Power system resilience in Asia: how to ensure that energy transition doesn’t collapse our world

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As we shift towards decarbonated energy, Asia faces the biggest challenge due to its size (60 % of the world’s population), its enduring reliance on coal and gas, and its geography.

- Energy transition poses many questions such as how to mobilise the capital expenditure, how to transfer employment and supply chains...
- A systemic issue also emerges: how stable would the grid be when generation is mostly variable renewable energy? How can we ensure that the electricity system does not collapse?

We will put forward our solutions to mitigate this risk.
EDF Key Figures

- 37.9 million customer sites
- 120.5GW (1) installed capacity
  - Nuclear: 71.2GW
  - Renewables (incl. Hydro): 29.7GW
  - Fossil-fired (excl. coal): 15.9GW
  - Coal (2) 3.7GW
- 501.9TWh electricity output (3)
  - Nuclear: 76.5%
  - Renewables (incl. Hydro): 13.7%
  - Fossil-fired (excl. coal): 9.3%
  - Coal (2) 0.4%
- 165,200 employees

A central position in Europe

In 2013, 37 interconnection lines over 6 borders that can reach an export capacity of 14 GW and an import capacity of 11 GW.

- Strengthening of the internal French network to increase interconnection capacity with Germany, Belgium and Switzerland.
- Project of a 600 km submarine cable being studied to link Ireland to Britain.
- Construction of a new link between Savoy and Piedmont and strengthening of the alpine network which will raise export capacity to more than 4,000 MW.
- Study of a new submarine link across the Bay of Biscay which allows the flow of an additional 2,000 MW.

Daily maximum capacity values reached in 2013. These values are variable and the maximum reached may be different from one year to the other.
When states transit their electricity system, they do one or more of the following:

1. Close down coal-fired power plants (CFPPs) and diesel generators.
2. Convert CFPP and diesel generators to less carbon-intensive operation.
3. Close down gas-fired power plants (CCGTs).
4. Convert CCGT to less carbon-intensive operation.
5. Encourage stable renewables energy such as hydro power plants (HPP), biomass power plants, geothermal power plants, and marine energy sources.
6. Encourage variable renewables energy systems (VRE) such as photovoltaics (PV) and wind turbines.
7. Encourage the development of nuclear power.
Electricity needs to be balanced in real time. System stability is currently maintained by having reliable, centralised power sources that can be controlled and respond quickly.

The balance is fragile. Systems are subject to collapse; there are many examples of impactful blackouts, sometimes affecting several countries simultaneously, as shown in the table.

Introducing a large proportion of VRE impacts systems by creating more potential for imbalance.

Human activity is reliant on electricity and the collapse of the system is to be avoided imperatively.

<table>
<thead>
<tr>
<th>Country</th>
<th>Affected population</th>
<th>Date</th>
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<tbody>
<tr>
<td>India</td>
<td>670 Millions</td>
<td>30-07-2012</td>
</tr>
<tr>
<td>Indonesia (Java)</td>
<td>120 Millions</td>
<td>04-08-2019</td>
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<tr>
<td>Brazil &amp; Paraguay</td>
<td>87 Millions</td>
<td>10-11-2009</td>
</tr>
<tr>
<td>Turkey</td>
<td>70 Millions</td>
<td>31-03-2015</td>
</tr>
<tr>
<td>USA</td>
<td>55 Millions</td>
<td>14-08-2003</td>
</tr>
<tr>
<td>Italy</td>
<td>50 Millions</td>
<td>29-09-2003</td>
</tr>
<tr>
<td>Argentina, Paraguay and Uruguay</td>
<td>48 Millions</td>
<td>16-06-2019</td>
</tr>
</tbody>
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Safe Energy Transition:

1) Balancing the energy mix

- VRE should, where possible, include *both* solar power and wind, helping to mitigate the risk of sudden generation drops.
- Dispatchable (controllable) generation should have a balanced mix, notably when hydrocarbon-based power stations are present because the supply of fuels is subject to price variations and geo-political influences.
- Dispatchable renewables such as hydro, marine energy, and biomass should be encouraged as they present the double advantage of being environmentally friendly and providing a steady power supply.
- If the political and logistical conditions are present, then including nuclear power in the mix presents the advantage of ensuring a large base-load and controllable power supply.
Safe Energy Transition:

2) Developing the grid infrastructure and interconnections

- This allows to increase the overall resilience of the grids that by increasing access to back-up electricity.
- The best example of this is the European system, where all of Europe (including the United Kingdom) has high levels of interconnection.
- Around the world, there are programmes, projects and plans to interconnect countries and regions.
- Follows a map showing some examples of these.
- In practice, however, there are many barriers to these initiatives, most notably the geopolitical concerns of international relations, but also the issue of cost/benefit distribution between the countries.
There are existing interconnections in the region...
...and many more planned around the world.
The main barriers are:
- Geopolitics
- Cost/benefit sharing
Safe Energy Transition:

3) Managing the energy flows

- This is a smart way of minimising infrastructure investment.
- Battery storage and pumped hydro power (PHP) should be examined as balancing tools.
- Energy flow control, traditionally centralised and based on a limited number of large generators, should evolve to ensure better, finer tuning in real-time.
- As generators become numerous and distributed, focus on a local level whilst keeping a centralised overview that includes interconnections.
- Advances in computing and data analysis allow dispatching centres to analyse huge quantities of data very quickly, and therefore to manage very finely the system.
- Energy Markets play a major role in system resilience, as they influence the behaviour of the players. By designing the market rules towards greater reactivity and balancing, then the resilience is increased.
Energy Transition