Akıllı Sistemler ile Elektrik Arz Güvenliği

Barış Sanlı

Bu sunumdaki tüm görüşler şahsi görüşlerdir. Hiçbir kurum ya da kuruluşa atfedilemez.

Akıllı sistemlerdeki dönüşüm
(Elektrik)

- 1970lerin sonu-80lerin başı
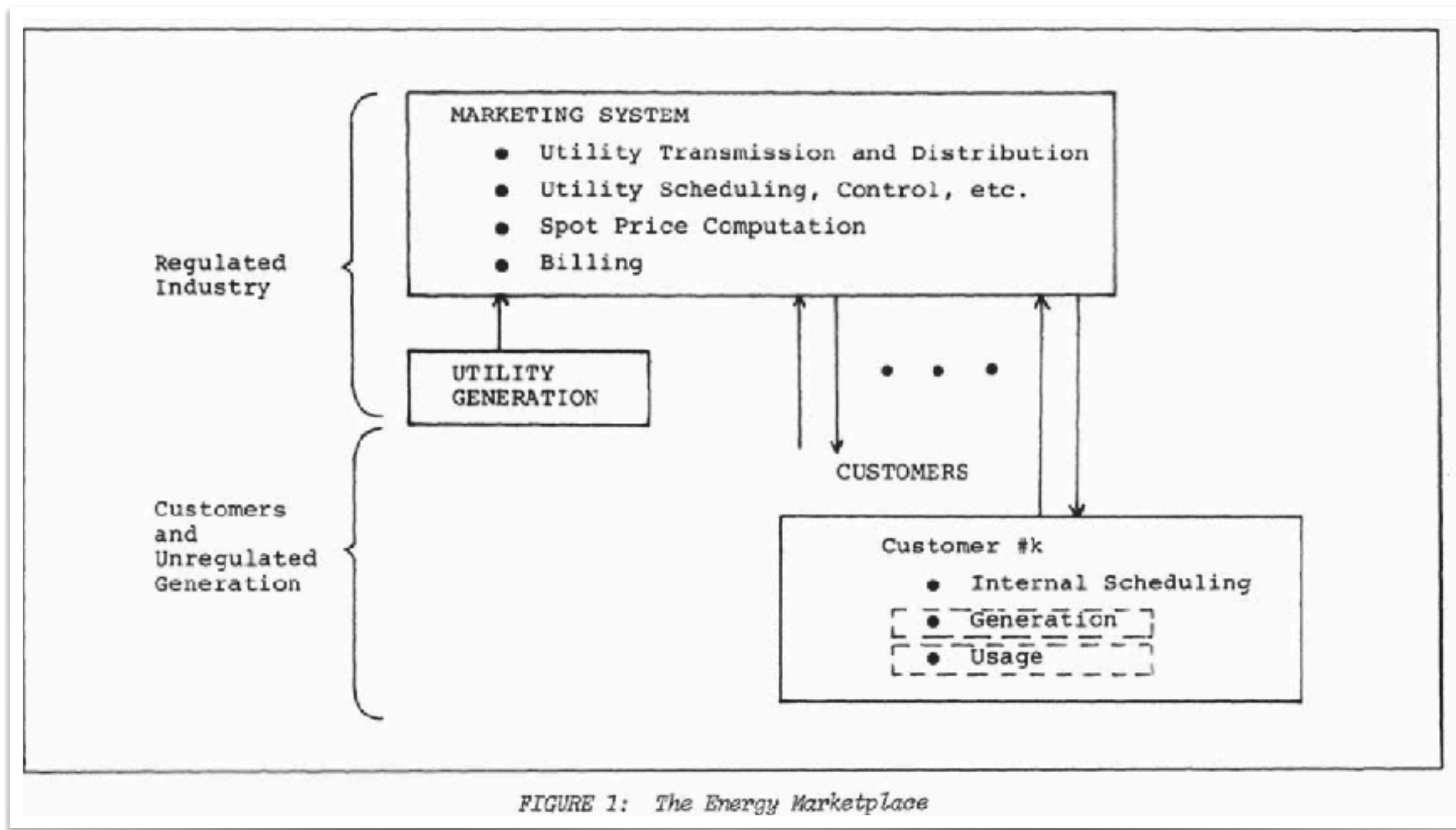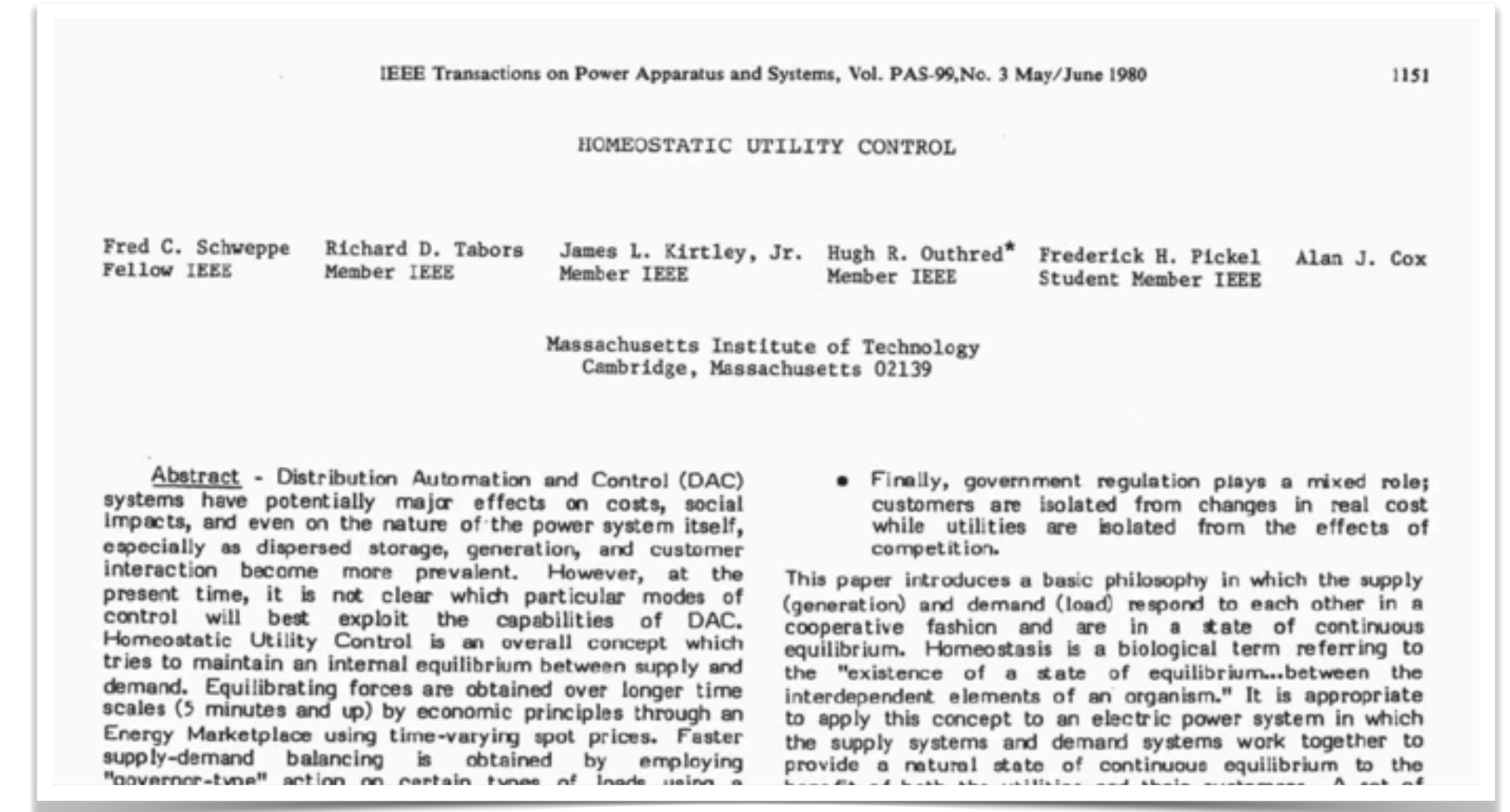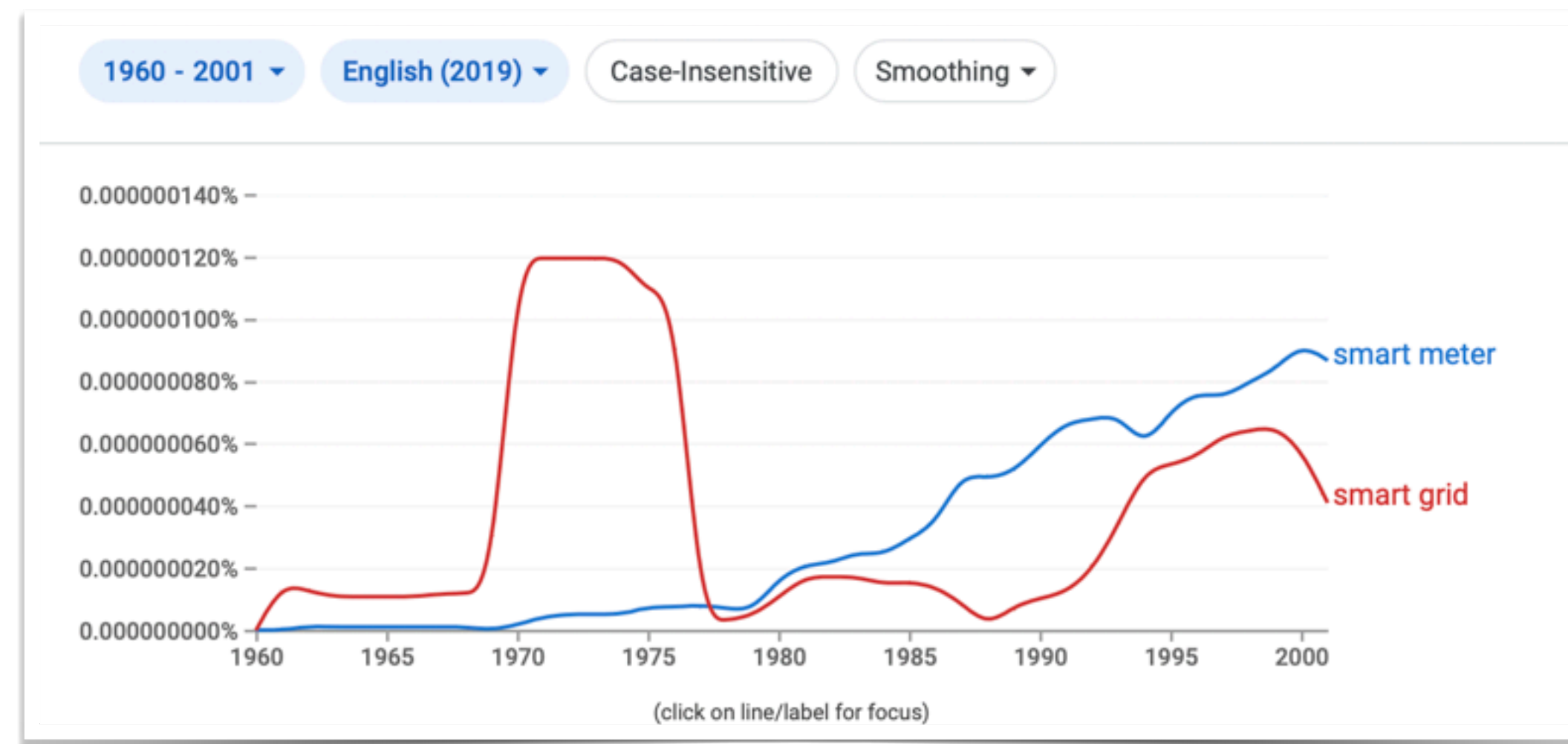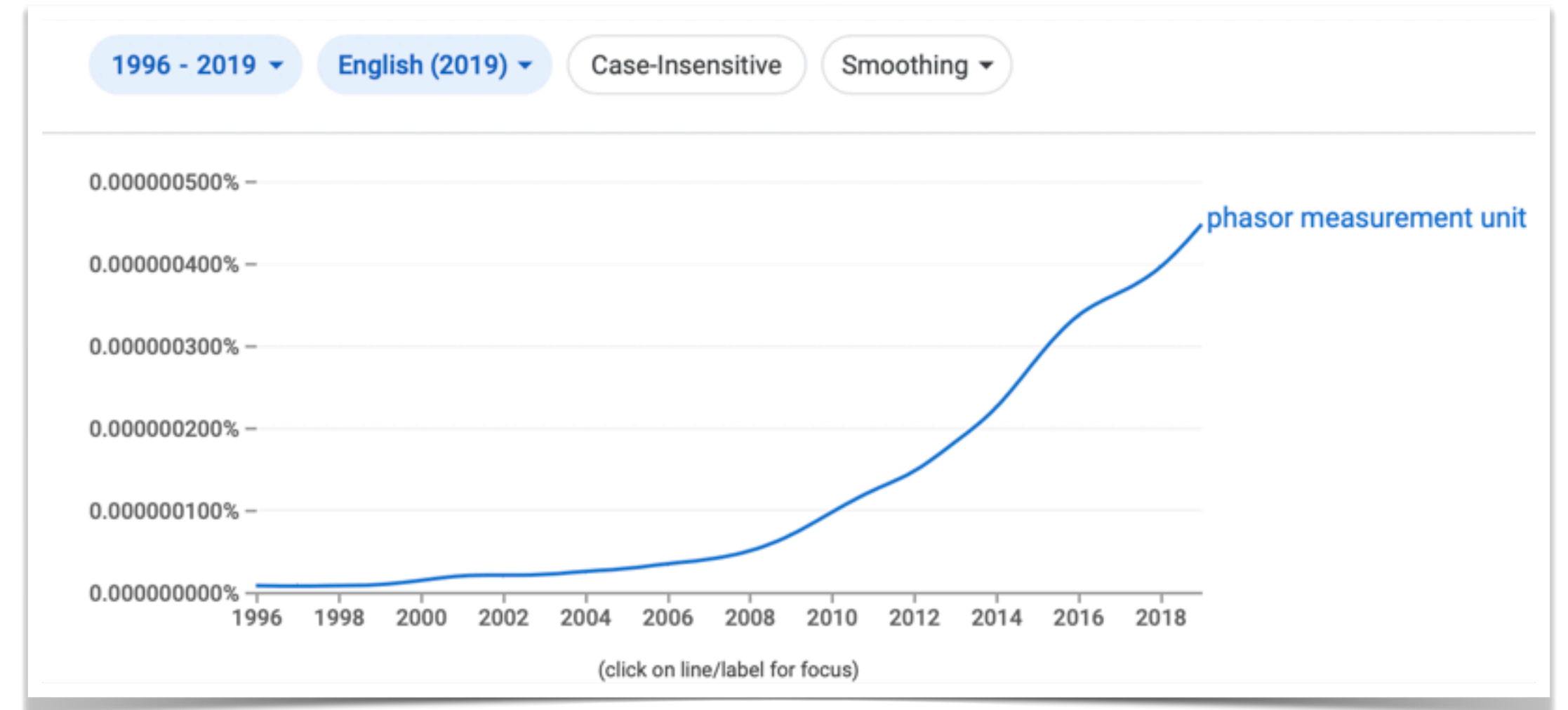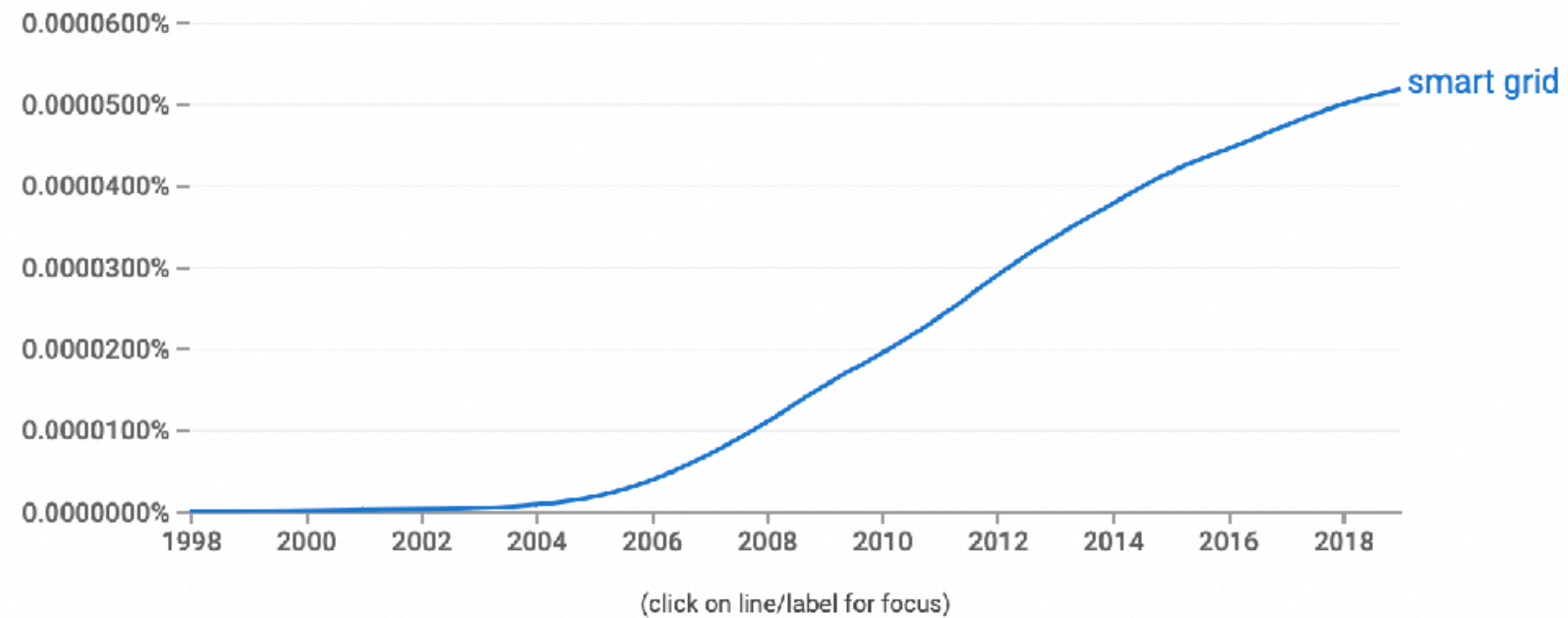
  - homeostatik kontrol

