The Relevance of Resilience in Energy Policy: A Post-pandemic Perspective

MEEPS 2021
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04 November 2021

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Topics

- Introduction to resilience
- Impact of pandemic on Power systems

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CIGRE WG C4.47 Resilience Definition

*the ability to limit the **extent, severity** and **duration** of **system degradation** following an **extreme event**.*

- In CIGRE definitions, the generic term "*magnitude*" usually used in resilience definitions is replaced by the two terms "***extent and severity***", which respectively refer to the *geographical extension* and the *intensity of the effects* of the event on the system.
- **"*Severity*"** in the present definition refers to the "*severity of the event consequences*", which must be kept separate from the "*severity of the event*" which in general does not imply any system degradations.
- The term "***degradation***" is intended as "*deviation from specified target performances*", both in system planning and operation as well as infrastructural and operational resilience.
- The term "***extreme event***" refers to high impact low probability (HILP) events, going beyond the "ordinary events" and referring to the "out of range type of contingencies" (ENTSO-E).

Acknowledgments: Emanuele Ciapessoni, Diego Cirio and Andrea Pitto, RSE, Italy

Source: Mathaios Panteli, CIGRE event "Power System Stability challenges and solutions towards a zero-carbon future" held in conjunction with C4 Liaison Meeting 26th September 2019 hosted by the University of Manchester.

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CIGRE WG C4.47 Resilience Definition (cont.)

Power system resilience is achieved through a set of ***key actionable measures*** to be ***taken*** before, during and after extreme events, such as:

Anticipation	Preparation	Absorption	Adaptation	Rapid recovery	Sustainment of critical system operation
• the process by which newly incorporated knowledge gained is used to foresee possible crises and disasters	• the process through which grid operators establish a set of actions to be deployed in case the critical operating condition occurs	• the process through which a set of measures is deployed to limit the extent, the severity and the slope of the degradation of power system performance	• the process through which changes are carried out in the power system management procedures, on the basis of past disruptions, in order to adjust the system to undesirable situations	• the process through which the energy supply to the customers is restored and the damages to the grid infrastructure are repaired	• the process which deploys the measures allowing an impaired power system to supply a minimum system load level in order to maintain a reduced but acceptable functioning of everyday life

Source: Mathaios Panteli, CIGRE event “Power System Stability challenges and solutions towards a zero-carbon future” held in conjunction with C4 Liaison Meeting 26th September 2019 hosted by the University of Manchester.

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Reliability Criteria

Network Reliability: *"Reliability is a general term encompassing all the measures of the ability of the system, generally given as numerical indices, to deliver electricity to all points of utilisation within acceptable standards and in the amounts desired. Network reliability (comprising generation and transmission facilities) can be described by two basic and functional attributes: Adequacy and Security."*

Source: ENTSO-E Data Handbook

Typical Outages	Catastrophic Outages
Most cases involve a single fault/failure	Multiple or numerous components are damages
A small number of customers are affected	A large number of customers are affected
Power sources are available and accessible	Power sources may not be available or accessible
Transmission and distribution system facilities are available	Transmission and distribution system facilities may be damaged or unavailable
Repair and restoration are straightforward	Repair and restoration are complex

