

System Protection Scheme (SPS) Installations in Norway

By

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Use of SPS

Automatically surveillance of grid and market.



More distributed production with wind, solar, new use of hydro power. Integrated with flexible solutions on the consumer side



How can SPS contribute to:

- More integrated solutions in energy production ?
- Safe operation in power systems with small amount of inertia and more converter based production ?
- New markets and products on producer and consumer side ?
- Integrated solutions in Nordic and European activations platforms for reserve power ?
- Use of artificial intelligence (AI) and machine learning to be used to for optimize algorithm for setting of SPSs ?

Integrated European and Nordic solutions for grid monitoring and activation of electric energy reserves

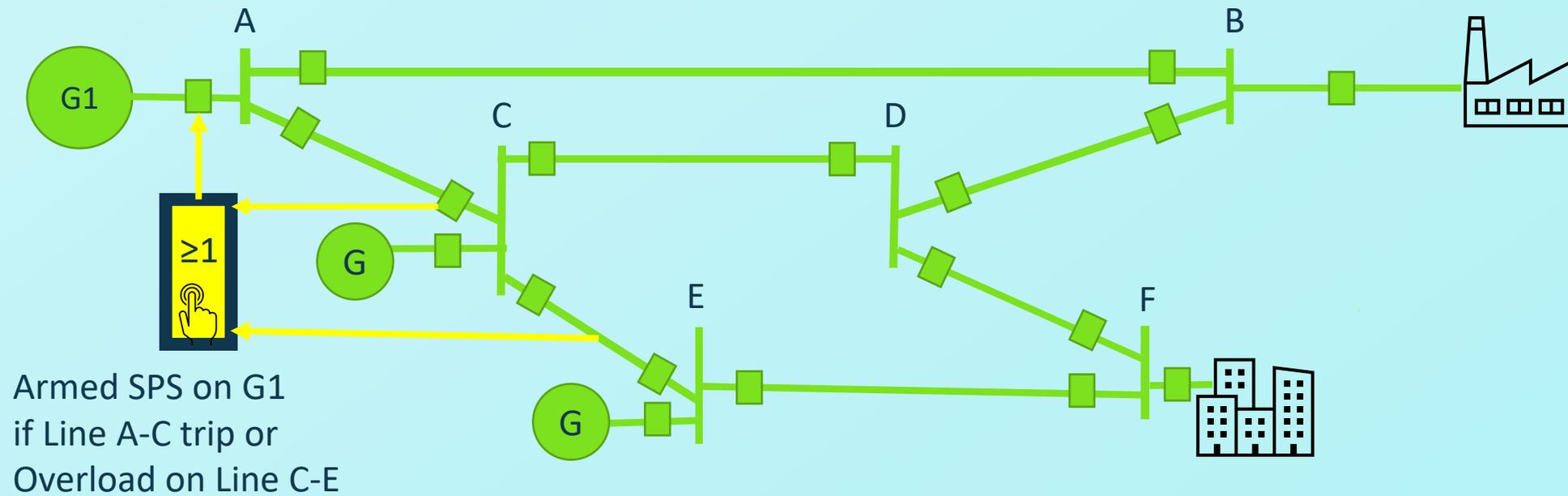




System protection schemes (SPS)
Gives grid operation possibility to stay inside
N-1 criteria within acceptable risks

System Protection Schemes (SPS)

