

CIGRE and the Energy Transition



cigre

For power system expertise

Content

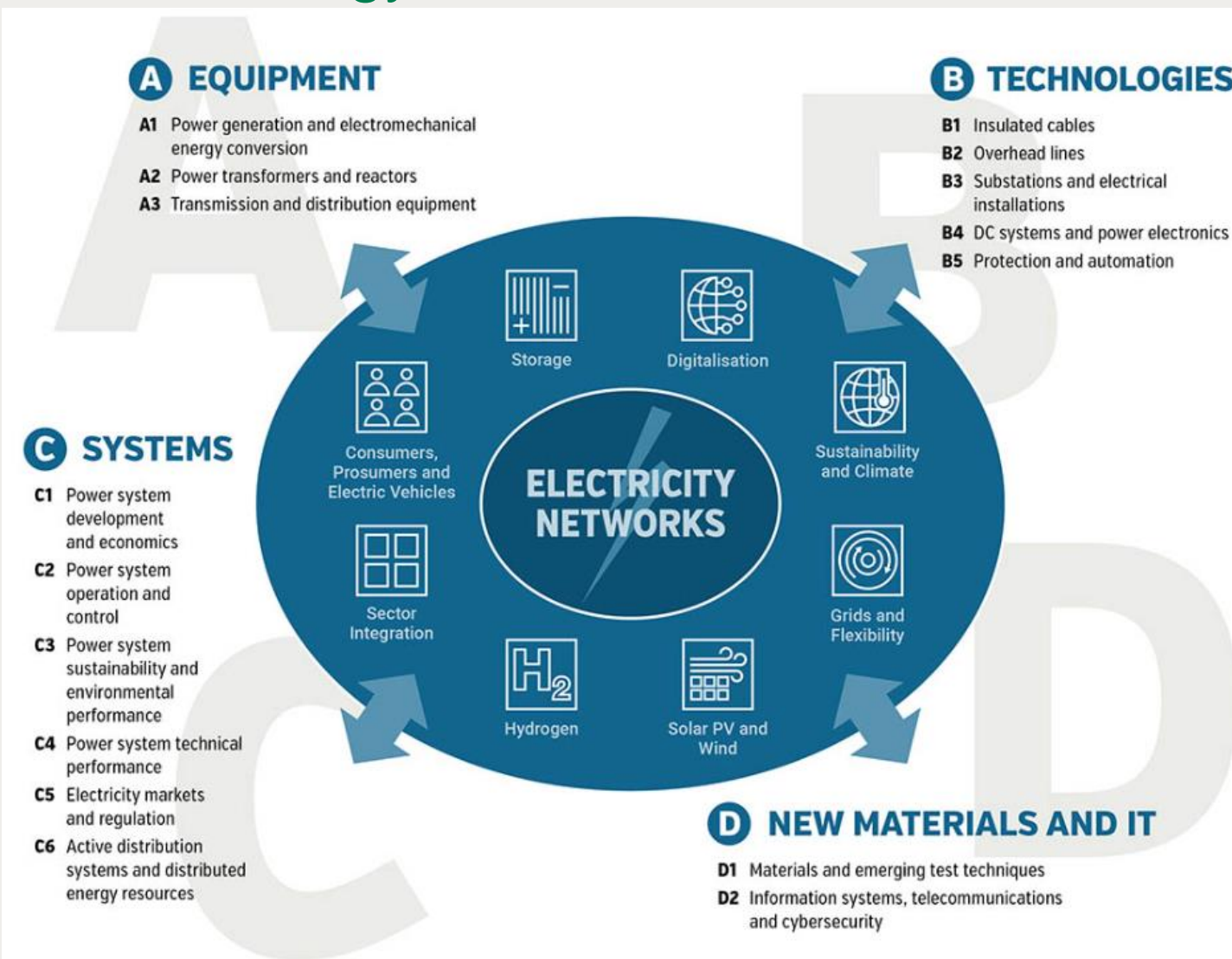
1. CIGRE brief history
2. CIGRE vision of the energy transition
 - The legacy power system
 - The power system of the future
 - The technical challenges of the transition
3. CIGRE contribution to the transition



