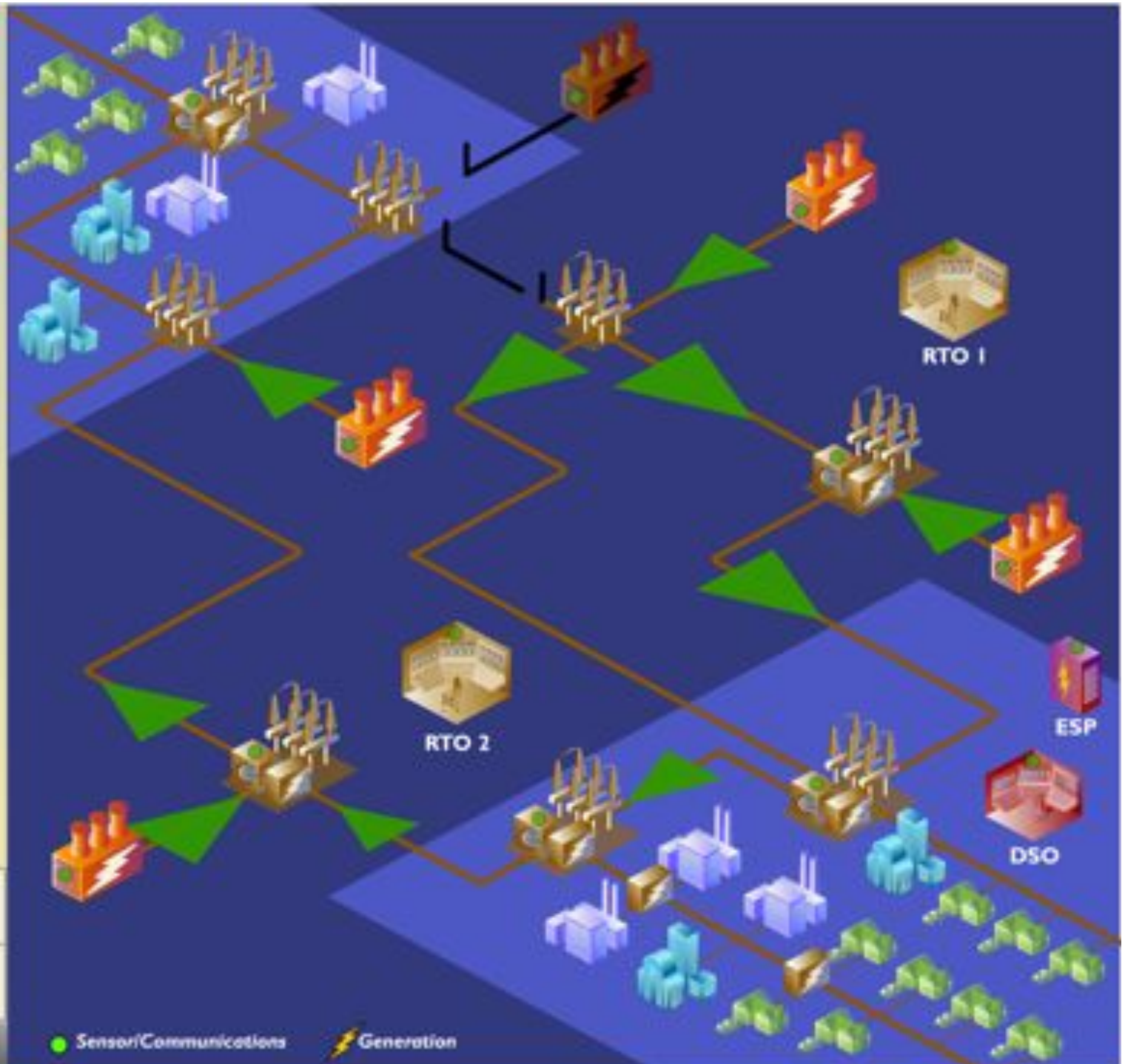


Scenario: Peak Load/Blackout

II.

The situation is stable. As some DER are on, the capacity of the grid is increased and the shaded loads can be recovered, even in this peak load situation.

By the application of FSM, a blackout is averted.



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Thank you