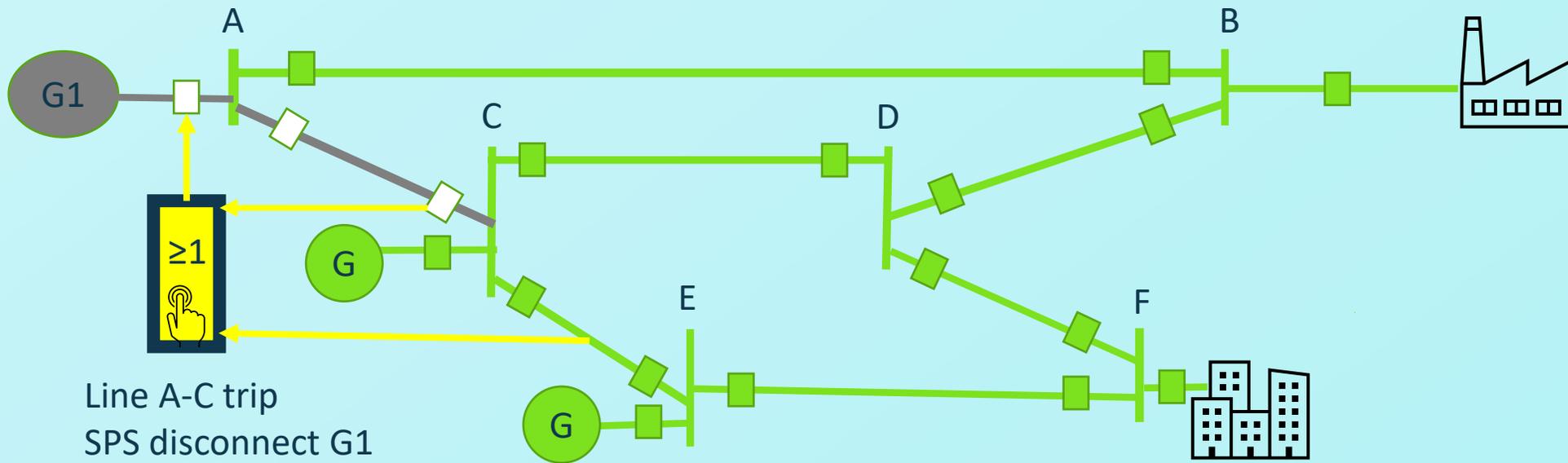
Event-based protection solutions
Disconnection of production (PFK)



System Protection Schemes (SPS)

Event-based protection solutions

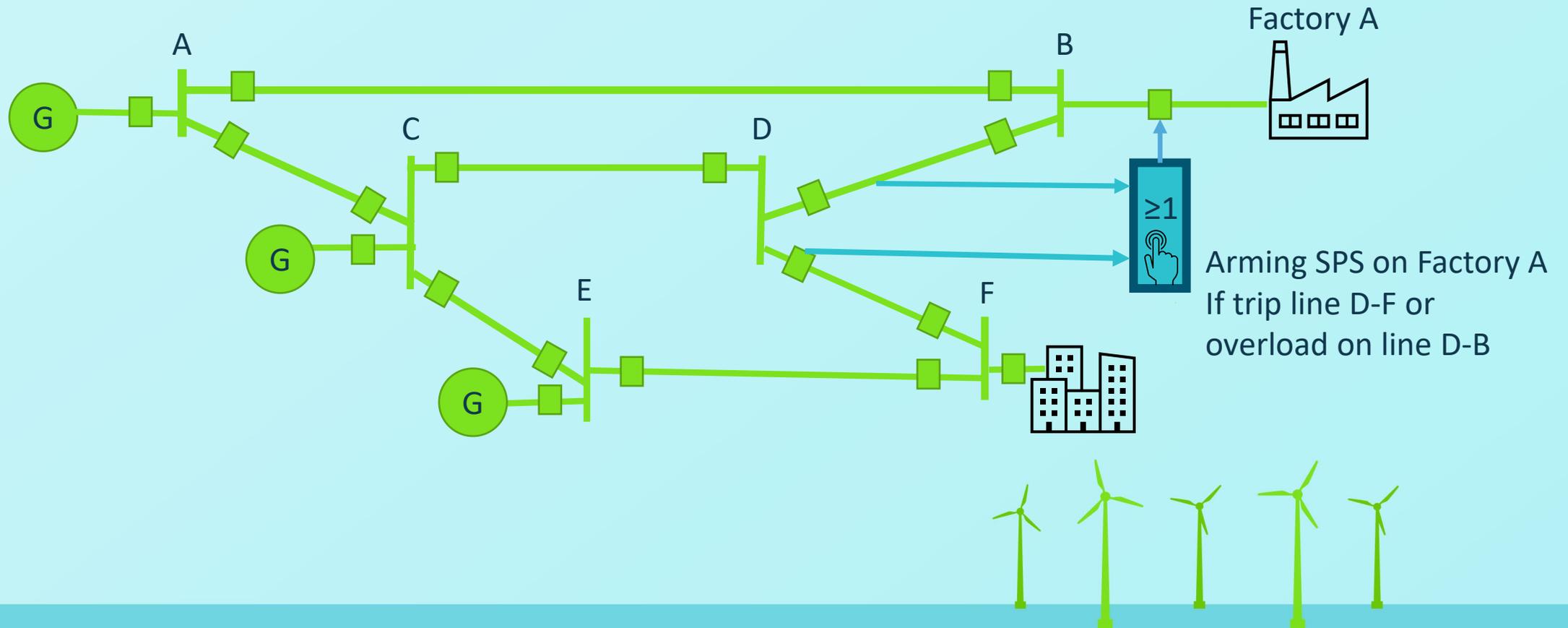
Disconnection of production (PFK)



