Vulnerability of society to a pandemic

This hypothesis starts with the paper

Front. Polit. Sci., 12 April 2021 | https://doi.org/10.3389/fpos.2021.622069 I Do it My Way: Understanding Policy Variation in Pandemic Response Across Europe
by Clara Egger, Raul Magni-Berton, Sebastian Roché and Kees Aarts

and the leading question: how and why do politicians react the way they do.

My contribution to the discussions is that our society is not robust at all, or at least far less than most people think.

This has his origin in my experience working as an operator (I retired in 2004) in the control center of the electricity grid in Flanders (Belgium). I followed training sessions in the grid simulator and training center in France (in Caen at that time). As far as I can observe the situation is not evolved towards a more robust situation in regard to the dependence and vulnerability of our society to the availability of electricity, on the contrary. Furthermore I was unable to find out, when I was still at work, if the gas distribution was independent from the availability of electricity from the grid. This is the case in some states in the US. This way back up gas fired generators (also small domestic) can take over emergency production of electricity while the electricity grid is down (in most cases due to massive high voltage line failure caused by tornado, storm etc). At work we made risk assessments every day because grid situation and load differs every day, also due to planned outages of production plants and/or high voltage lines etc.. Then we calculated (computers did) what we could "lose" additionally. A nuclear production plant (1000 MW), a 400 KV line (backbone of the grid), a transformer 400/150 KV etc. In normal exploitation we tried to be capable to lose 3 key elements without being forced to intervene and cut load without warning (consumers, be it industrial or residential).

I argue that the measures taken by politicians are also dependent on the estimated vulnerability of the society as a whole and the possibility of a total collapse.

Then the question is: what would be the next "vital sector", after the hospitals, that would collapse due to a pandemic, and the effects on society.

Transport perhaps, flight control personnel, pilots, radar personnel on rivers, harbors and airports, all highly specialized and not directly replaceable when sick in great numbers?

In general, those services that are using highly specialized operational personnel together with specialized equipment and the specialized maintenance staff. This with the whole chain of specialized spare parts from fabrication to delivery.

For me the most likely worst case candidate is a black out of the electricity grid. Probably not completely and abruptly but with severe disruptions, outages and heavy rationing. Especially the nuclear sector is vulnerable, the operators of the power plants, specialized personnel performing repairs and maintenance and so on, are highly specialized and even some of them are only allowed to work when licensed (with frequent training in simulators and annual exams). A significant loss of that personnel and in the whole sector of production and delivery of highly specialized spare parts and materials makes the whole sector very vulnerable.