FIGURE 1: The Energy Marketplace

Akıllı sayaç, şebeke, PMU

IEA - Net Sıfır Emisyon(NZE) raporu

Key clean technologies ramp up by 2030 in the net zero pathway

Capacity additions (GW) — Wind, Solar PV; 2020, 2030; x 4

Electric car sales (millions) — 2020, 2030; x 18

Energy intensity of GDP (MJ per USD ppp) — 2020, 2030; 4% per year
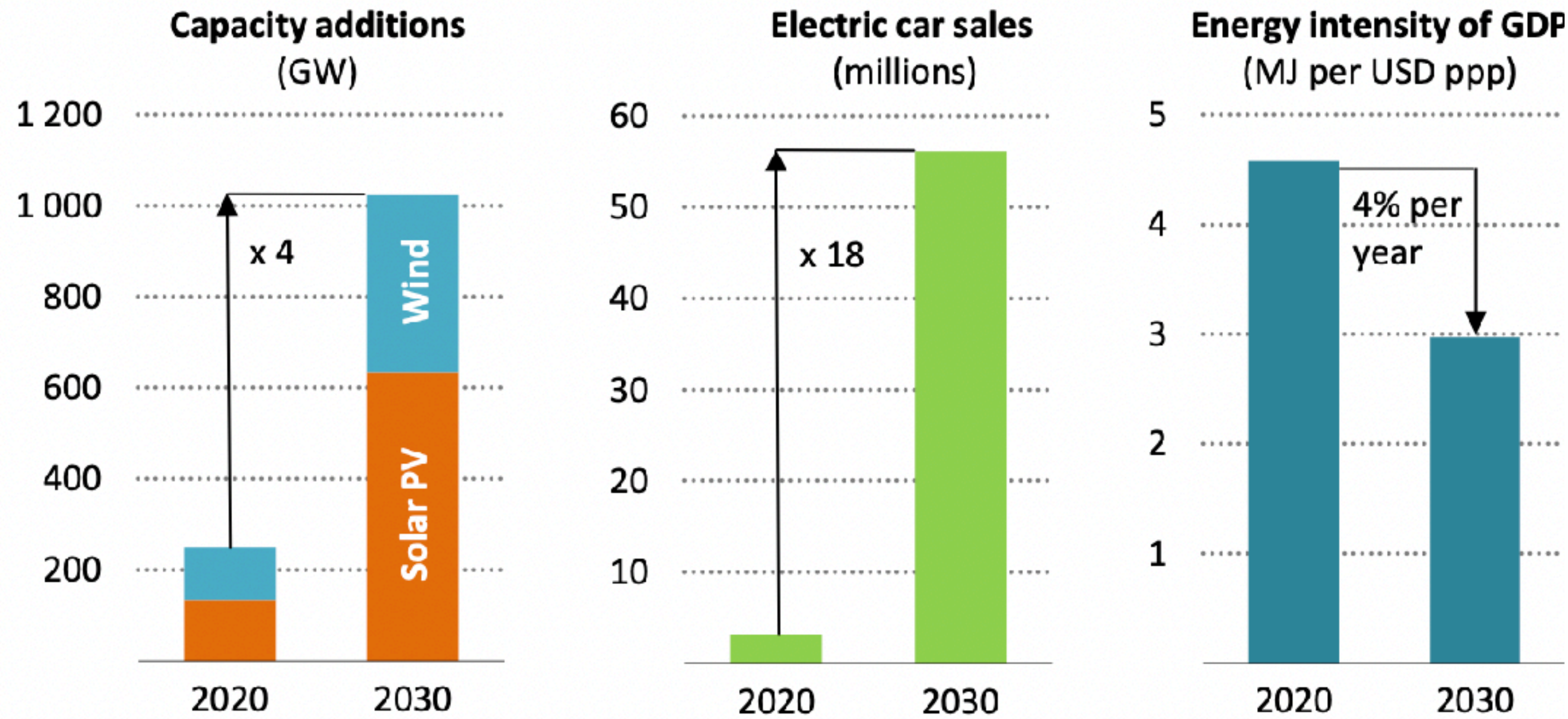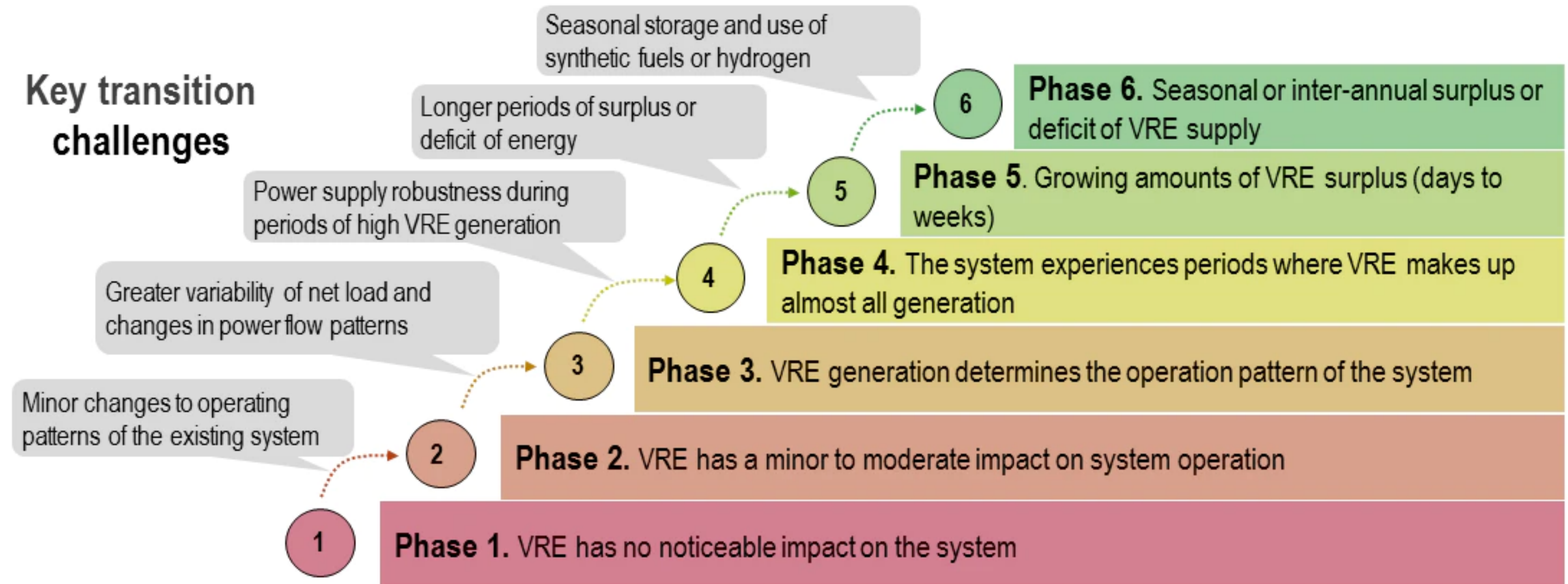
Note: MJ = megajoules; GDP = gross domestic product in purchasing power parity.

Key milestones in the pathway to net zero
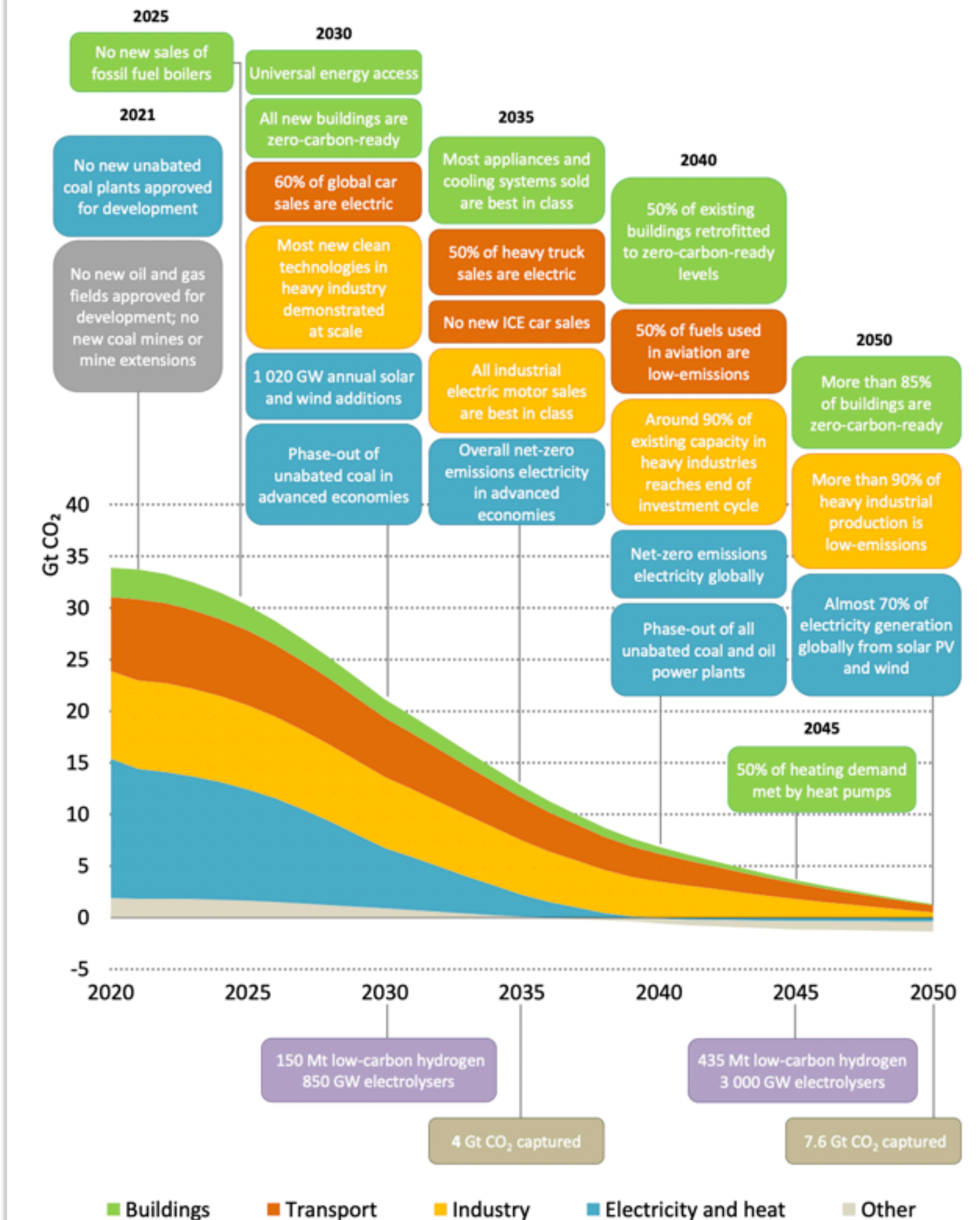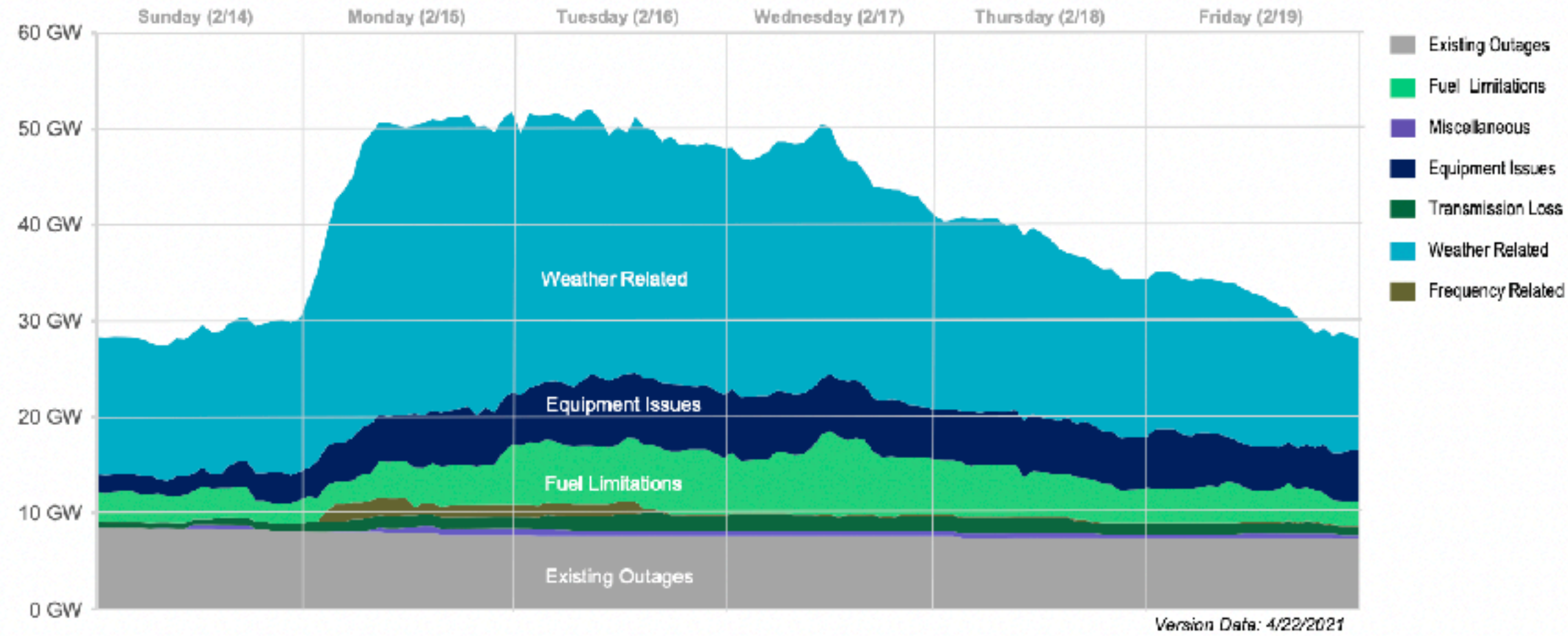
Sorunların değişimi

- Şebeke kontrolü - elektrik kesintilerini azaltmak - sistem güvenliği

- Anlık sistem kontrolü (iletimden dağıtıma)

- Uzaktan okuma sistemleri (fiber optik vs)

- Yenilenebilir

  - Şebeke ataleti-inertia

- Mikroşebekeler

- Piyasa eşleşmesi

  - doğalgaz-elektrik

- Uç hava olayları

https://www.iea.org/reports/status-of-power-system-transformation-2019

Şubat 2021 - Texas Enerji Krizi

- Uç hava olayı

- "Zincirin gücü en zayıf halkasının gücü kadardır".