A brief history of CIGRE from 1921 to now

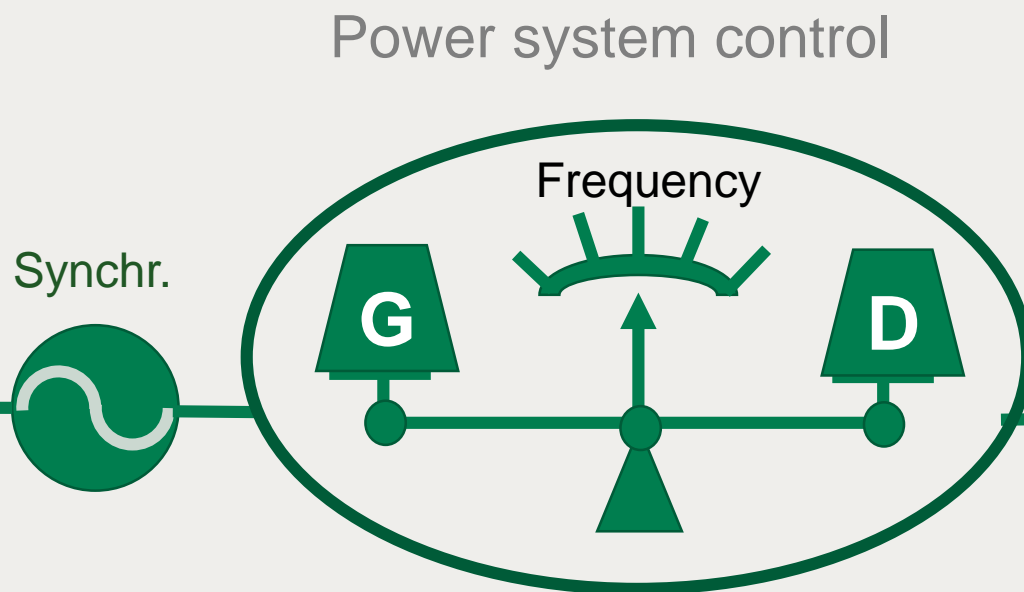
- 1921 : a **conference**, Conférence Internationale des Grands Réseaux Electriques = CIGRE, (International **Conference** on Large Electric Systems), created to **prepare for standardization** in the sector stimulated by the post-war economy,
- 1931 : established by French Law as **non for profit** association
- 2000 : Legal name = International **Council** on Large Electric Systems
- 2018 : branding campaign : CIGRE the **brand name** no longer an acronym
- CIGRE dedicated to “**Power System Expertise**” promoting exchanges and facilitating the collaboration on topical issues,
 - ✓ Electrification of territories (1920 - 1950)
 - ✓ Transmission and interconnection (1950 - 1990)
 - ✓ Electricity markets (1990 - 2010)
 - ✓ Energy transition (2010 - 2030)

CIGRE and the Energy Transition



The legacy power system

- Hydro
- Coal
- Oil
- Gas
- Nuclear
- Others



- Lighting
- Appliances
- Heating/cooling
- Motors
- Furnaces
- Railways

- Power reserves >> frequency control
- Reactive power capacity >> voltage control
- Short-circuit current >> fault detection

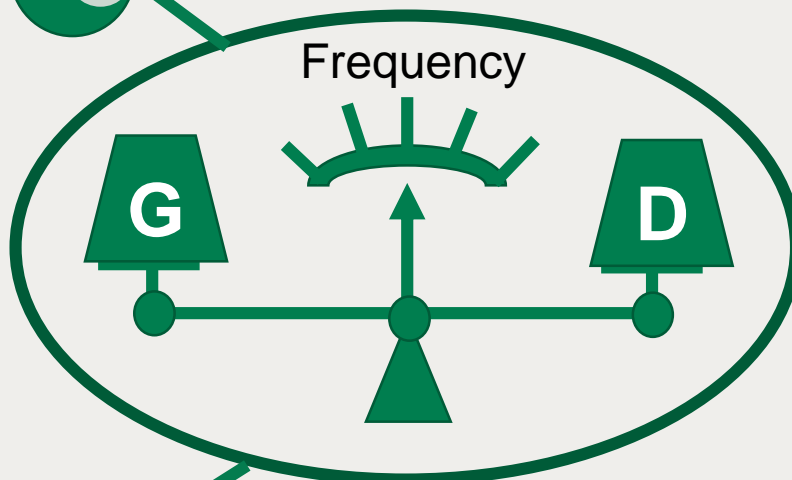
The power system of the future

Power system control

Synchr.