Source: Distribution systems: Reliable but not resilient?, C. C. Liu, 2015

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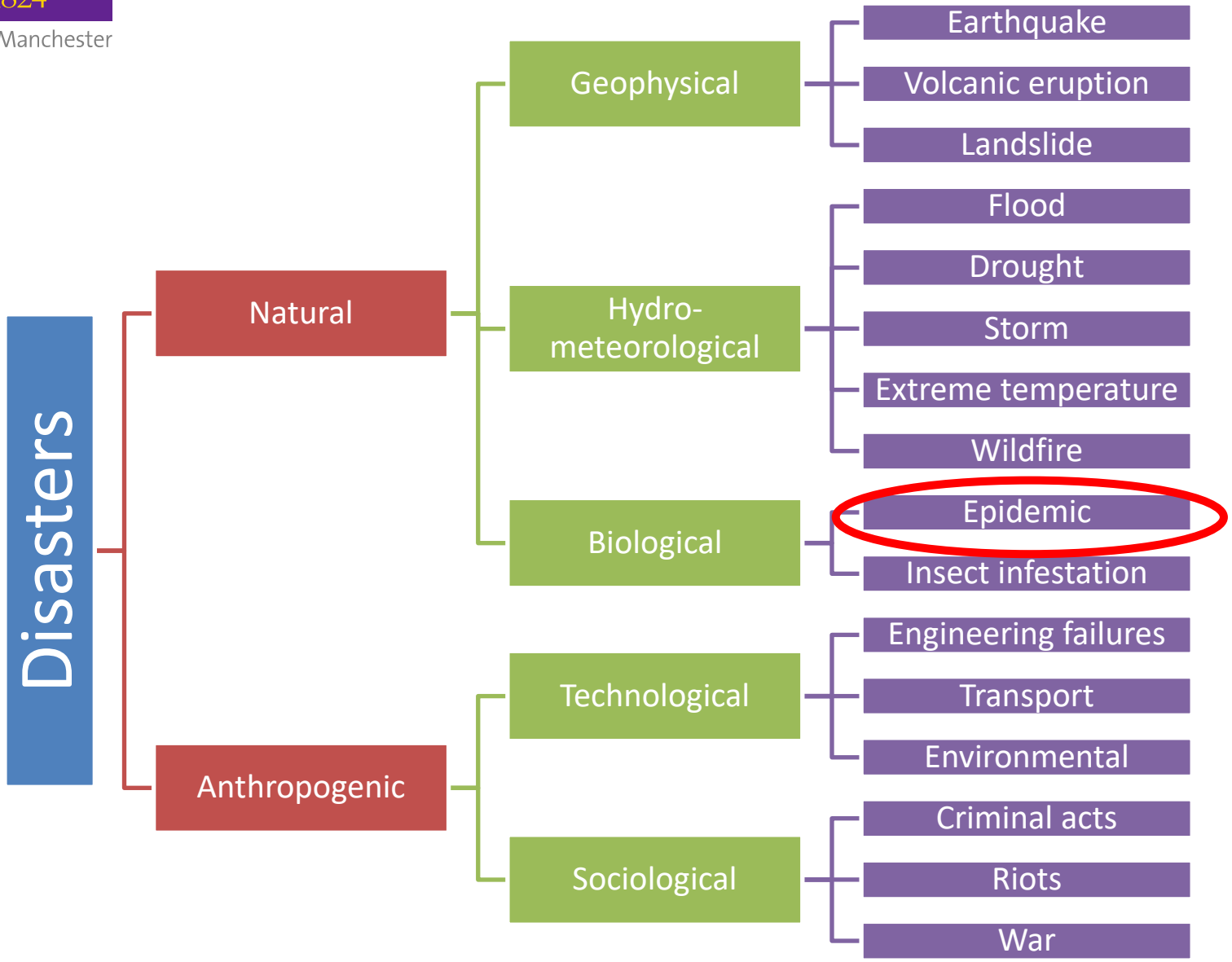
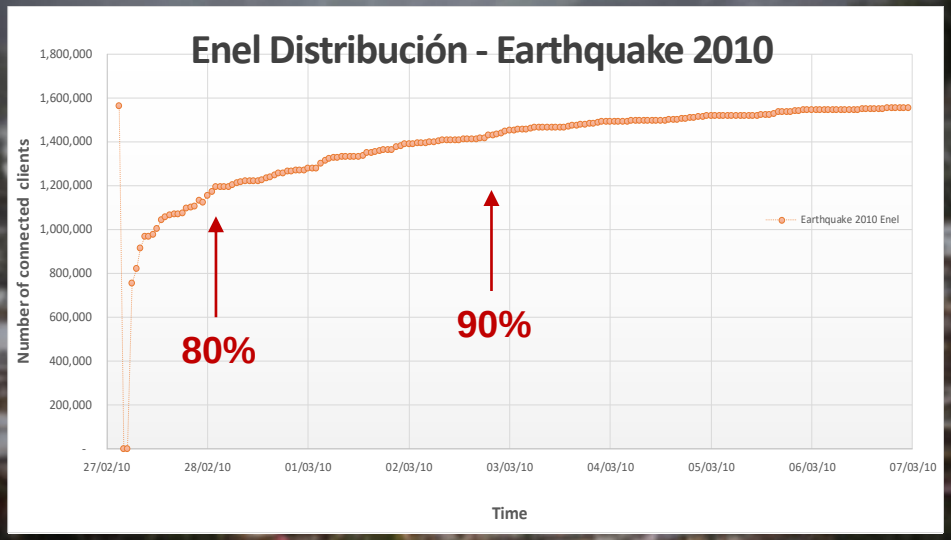