ERCOT, Update to April 6, 2021 Preliminary Report on Causes of Generator Outages and Derates During the February 2021 Extreme Cold Weather Event
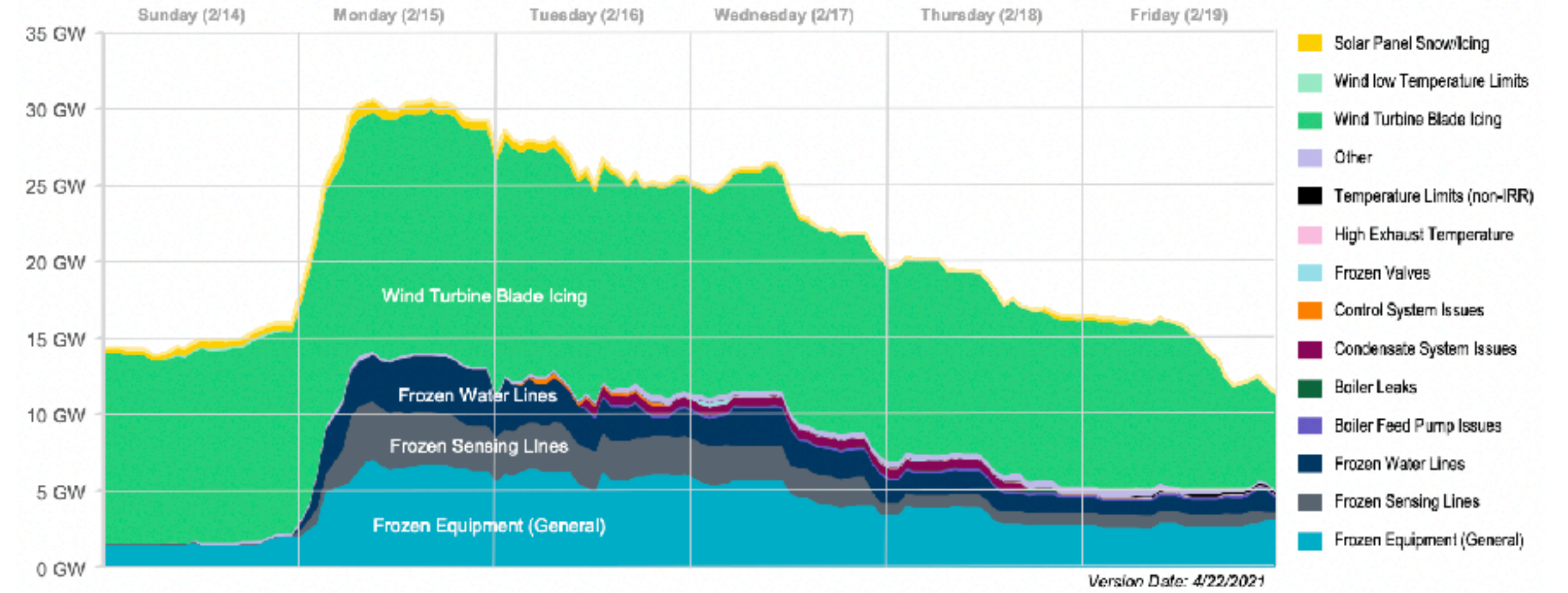
8 Ocak 14:04 Avrupa Sistem Ayrışması