System Protection Schemes (SPS)

Event-based protection solutions

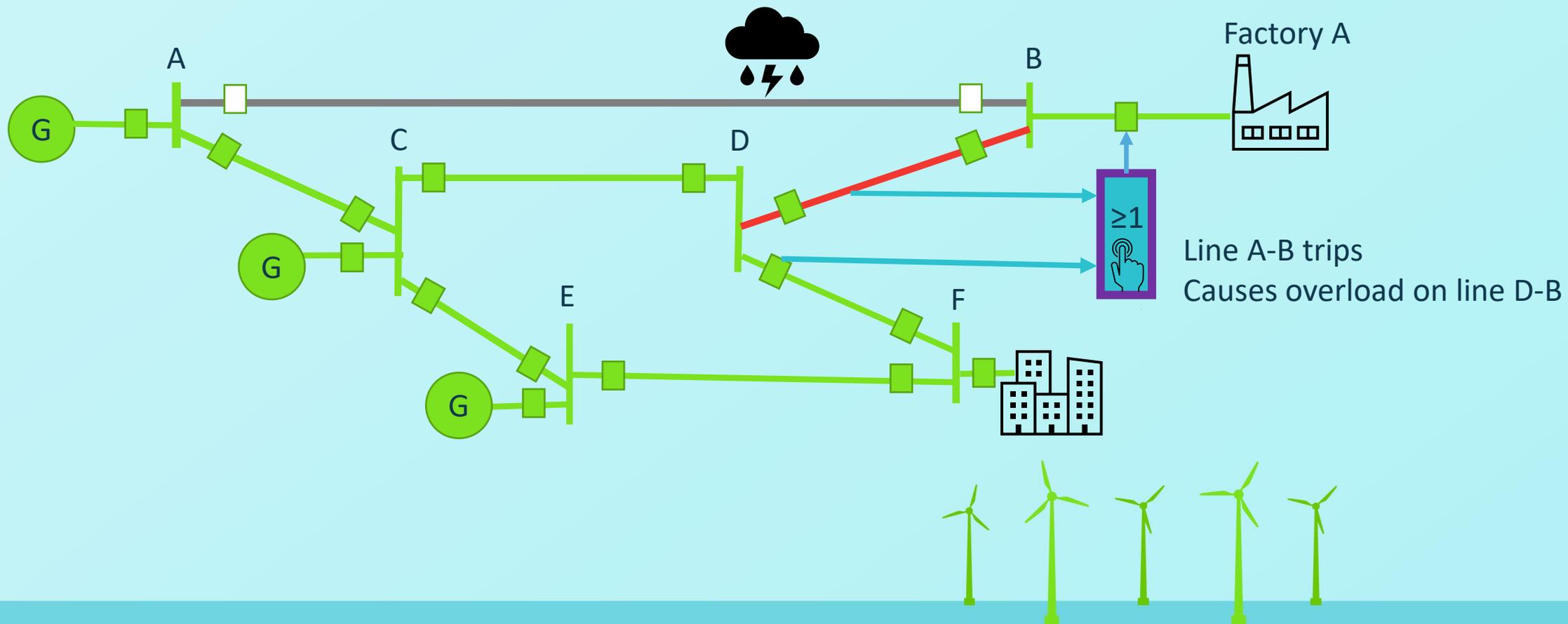
Disconnection of load (BFK)