Frequency



IBR

(Coal / Oil / Gas) + CCS

Hydro / Nuclear /
Others

Solar thermal

Wind

Solar PV

**Efficient
consumers**

Prosumers

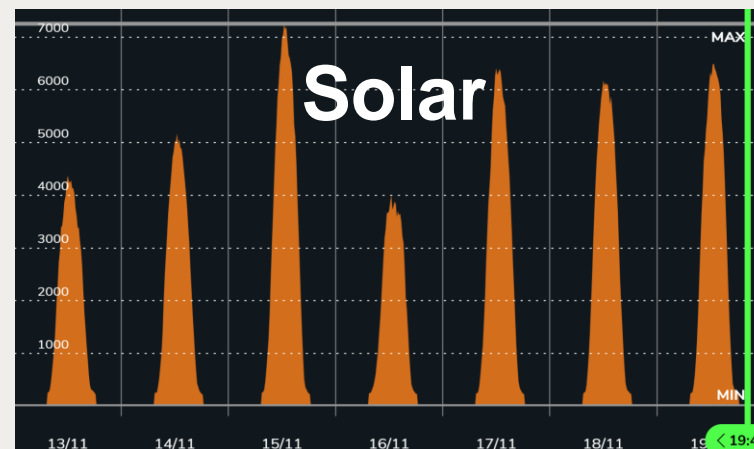
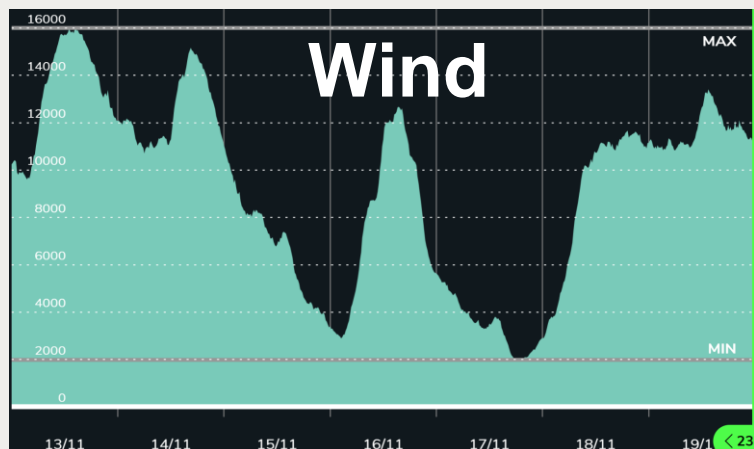
Electrical vehicles

Electrolysers

**Electrification
of more
industrial
processes**

The technical challenges of the transition

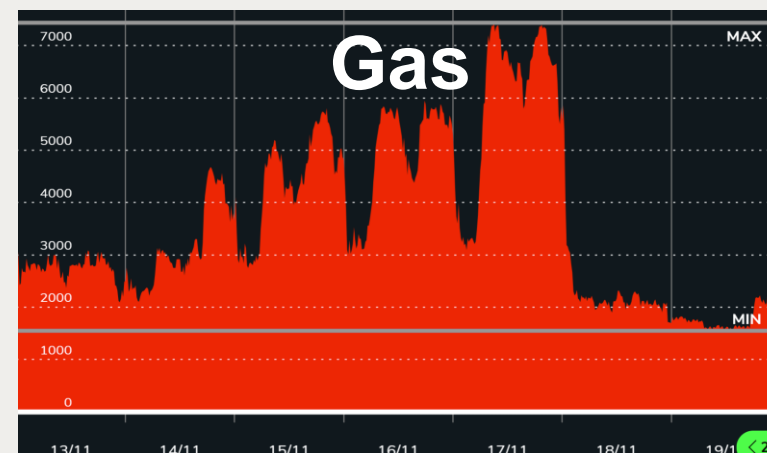
- Solar and wind generation are intermittent and not controllable