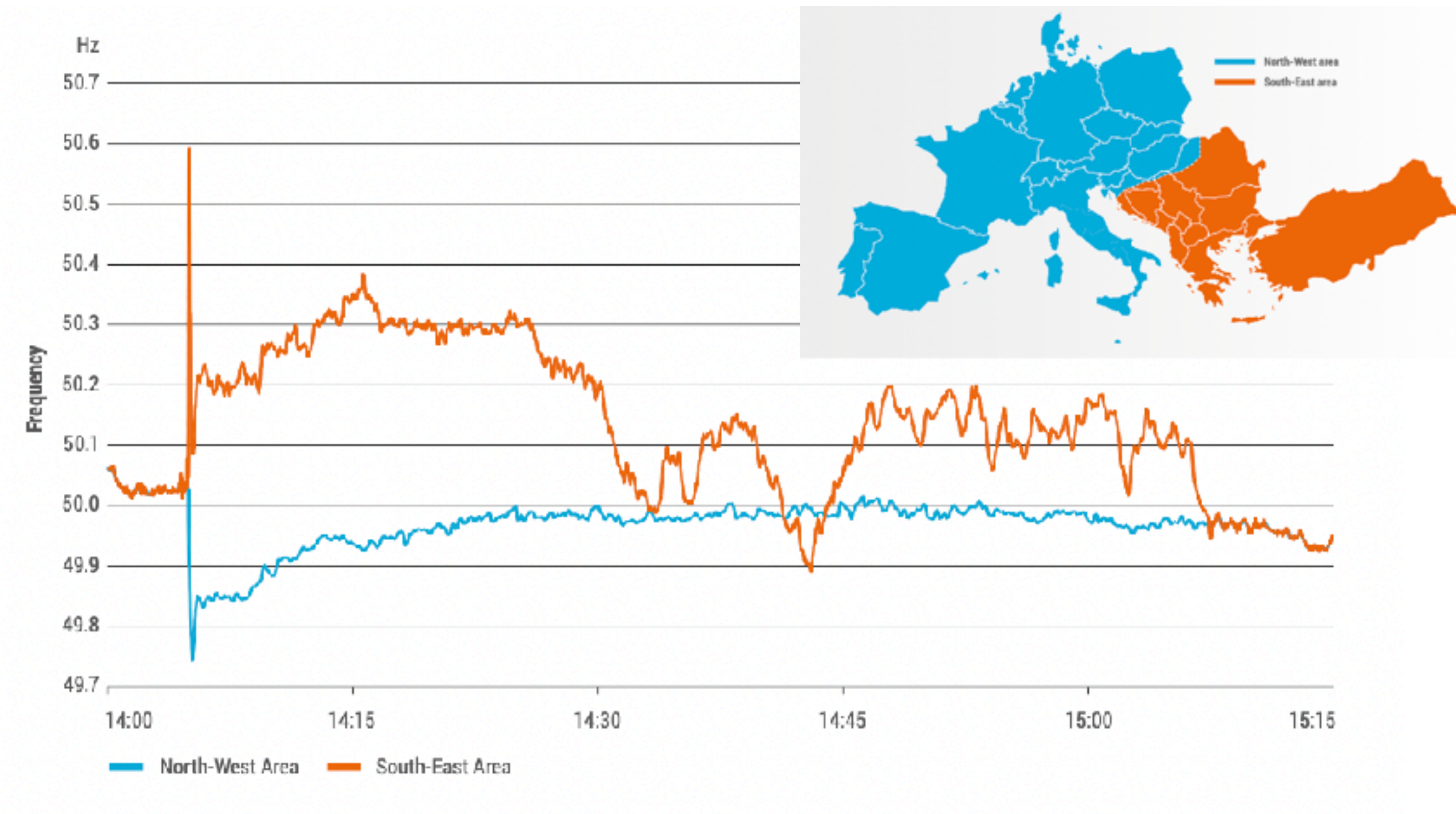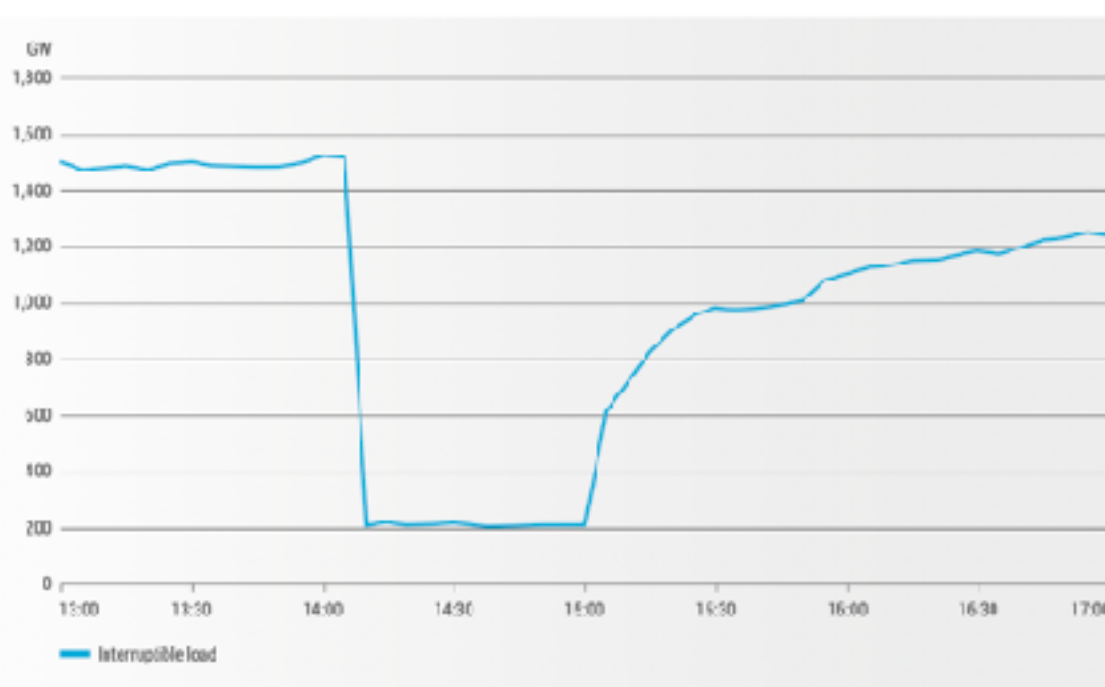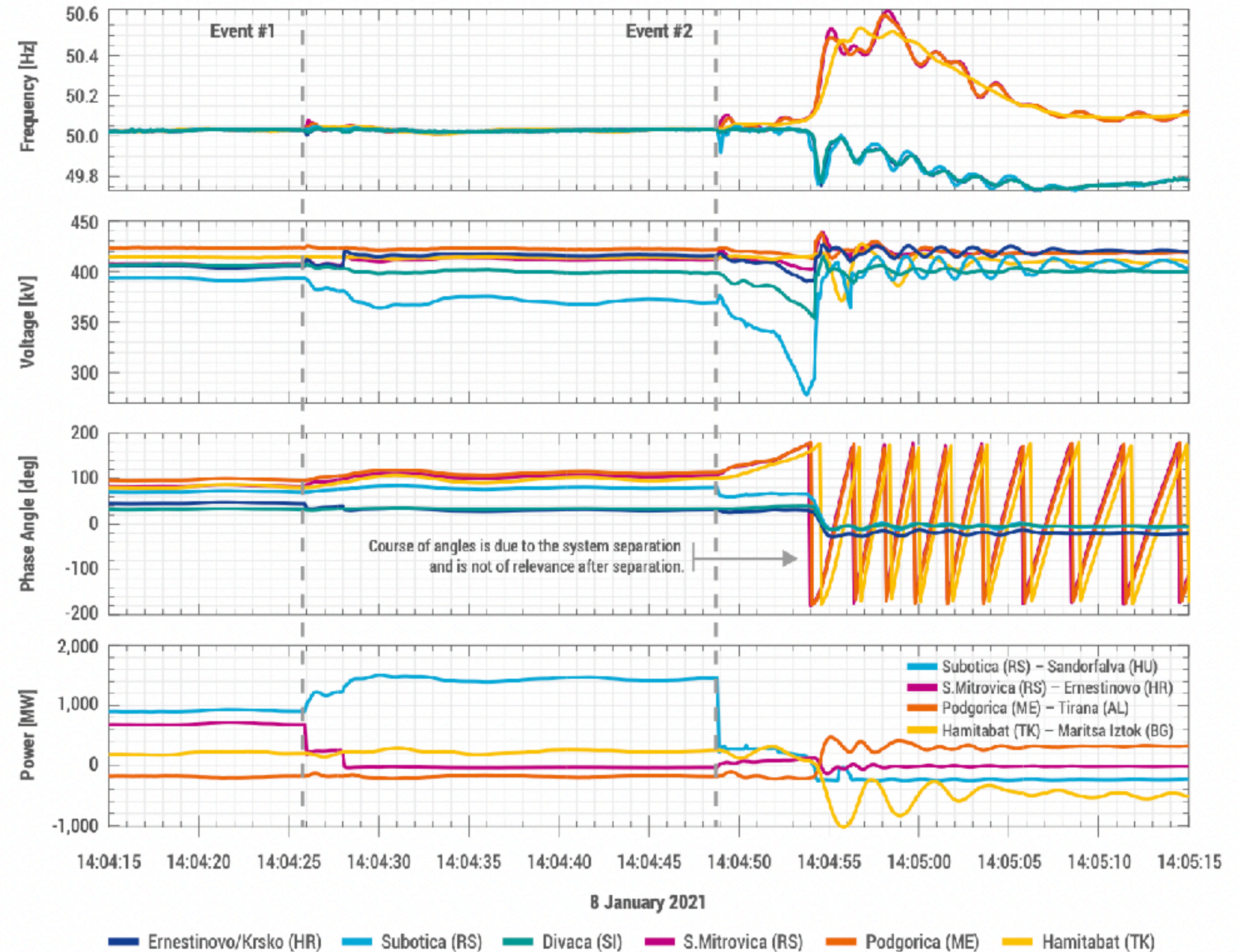
Sorunlardan biri - Sanal Atalet (Inertia)
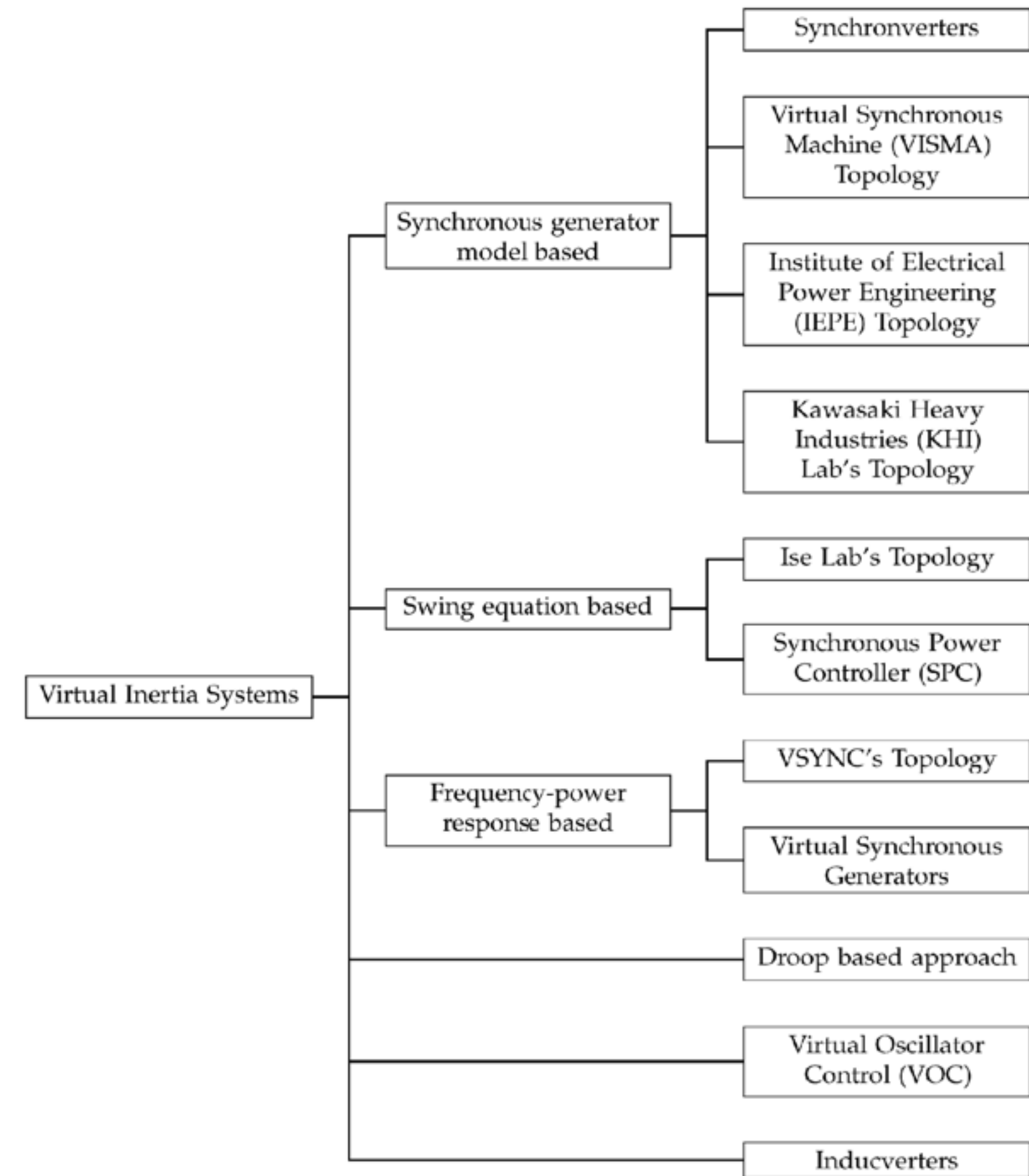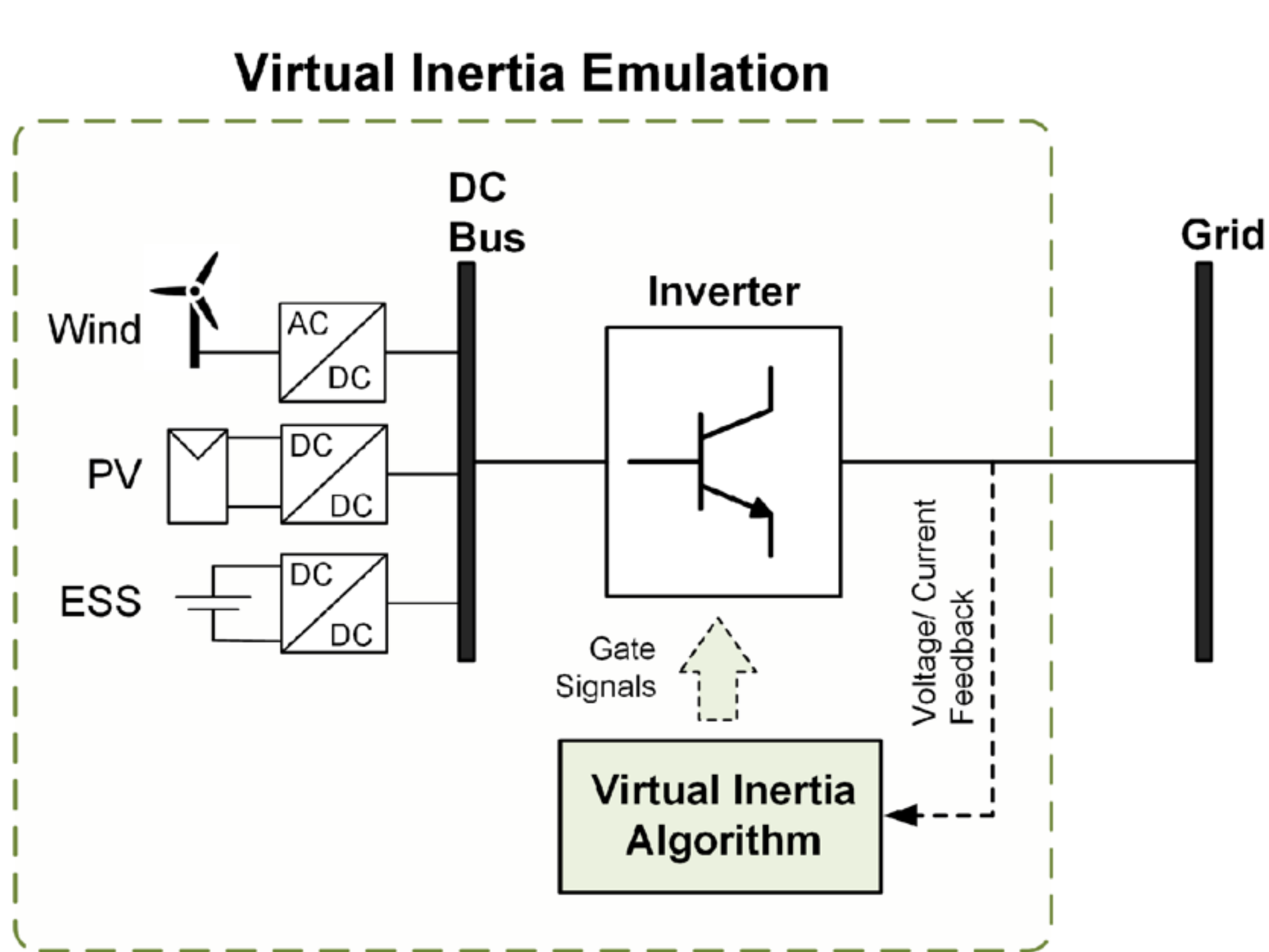
Efektif atalet