System Protection Schemes (SPS)

Event-based protection solutions

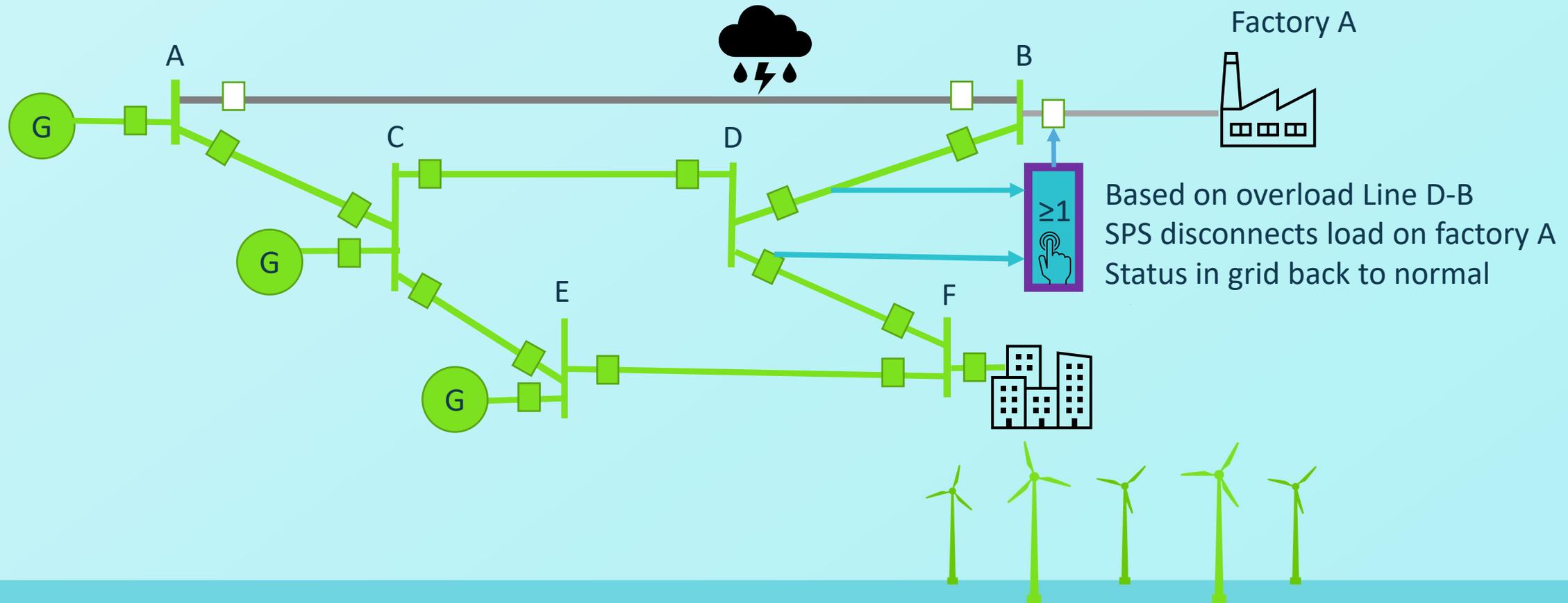
Disconnection of load (BFK)



System Protection Schemes (SPS)