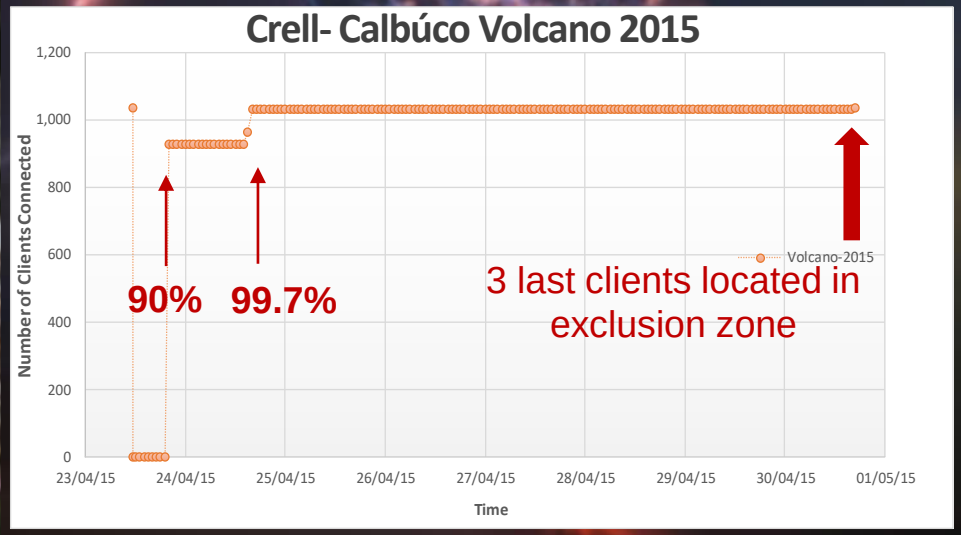
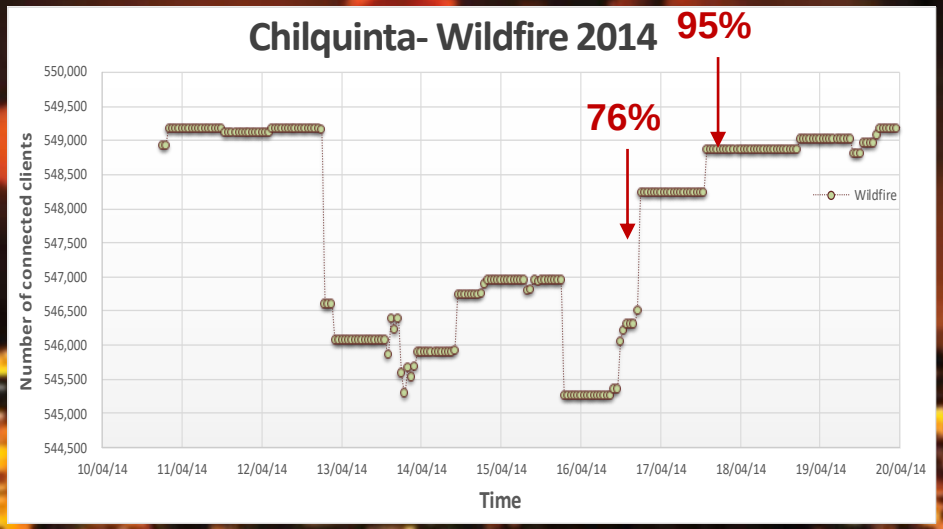
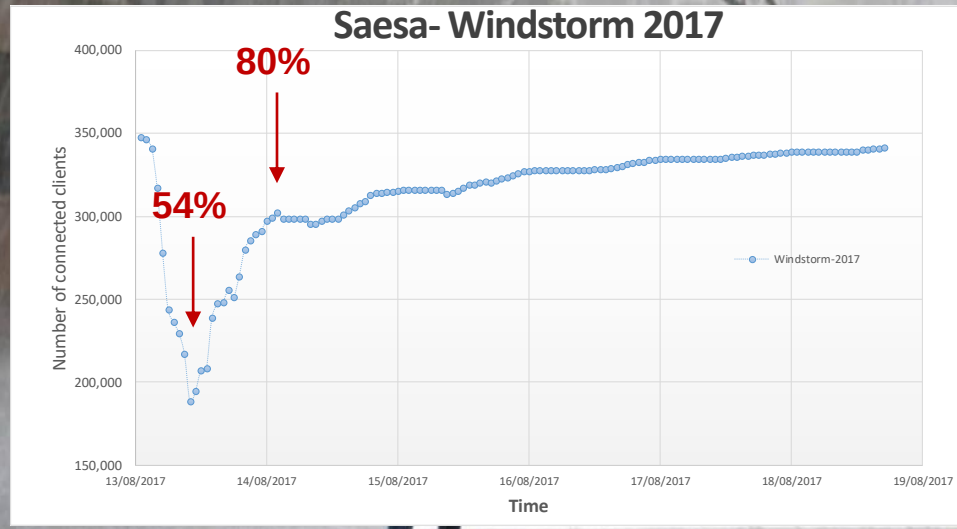