Effective Inertia Metering

- The principle is built upon a proven PMU-based method for continuous metering at a regional level.
- The frequency is measured at selected points within the area, preferably close to main sources of real inertia.
- PMUs are located on all transmission circuits crossing the area boundary > summation of net power exchange.

Inertia metering versus model estimate

Effective Inertia Forecast

- Applying machine learning relates inertia to known and predictable values: conventional rotating inertia, load, solar power, wind power.
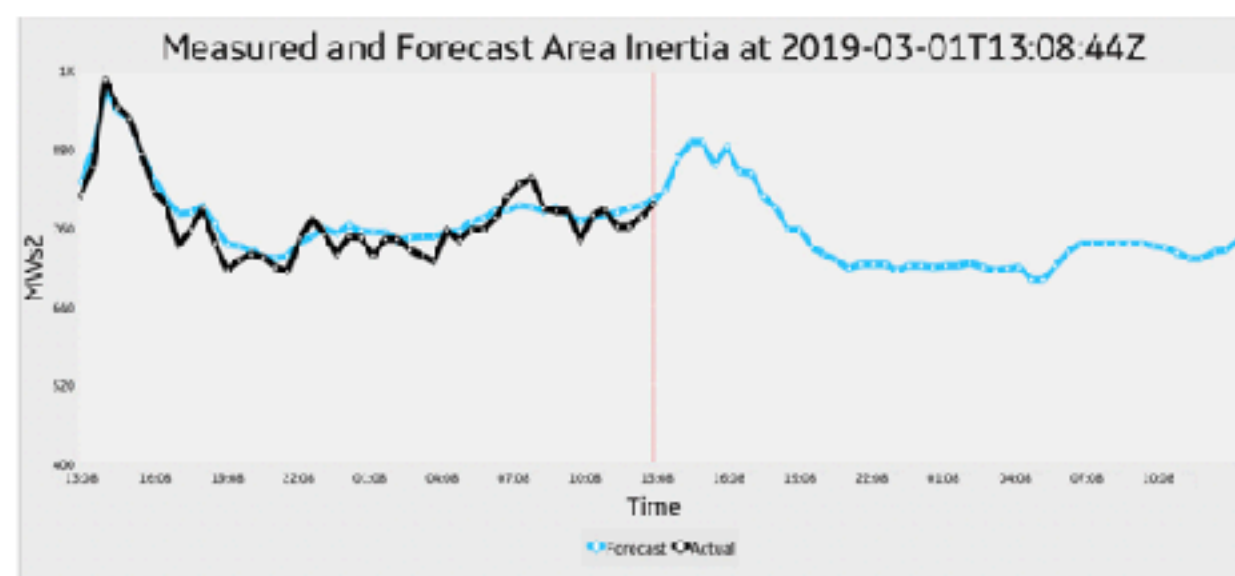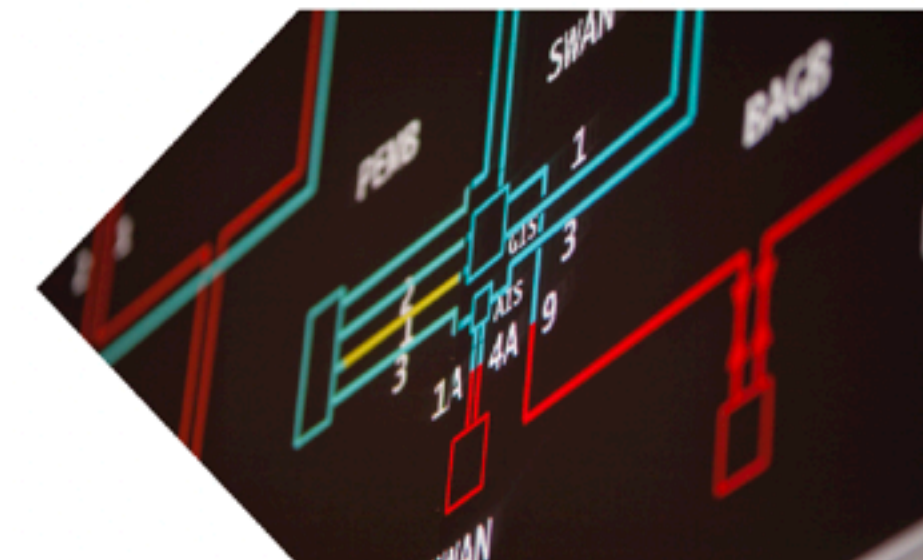- Accurate inertia forecasting give the TSO confidence in a secure level of renewables penetration and associated reserve services.

Inertia forecast chart showing historical forecasts vs. actual metered inertia and 1-day ahead forecast

'Sonar of the power grid': new inertia measurement tools planned for Great Britain's electricity system

11th December 2020 - *Balancing the grid*

As Electricity System Operator it's our job to keep the grid stable, including managing its key properties such as voltage or frequency – and, increasingly, levels of something called inertia.

Our electricity control room is developing two new tools to manage this key characteristic – part of a pioneering world first approach to measuring and managing power grid inertia.

In this blog, the Head of our Control room Rob Rome explains more.

First things first – what is inertia?

This gives our operators a real-time view of inertia in each region of the grid, as well as the total GB level. By applying advanced machine learning, the software also provides forecasts of effective inertia based on predictors such as levels of demand and different generation types – giving us an important tool to help plan the system operation effectively.

Secondly, our partnership with Reactive Technologies will see an ultracapacitor used to directly measure inertia by sending pulses of power through the grid - similar to the underwater sound waves used in sonar. These pulses are measured and processed by Reactive's 'XMU' measurement units and their cloud computing platform. Using this system they can accurately map any deviations in levels of inertia and electrical frequency, allowing an almost instantaneous response to keep the grid in balance.