Event-based protection solutions

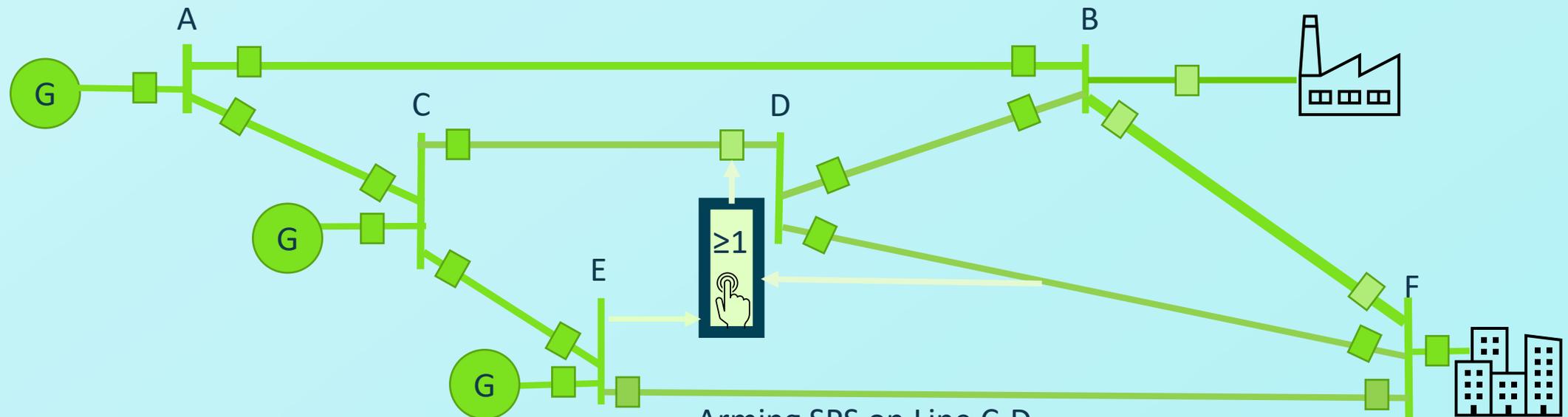
Disconnection of load (BFK)



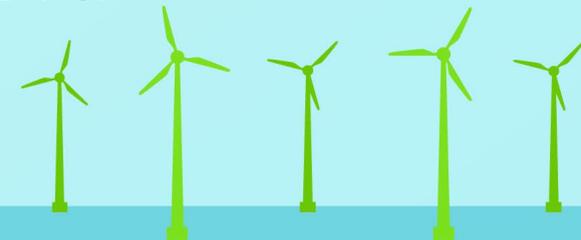
System Protection Schemes (SPS)

Event-based protection solutions

Change topology (Nettsplitt)



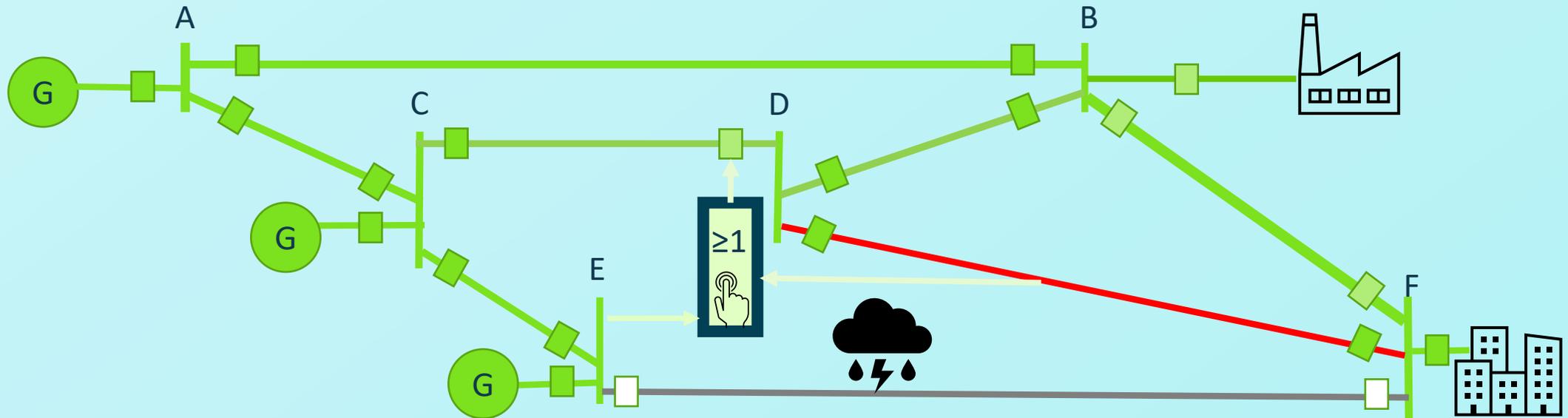
Arming SPS on Line C-D
If overload on line D-F or
trip on busbar E