Generation in France in the week November 13 to 19, 2023

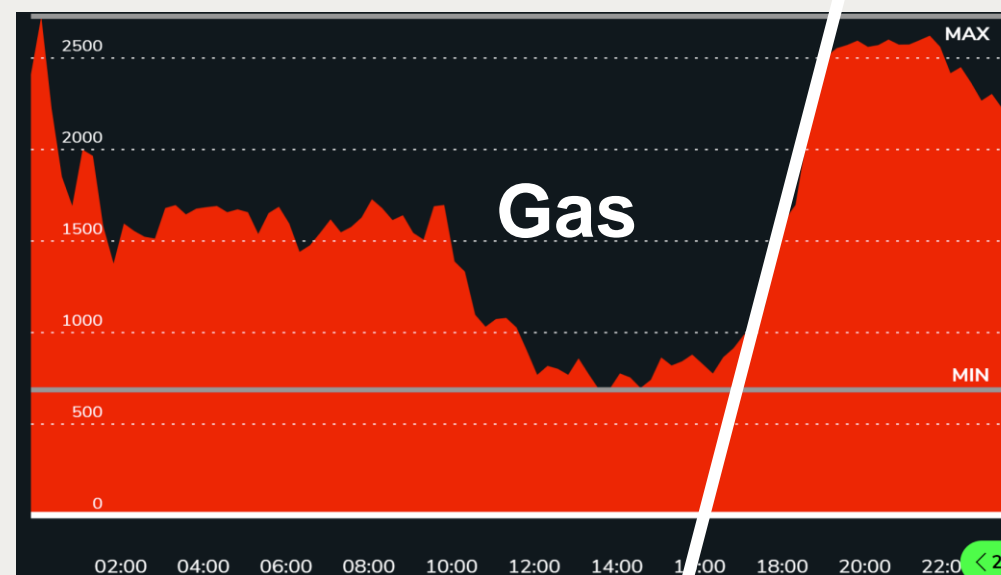
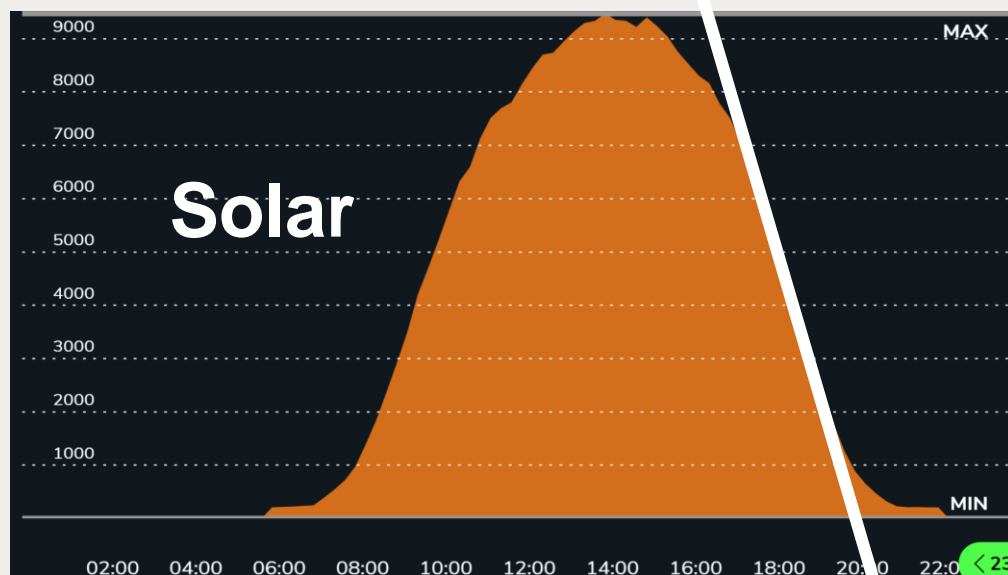
Source: RTE

- Mitigation with:
 - Backup generation
 - Storage systems
 - Flexibility of consumers
 - Interconnection