Enel Distribución - Earthquake 2010
Number of connected clients
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
-
27/02/10
28/02/10
01/03/10
02/03/10
03/03/10
04/03/10
05/03/10
06/03/10
07/03/10
Time
Earthquake 2010 Enel
80%
90%


Crell- Calbúco Volcano 2015
Number of Clients Connected
1,200
1,000
800
600
400
200
0
23/04/15
24/04/15
25/04/15
26/04/15
27/04/15
28/04/15
29/04/15
30/04/15
01/05/15
Time
Volcano-2015
90%
99.7%
3 last clients located in exclusion zone


Chilquinta- Wildfire 2014
Number of connected clients
550,000
549,500
549,000
548,500
548,000
547,500
547,000
546,500
546,000
545,500
545,000
544,500
10/04/14
11/04/14
12/04/14
13/04/14
14/04/14
15/04/14
16/04/14
17/04/14
18/04/14
19/04/14
20/04/14
Time
Wildfire
95%
76%


Saesa- Windstorm 2017
Number of connected clients
400,000
350,000
300,000
250,000
200,000
150,000
13/08/2017
14/08/2017
15/08/2017
16/08/2017
17/08/2017
18/08/2017
19/08/2017
Time
Windstorm-2017
80%
54%

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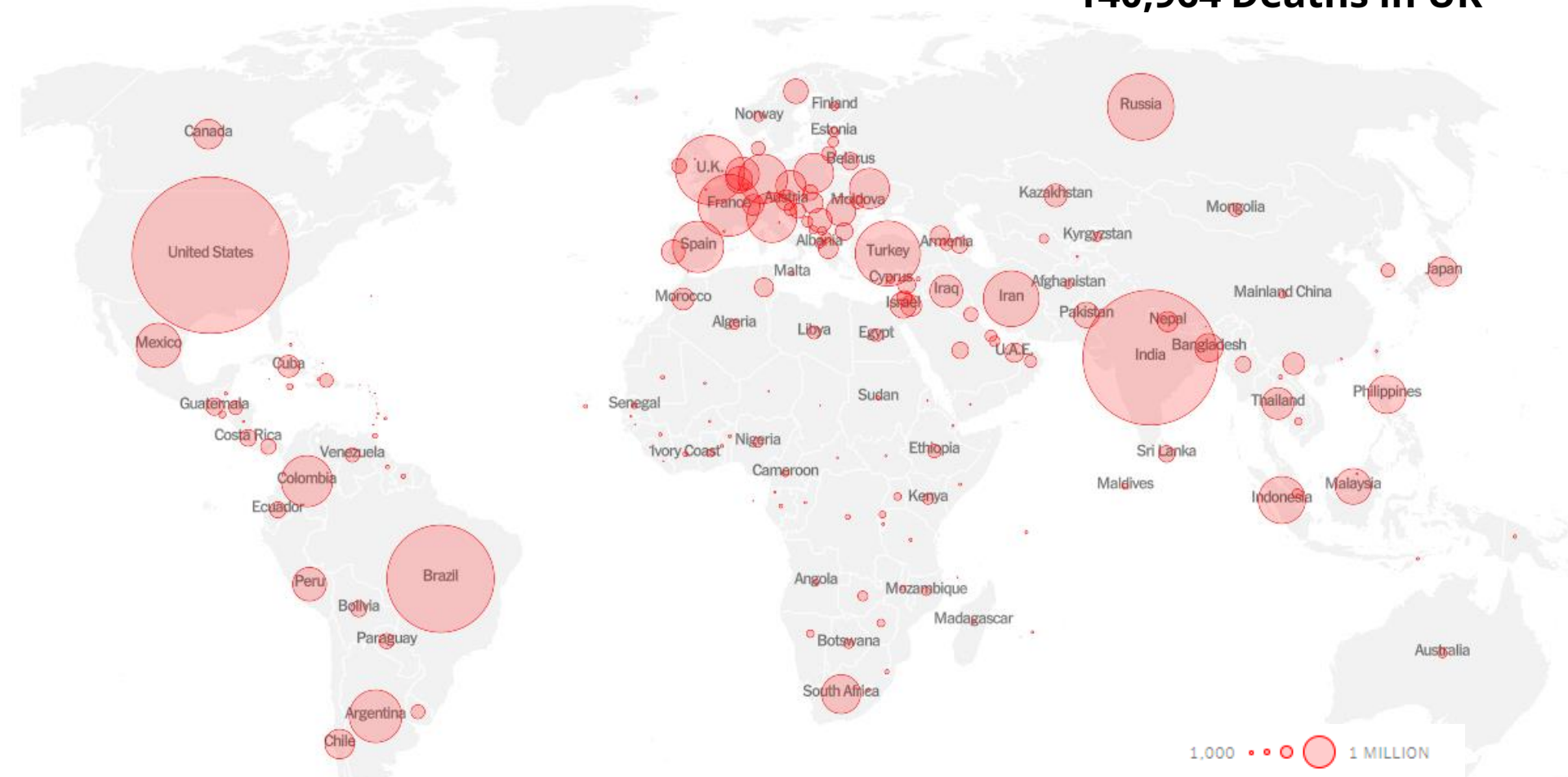
Coronavirus Pandemic