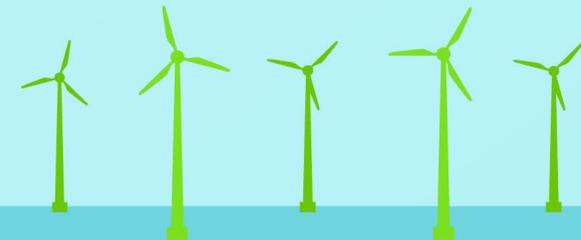
System Protection Schemes (SPS)

Event-based protection solutions

Disconnection of load (BFK) and change topology (Nettsplitt)



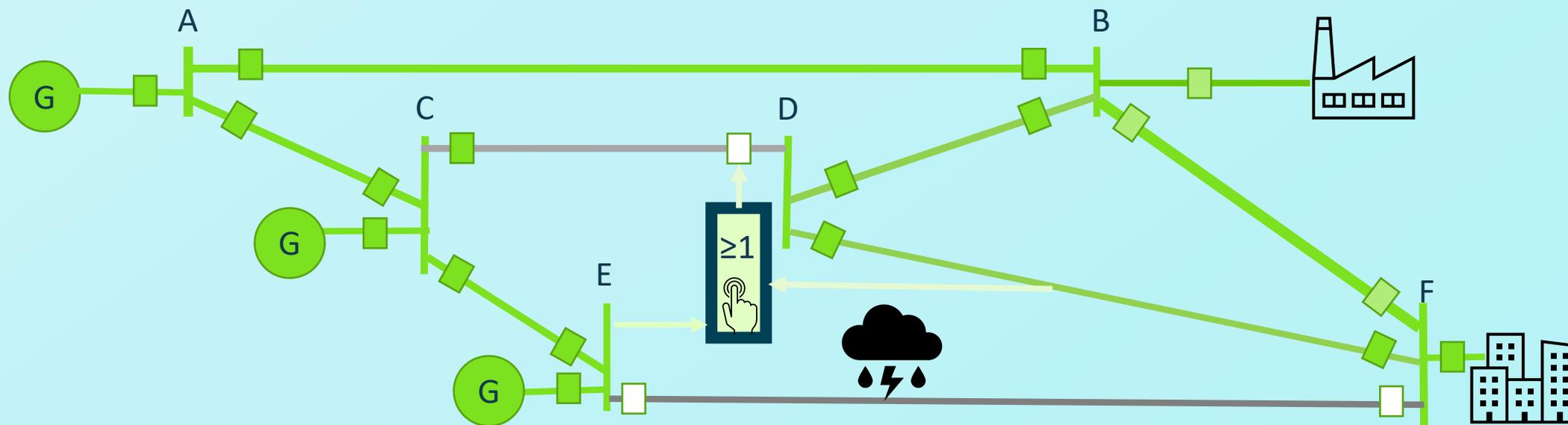
Line E-F trips, causes overload on line D-F



System Protection Schemes (SPS)

Event-based protection solutions

Disconnection of load (BFK) and change topology (Nettsplitt)