The technical challenges of the transition

- Fast power generation changes of wind and solar



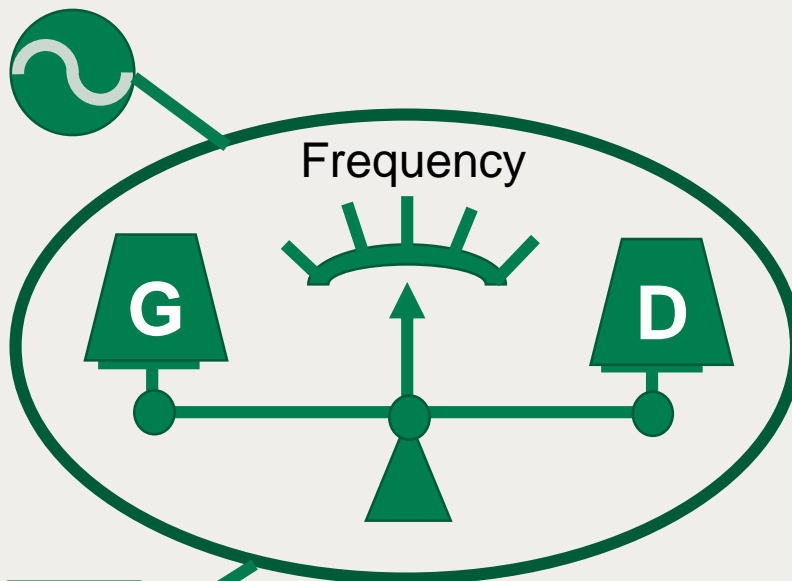
- Mitigation with fast backup generation: gas turbines, storage

Generation in
France on
August 15, 2023
Source: RTE

The power system of the future

Power system control

Synchr.



IBR

(Coal / Oil / Gas) + CCS

Hydro / Nuclear /
Others

Solar thermal

AC storage
discharge

Wind

Solar PV

DC storage
discharge

Efficient and
flexible consumers

Prosumers

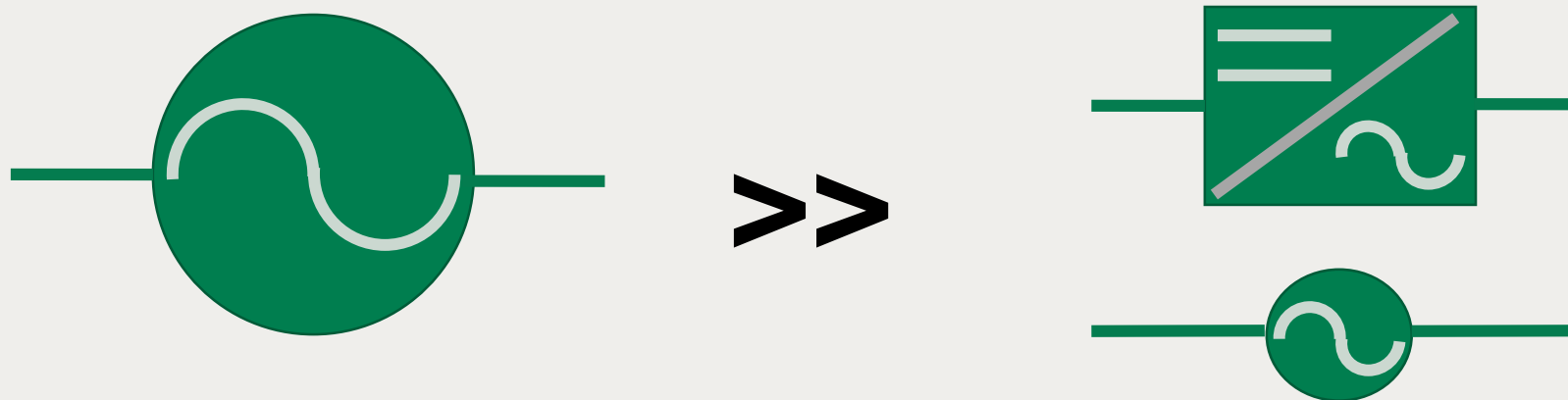
Evs + **AC & DC**
storage charging

Electrolysers

Electrification
of more
industrial
processes

The technical challenges of the transition

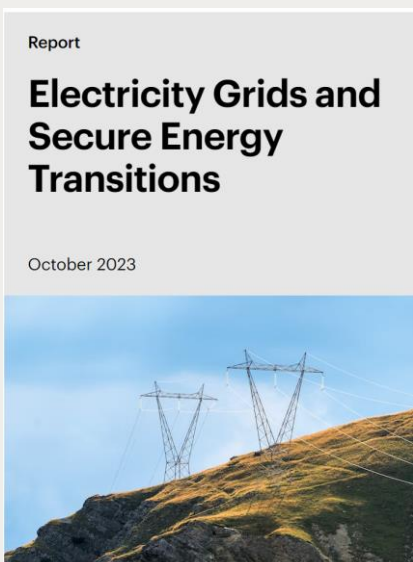
- Large amount of inverter based resources
 - Reduction of system inertia >> frequency control issues
 - Reduction of short-circuit current >> fault detection and protection operation