248,454,008 Cases worldwide

5,032,108 Deaths worldwide

9,130,857 Cases in UK

140,964 Deaths in UK



Source: The New York Time
https://www.nytimes.com/interactive/2020/world/coronavirus-maps.html
https://www.worldometers.info/coronavirus/country/uk/

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Government measures

- Reduce mobility
  - Restrict physical contact
  - Lockdown (as of March 23 in UK).

- Economical support
  - Budget 2020 (March 12): injection of £ 30 trillion into the economy.
  - Job retention scheme: the government will pay 80% of salary, capped at £ 2,500 to those suspended or self-employed.
  - Lend to Small business of up to £ 5 million, paid back in up to 6 years.
  - The Bank of England lowered the interest rate from 0.75% to 0.25% and then to 0.1%.

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Impact on electricity demand

- Modified demand levels and patterns:
  - Decrease of industrial and commercial demand
  - Increase of residential demand
  - Migration from urban to rural areas

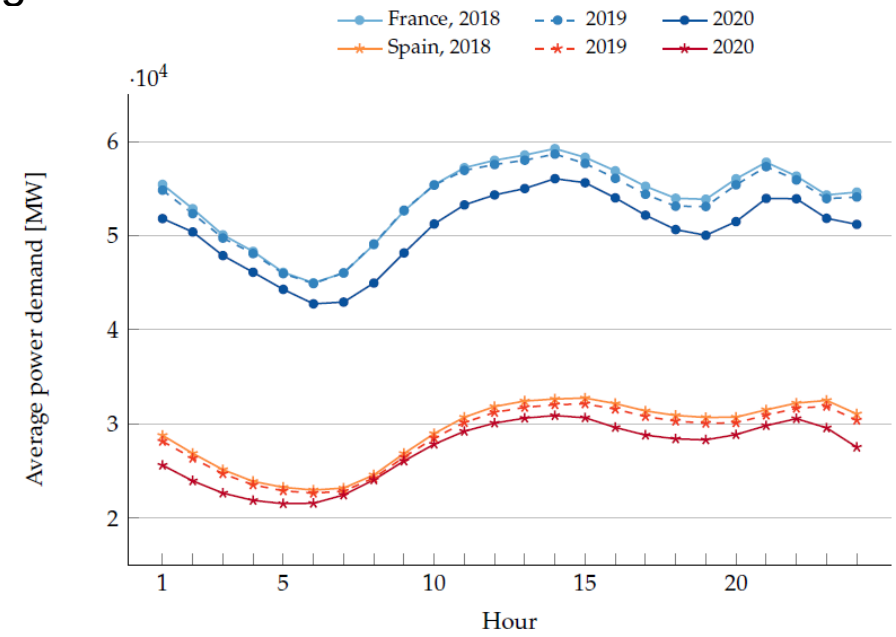
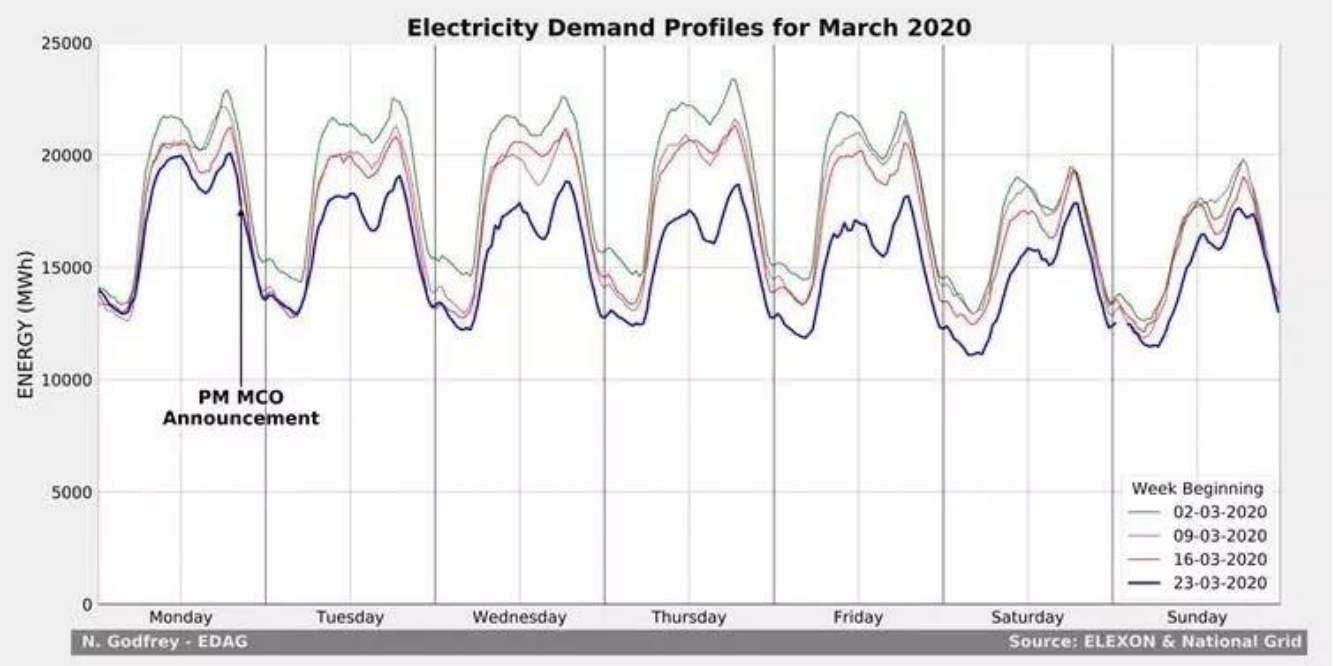


Figure 1. Comparison of the total daily average demand [MW] for 2018, 2019, and 2020 in France and Spain.

Source: Effects of the COVID-19 Pandemic on Energy Systems and Electric Power Grids—A Review of the Challenges Ahead. 2021 . Aviad Navon at all

Impact on electricity demand (UK)

- During the first week of lockdown (March 23) there was a 5% -10% reduction in demand.



Source: https://www.weforum.org/agenda/2020/04/we-analysed-electricity-demand-and-found-coronavirus-has-turned-weekdays-into-weekends/