Due to overload on Line D-F

SPS disconnects Line C-D

The powerflow changes, due to change in topology. More powerflow on line B-F

Situation in the grid goes back to normal

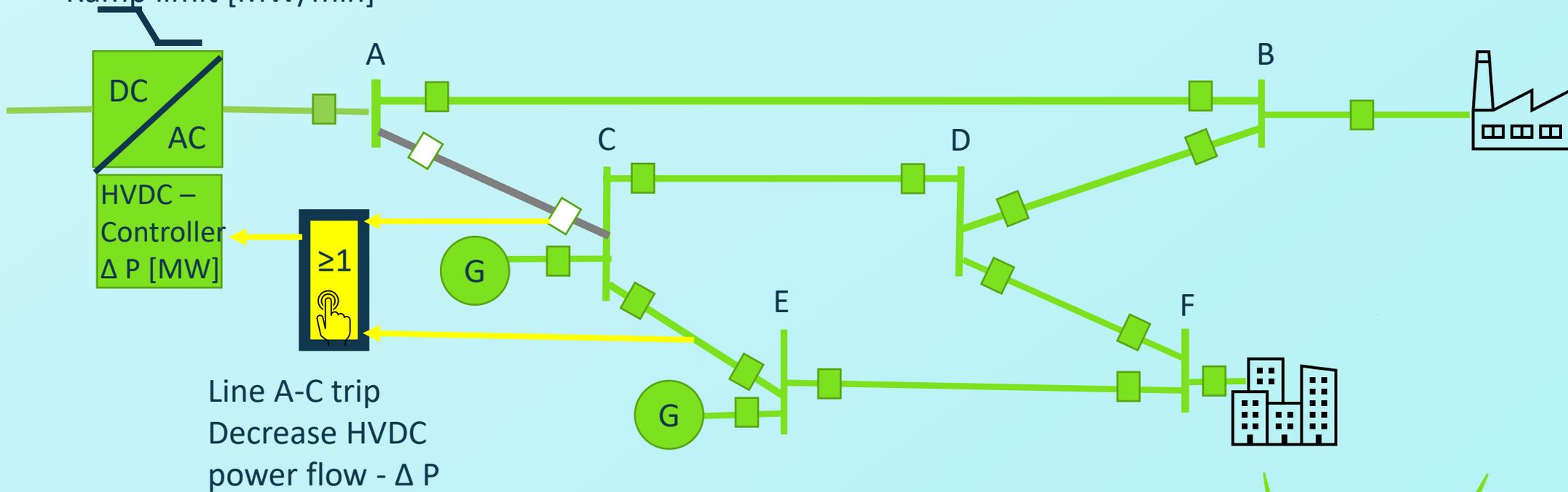


System Protection Schemes (SPS)

Event-based protection solutions

Reduction in HVDC Power flow $-\Delta P$

Ramp limit [MW/min]



Line A-C trip
Decrease HVDC
power flow $-\Delta P$



More than 350 SPS functions in the Norwegian power system.

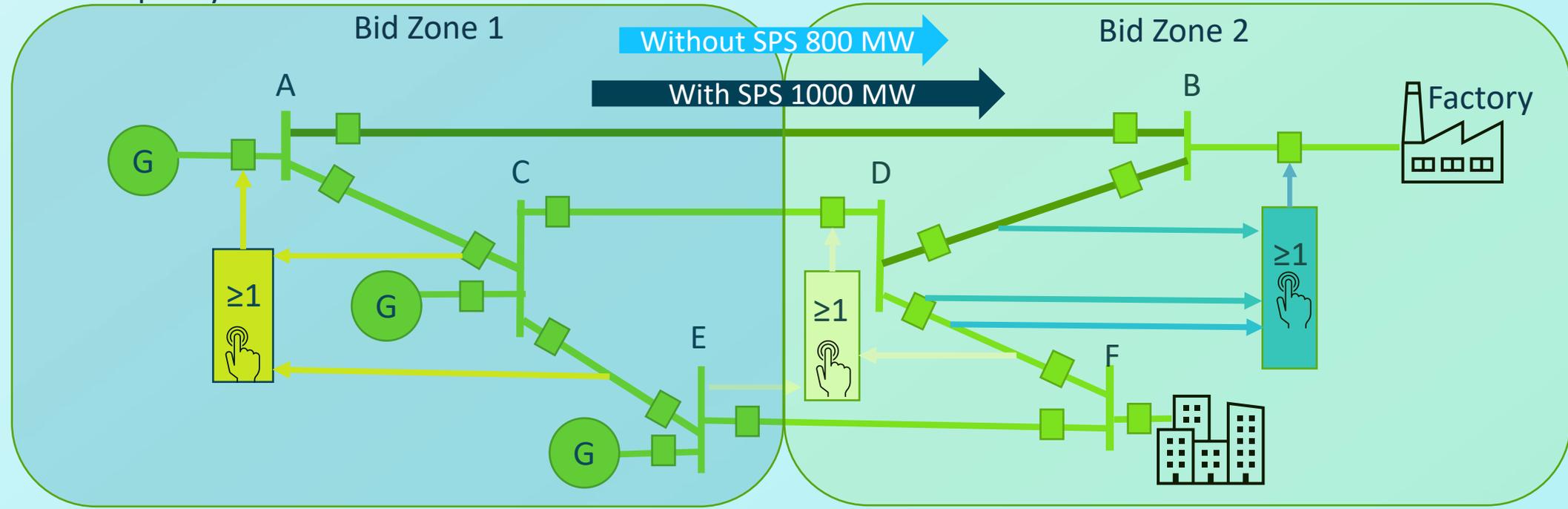
All settings are performed manually by operators