- Mitigation:
 - Synchronous compensators with inertia
 - Grid forming inverters with storage
- Modelling of the fast response of power electronics

The technical challenges of the transition

- Geographic dispersion of wind and solar:
 - Voltage control in distribution networks
 - Harvesting over wide areas on-shore and off-shore
 - Transmission over long distances from on-shore and off-shore generation to consumption areas
 - More infrastructures for distribution and transmission



International Energy Agency report:

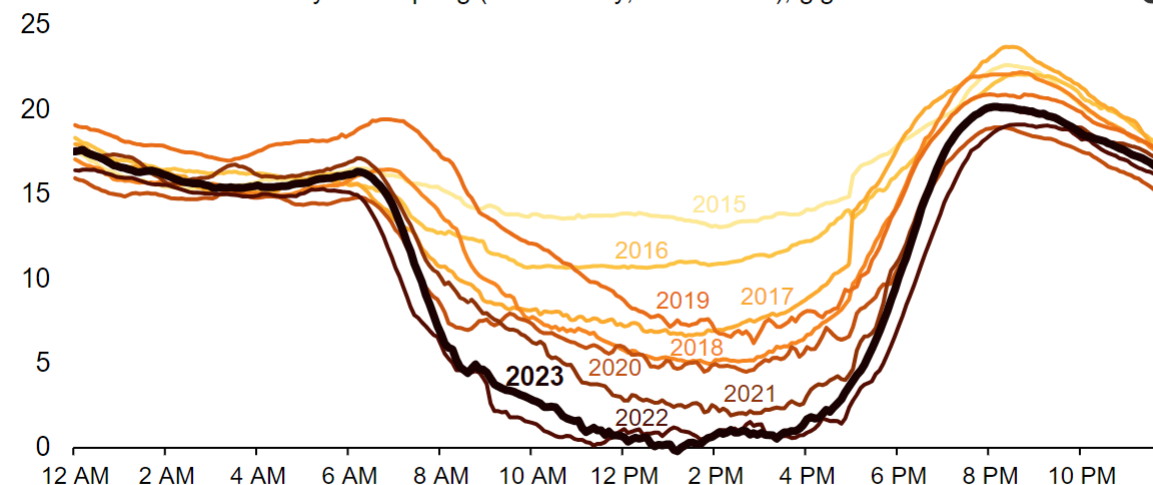
- Modern, smart and expanded grids are essential for successful energy transitions
- Grids risk becoming the weak link of clean energy transitions
- Action today can secure grids for the future

The technical challenges of the transition

- Power market issues:
 - Overgeneration « duck curve »
 - Negative kWh prices

California's duck curve is getting deeper

CAISO lowest net load day each spring (March–May, 2015–2023), gigawatts



Data source: [California Independent System Operator \(CAISO\)](#)

- Exchanges of data and communication
 - Operation of more complex systems
 - DSO/TSO interactions
 - Guaranty of origins (blockchain)
 - Cybersecurity

CIGRE contribution to the transition

- Based on the experiences of its members, CIGRE is addressing the challenges described above, and appointed Working Groups to propose state of the art, best practices and recommendations on system planning, design, construction and operation in the new context of the energy transition
- By selecting relevant topics for its conferences (Paris Session, symposia), CIGRE facilitates the sharing of operational experiences
- The « Large disturbance workshop » of the Paris Session is an opportunity for experts to share lessons learnt from large incidents or blackouts due to the integration of large amounts of renewable energy sources
- CIGRE stimulates technical innovations by bringing together experts from the operators, research centers, consultants, and technology providers, to solve problems at a global level

<https://www.cigre.org>

<https://e-cigre.org>

<https://join.cigre.org>

<https://session.cigre.org>