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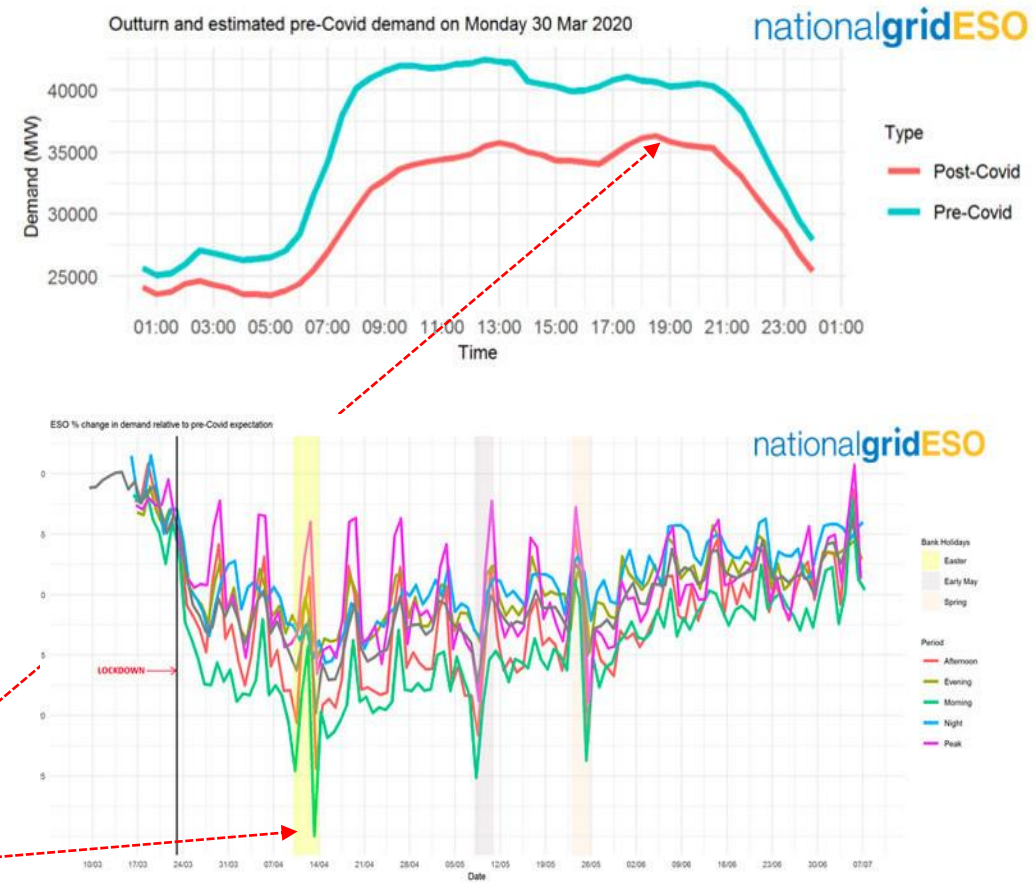
Impact on electricity demand (UK)

- According to the National grid as a consequence of the lockdown there were 4 changes in the demands patterns:
  - Traditional TV pickups returned.
  - Clap for carers caused a spike in demand when people went back inside home after clapping
  - Morning peak moved to later
  - Sharply drop in demand (Maximum 20% on Easter weekend (11/12 April)



Source: https://www.nationalgrid.com/uk/stories/grid-at-work-stories/4-ways-lockdown-life-affected-uk-electricity-use

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Renewable energy sources share

- Increase in renewable generation as demand decreases.
- Renewable generation is prioritized.
- Weather conditions

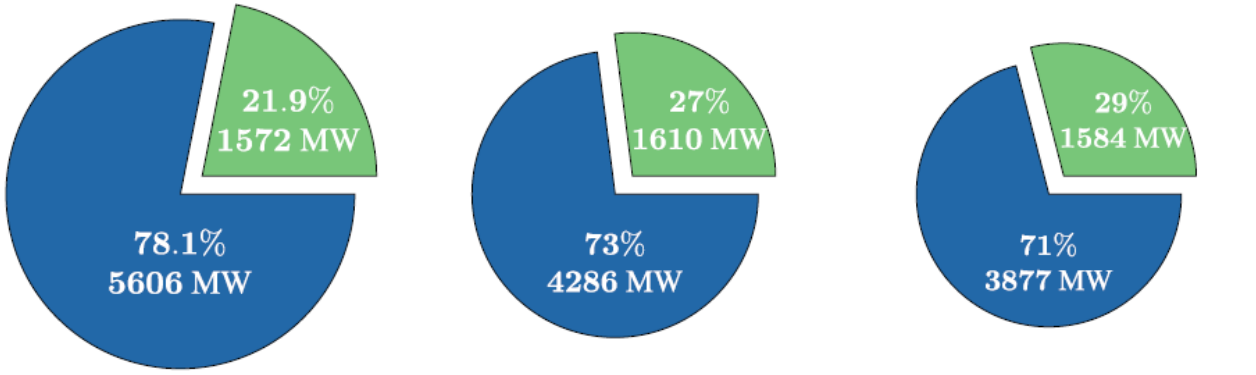

Figure 3. Maximum share of renewable energy in Israel before and during the first lockdown (2020), as a fraction of total generation.