A fleet of XMUs has already been rolled out across the UK, measuring at extremely high granularity and allowing an independent data source to the existing PMUs.
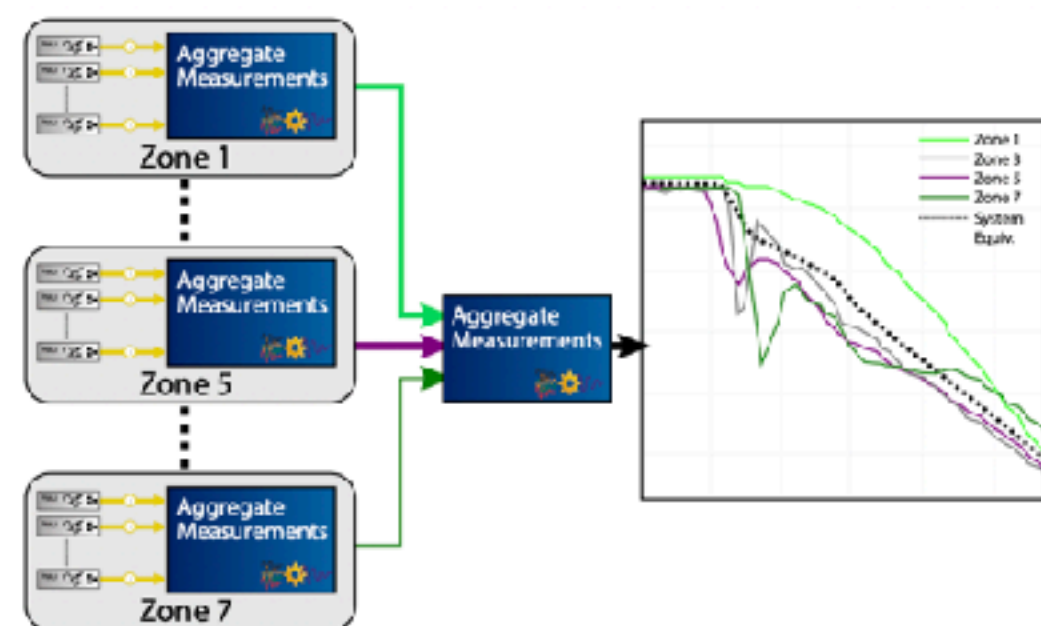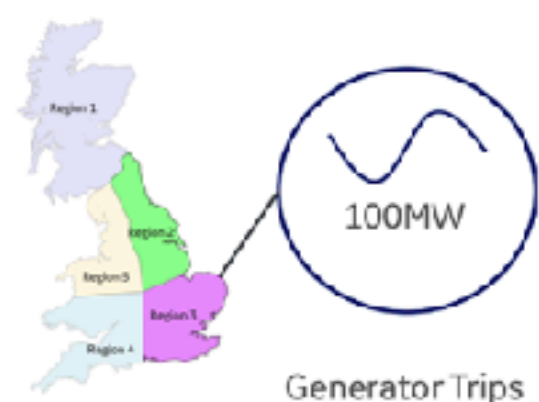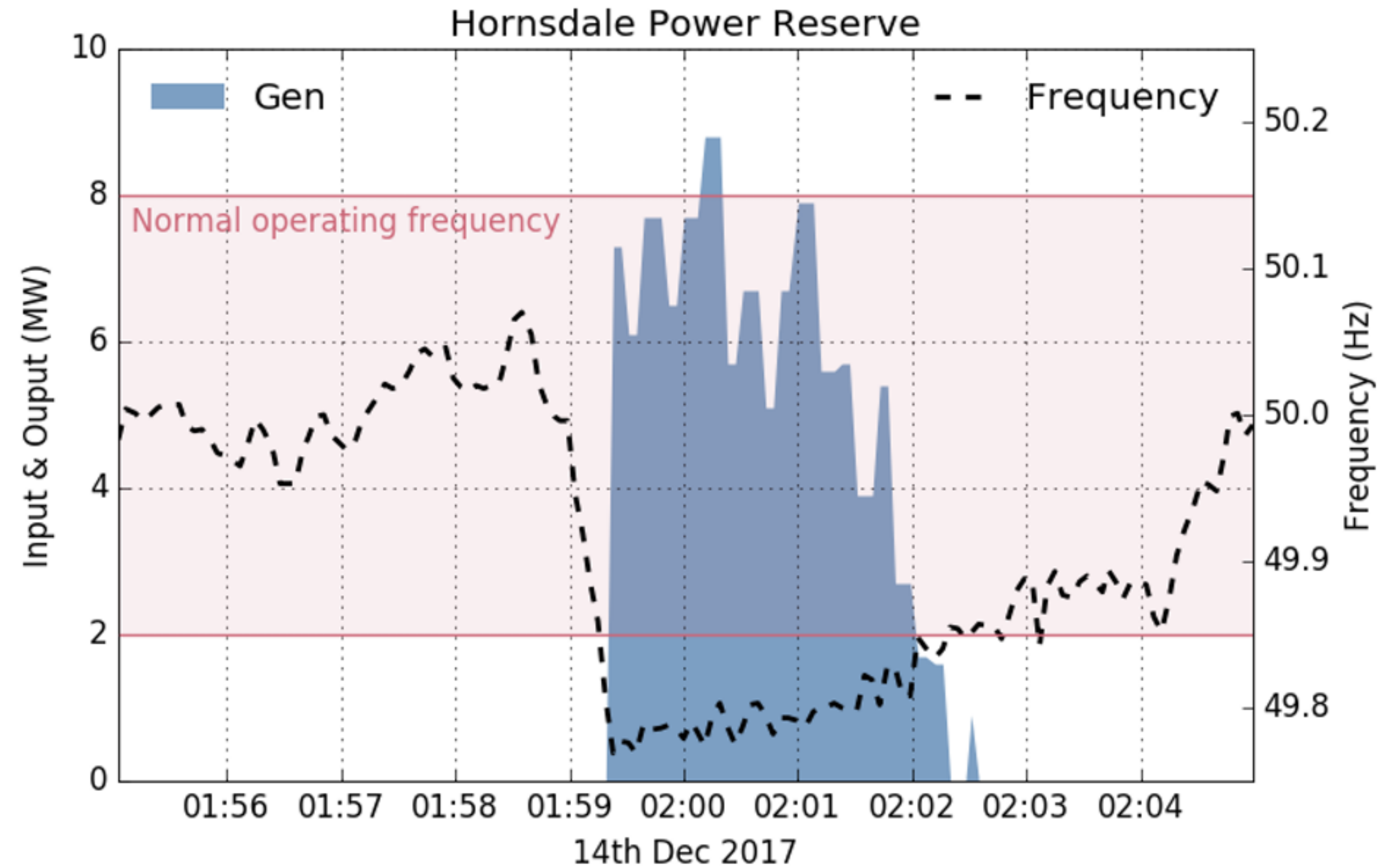
Contact Us
www.gepower.com/contact

https://www.ge.com/digital/sites/default/files/download_assets/effective-inertia-datasheet-ge-grid-analytics.pdf