Approximately 2000 change of settings pr year

Without a good overview and correct settings,
it could risk making unwanted interventions, with major
consequences

System Protection Schemes (SPS)

Capacity increase on transfer corridor due to SPS



Cut:
25% line A-B + line B-D

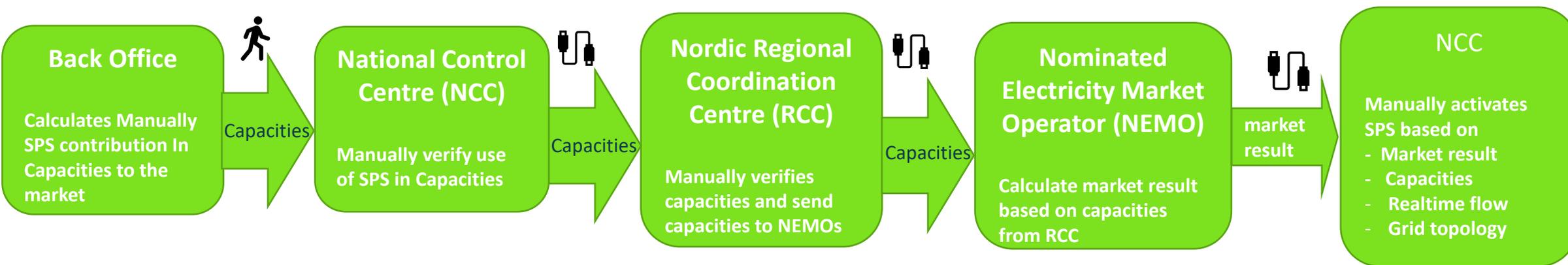
Contribution from SPS:
1 > line B-D
50% Factory (400MW)

Capacity Without SPS:
(limit on B-D)
800 MW

Capacity With SPS:
limit on B-D [800 MW] + SPS contribution [200 MW]
1000MW

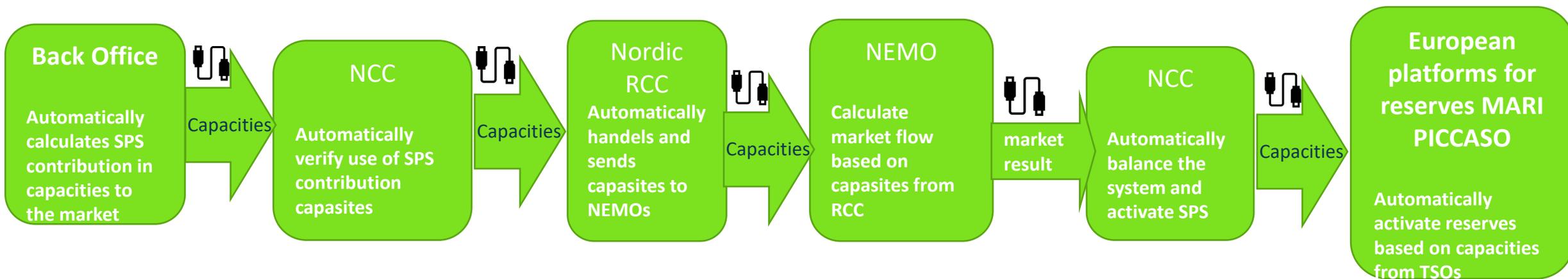


Steps in present use of SPS in market capacity (Today preformed in manually steps)



Steps in future use of SPS in market capacity and automatically activation of reserve power in operations.

- Future automation of system operation require automatic method for setting of SPS



A scenic landscape featuring a body of water in the foreground, a dense forest of evergreen trees in the middle ground, and rolling hills or mountains in the background. The scene is bathed in a soft, golden light, suggesting either sunrise or sunset. Overlaid on the center of the image is the text "Thank you" in a large, bright green font.

Thank you