Source: Effects of the COVID-19 Pandemic on Energy Systems and Electric Power Grids—A Review of the Challenges Ahead. 2021 . Aviad Navon at all

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Renewable energy sources share (UK)

- Increase in renewable generation as demand decreases. The coal and gas plants are used to give flexibility to the system.
- National Grid ESO warned that an excessive decrease in demand could generate stability problems due to “uncontrollable excess generation” (wind or solar). To provide more flexibility to the system, tools such as: “Negative Reserve Active Power Margin (NRAPM) notice” could be used by which generators are asked to reduce their generation to maintain reserve margins.
- Decrease in fossil fuel demand due to the restriction of flights and ground transportation.
- Decrease in the level of CO2 emissions due to lower demand and lower consumption of fossil fuels.

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Other impacts on power systems

- Our society's high level of dependence on electricity has been evidenced, and how important it is to have a resilient electrical system.
- It was affected the income of people and companies, reducing the payment capacity of many users. An increase in residential demand implies increases in household bills. In Spain, it has been estimated that it can reach 26 euros/month.
- Construction of critical transmission and generation infrastructure has been delayed (Chile)
- **The pandemic has put the safety of workers in check, considerably reducing the response capacity of companies, forcing them to prioritize activities.**
- **Distribution companies are in direct contact with customers, having the highest risk of contagion. Therefore, they must meet each of the customer's requirements, ensuring the safety of both customers and employees.**

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Impact of pandemic on power sector

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Measures implemented on power sector

Government - Private agreements

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Measures implemented on power system

- Ensure continuity of supply
  - Prioritization of emergency care, vulnerable users and hospital centres.
  - Accelerate processes of connection of services required by the NHS.
  - Postpone all non-urgent requests.
  - Suspend activities such as meter reading.
  - Focusing telephone attention on the emergency.
  - Grant distribution companies flexibility to meet other obligations such as the installation of smart meters (there is currently a campaign so that by the end of 2020, 26 million homes have smart meters).
  - Some distributors such as Scottish & Southern Electricity Networks have arranged additional measures such as £ 350,000 for competitive funds that provide grants of up to £ 3,000 to local projects that will increase the resilience response to the pandemic.

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Measures implemented on power system

- Ensure the safety of customers and workers.
  - Implementation of home-working when it is possible.
  - Respecting physical distance
  - Restricting access to critical facilities such as control centres
  - Establishing protocols to minimize the risks of contagion in homecare: Customers are asked if they have been in contact with someone infected, if someone is in quarantine, or if there is someone who belongs to the risk group, Hand washing is evident during care
- Customer support
  - Telephonic support
  - Non interruption supply due to non-payment
  - Payment flexibility
  - Prioritization of vulnerable customers

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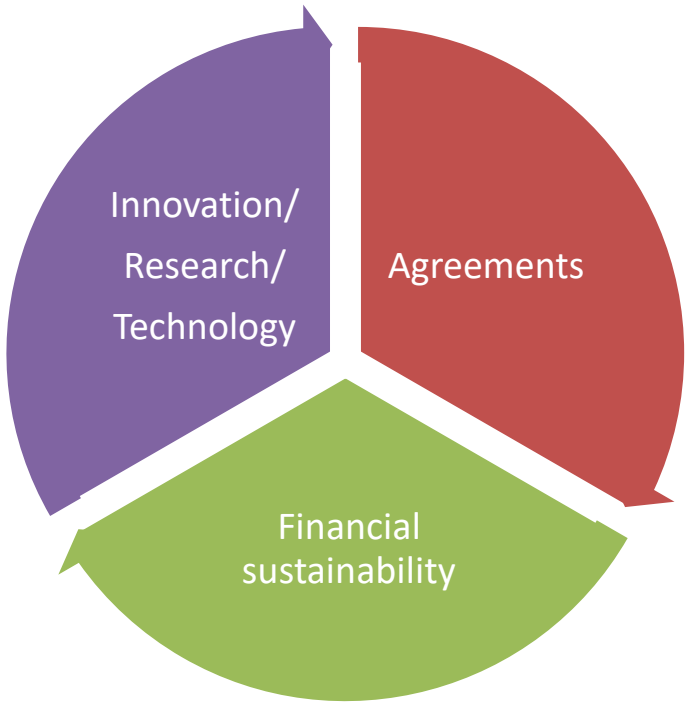
Future Challenges

- Implement technology and security measures to increase the share of renewable generation.
- Implement measures to ensure the viability of critical infrastructure projects.
- Provide tools for the operation of the security system.
- Push the introduction of smart meters
- Provide scheme to support vulnerable customers
- Ensure the financial sustainability of companies



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