Pil sistemleri + Algoritmalar
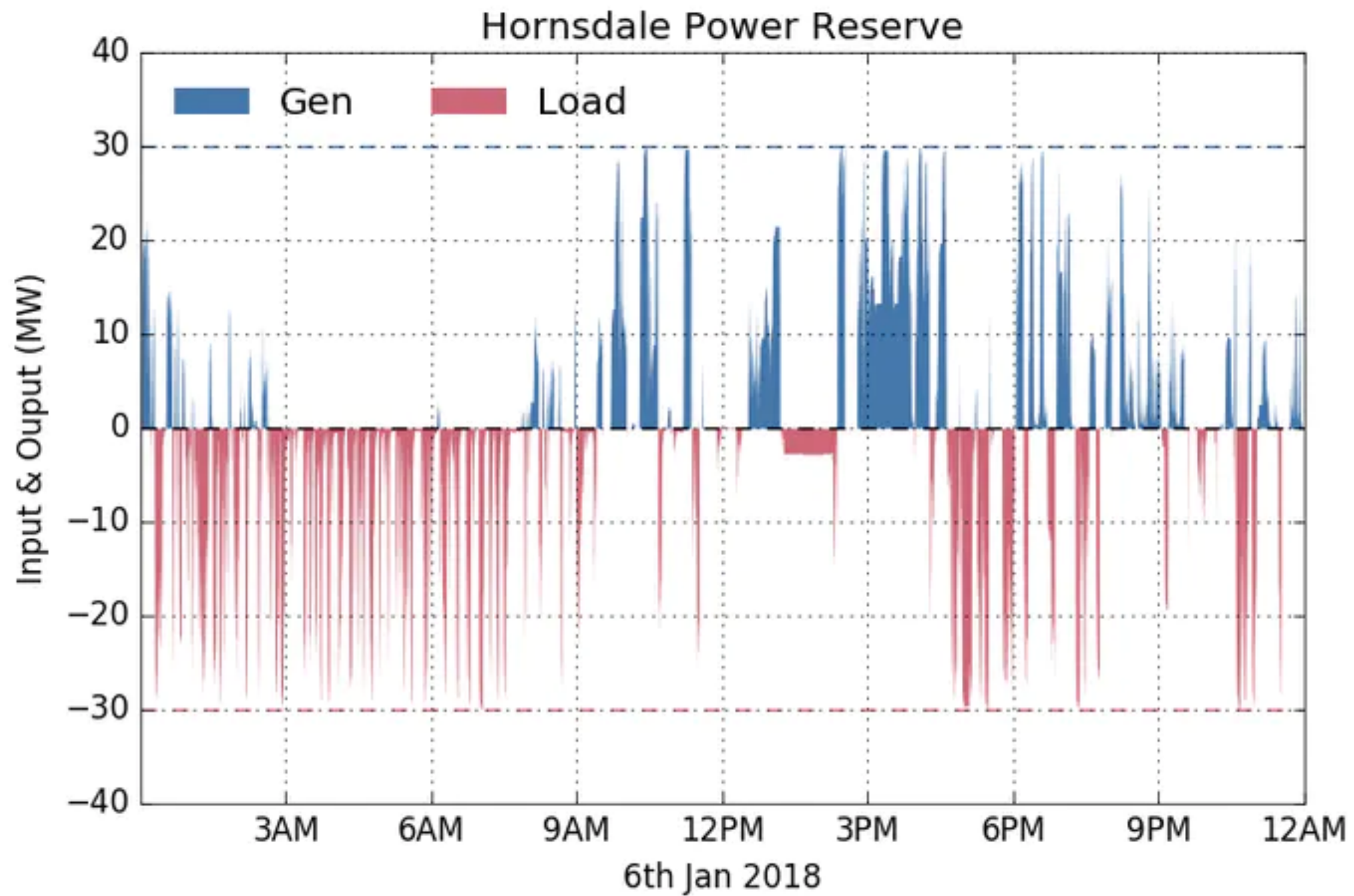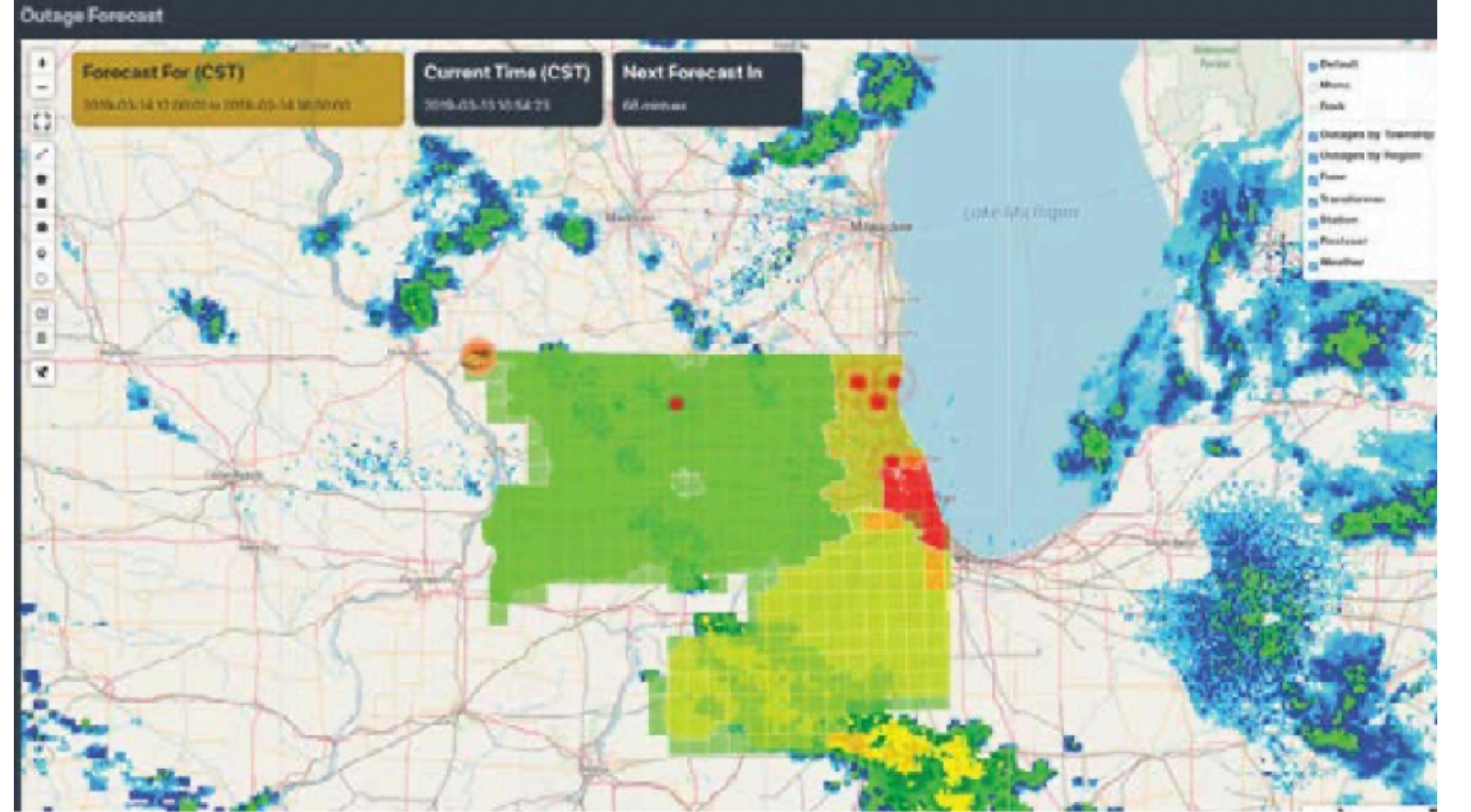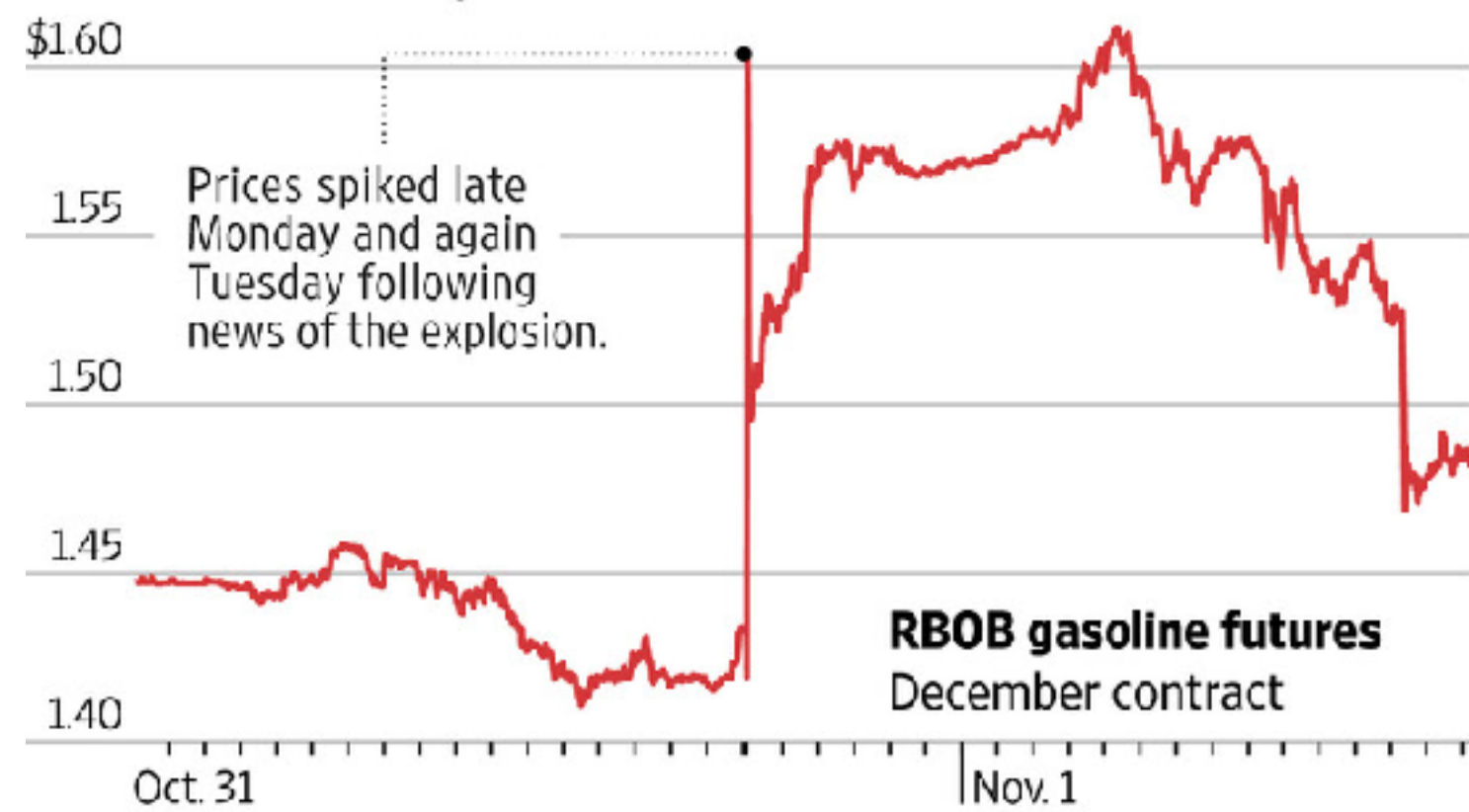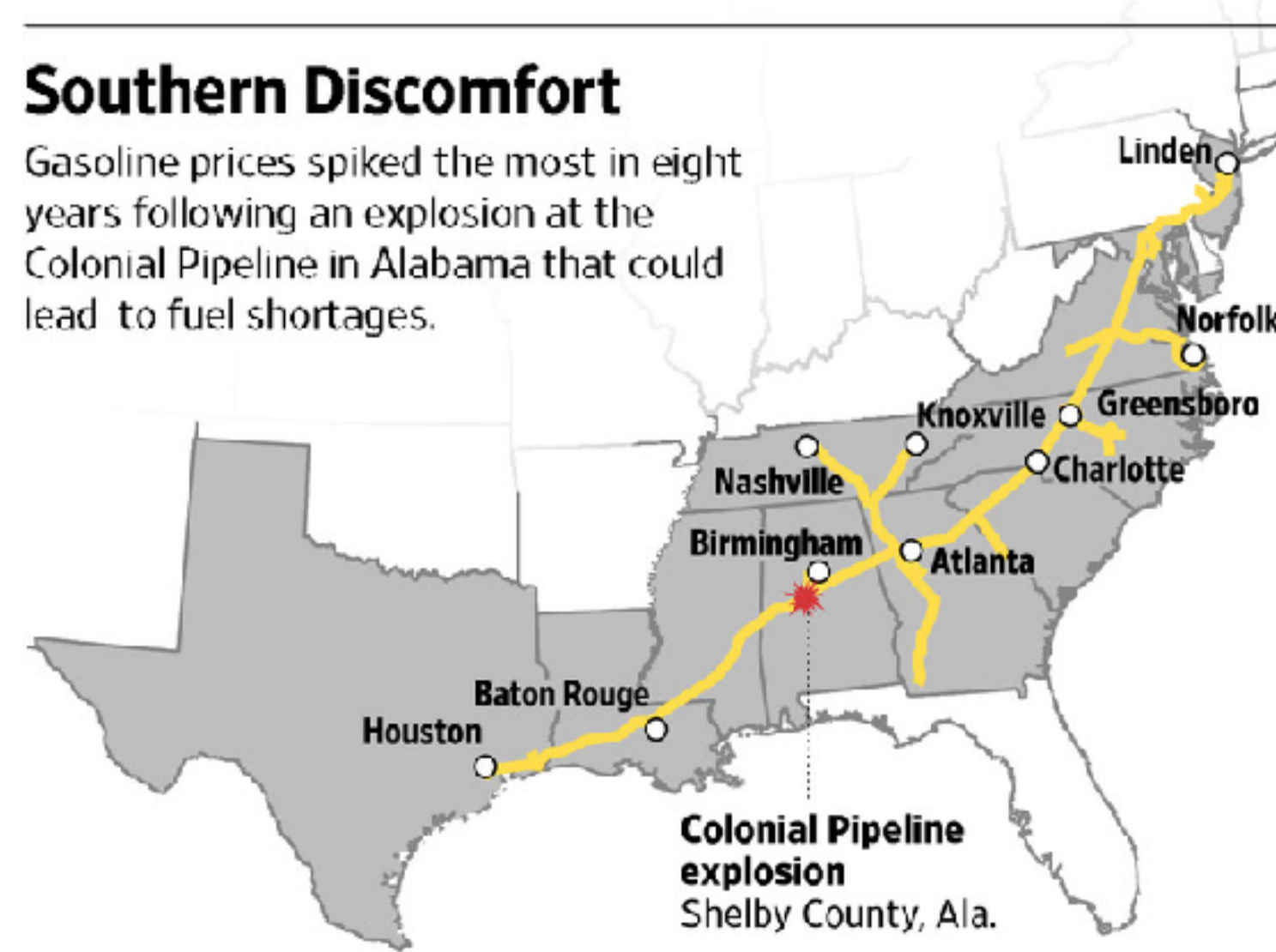
Uç hava olayları

- Engellenemez hadiseler

- Sistem dayanıklılığı önemli
  - darbe-geri dönüş

- Öngörülebilirlik önemli
  - Hava durumu
  - Talep
  - Yakıt

https://www.ge.com/digital/applications/grid-analytics

Sibergüvenlik - Colonial petrol boru hattı

Southern Discomfort

Gasoline prices spiked the most in eight years following an explosion at the Colonial Pipeline in Alabama that could lead to fuel shortages.

Linden
Norfolk
Greensboro
Knoxville
Charlotte
Nashville
Birmingham
Atlanta
Baton Rouge
Houston

Colonial Pipeline explosion
Shelby County, Ala.

$1.60

Prices spiked late Monday and again Tuesday following news of the explosion.

1.55

1.50

1.45

1.40

RBOB gasoline futures
December contract

Oct. 31   Nov. 1

Note: Break in trading from 5-6p.m.
Sources: the company (pipeline map); FactSet (futures)   THE WALL STREET JOURNAL.

- 2.5 milyon varil/gün
- Rehin yazılım
- 100 GB veri rehin

Striking oil
United States

Ransom payments, $'000
— Average   — Median
250
200
150
100
50
0

Median size of companies targeted by ransomware
Employees
250
200
150
100
50
0

2018   19   20   21

Sources: Coveware; Colonial Pipeline Company
The Economist

https://www.wsj.com/articles/gas-diesel-prices-spike-following-alabama-pipeline-fire-1478010889

Sonuç

- Net sıfır hedefleri

  - Daha fazla yenilenebilir (tevzilenemez, öngörülebilir)

- Yakıt sorunları -> sistem yönetim, esneklik problemleri

- Daha önce FACTS vs iken mikroşebeke, sanal atalet, depolama

  - Elektrik kesintilerinin doğası değişecek mi?

- Algoritmalar çok önemli, ama sistem yönetimini yapay zekaya bırakabilir miyiz?

- Dijitalleşme yanında sibergüvenlik

- Sistem evrildikçe, araçlar da değişiyor. Ama algoritmaların önemi artıyor

- İlk algoritmik elektrik kesintisi? 2025???

teşekkürler

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