WORLD NUCLEAR ASSOCIATION

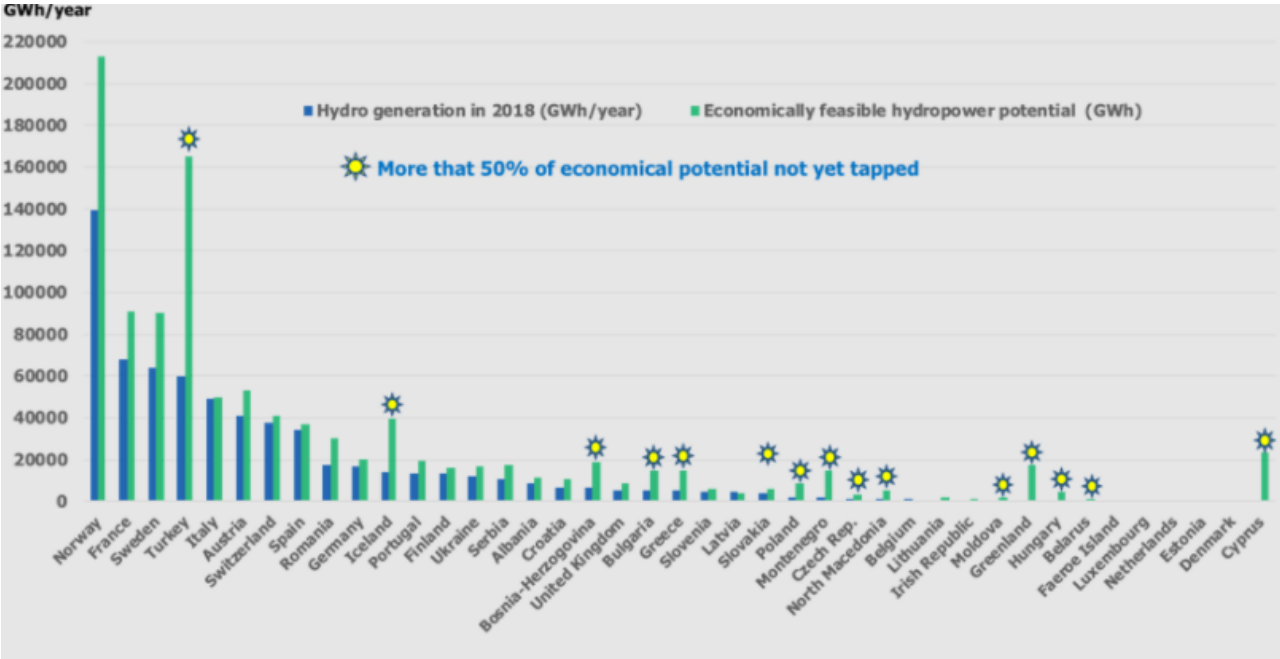
COUNTRY (Click name for Country Profile)	NUCLEAR ELECTRICITY GENERATION 2019		REACTORS OPERABLE February 2021		REACTORS UNDER CONSTRUCTION February 2021		REACTORS PLANNED February 2021		REACTORS PROPOSED February 2021		URANIUM REQUIRED 2021
	TWh	% e	No.	MWe net	No.	MWe gross	No.	MWe gross	No.	MWe gross	tonnes U
Belgium	41.4	47.6	7	5930	0	0	0	0	0	0	898
Bulgaria	15.9	37.5	2	2006	0	0	1	1000	1	1000	334
Czech Republic	28.6	35.2	6	3932	0	0	1	1200	3	3600	694
Finland	22.9	34.7	4	2794	1	1720	1	1250	0	0	758
France	382.4	70.6	56	61,370	1	1650	0	0	0	0	8701
Germany	71.9	12.4	6	8113	0	0	0	0	0	0	587
Hungary	15.4	49.2	4	1902	0	0	2	2400	0	0	360
Lithuania	0	0	0	0	0	0	0	0	2	2700	0
Netherlands	3.7	3.2	1	482	0	0	0	0	0	0	74
Poland	0	0	0	0	0	0	0	0	6	6000	0
Romania	10.4	18.5	2	1300	0	0	2	1440	1	720	187
Slovakia	14.2	53.9	4	1814	2	942	0	0	1	1200	428
Slovenia	5.5	37.0	1	688	0	0	0	0	1	1000	141
Spain	55.9	21.4	7	7121	0	0	0	0	0	0	1217
Sweden	64.4	34.0	6	6859	0	0	0	0	0	0	985
EU	**732.6**	26%	**106**	104,311	4	4312	**7**	**7290**	**15**	**16,220**	15,364
	TWh	**% e**	**No.**	**MWe**	**No.**	**MWe**	**No.**	**MWe**	**No.**	**MWe**	**tonnes U**
	NUCLEAR ELECTRICITY GENERATION		OPERABLE		UNDER CONSTRUCTION		PLANNED		PROPOSED		URANIUM REQUIRED

Is the nuclear electricity generation an indication for vulnerability? Sweden can loose 34% of electricity production, France 70 % when the nuclear capacity is down. Traditional power plants (hydro, coal, fuel, gas,..) can be run by electricians and engineers far more available than specialists in the nuclear industry and with far more tolerance, flexibility and imagination and in some cases nearly manual.

The electricity grid is also a vulnerable element, not only because of the small number of grid operators but the dependency on a few computers, with his maintenance staff, for grid monitoring and management. Of course the European grid is strongly interconnected even outside the EU, but a pandemic is affecting everybody. Furthermore this solidarity is also technically limited, be it in thermal

or constructive limits, when the transport lines become “to long”, in regard to the “transmissible power” (roughly one third of the thermal limit used in “short line” applications in AC), or other technical limits (open end voltage, phase angle,..). Grid management however is often possible in a manual way, very independently decentralized, in the local substations. Of course this takes time and personnel but can be done if available, also depending on the communication possibilities (portable and independent radio communication with the personnel in the field). Nevertheless nuclear power plants can only operate and be connected to a stable grid (in regard to load, voltage, phase angle, frequency,..). Even a fully operational nuclear power plant will not connect to a grid that is not in a “stable” condition.

Depending on the evolution and characteristics of the pandemic, degradation of the electricity availability can, in the best scenario, be in steps and more or less organized. Nevertheless the impact and **cost of such a degradation will be very high** (golden rule - follow the money https://www.collinsdictionary.com/submission/4508/Follow+the+money) and not only financial and economic.



Effects to society at a first glance:

It is clear that an absence or unstable and rationed delivery of electricity would severely influence our whole society. Hospitals have back up power generators (at least for some time) if they work, Internet and financial activity is down or severely disrupted, drinking water delivery disturbed, sewer pumping stations out of order, no gas, no cell phones (or very limited coverage), no lights, no heating nor cooling or ventilation, no fridge or deep freezers, no elevators, electrified locks and garage doors won't work, and so on. Bridges, locks and pumping stations on the waterways are disrupted, industrial cold rooms and other installations for food conservation have severe problems if they have no back up generators. Intensive animal farming will lose their animals in great numbers. Industry will be severely affected. Everything that works with electricity will experience problems directly or indirectly.

Fuel stations on the road are only functioning if they have back up power generators (some do). Most solar and wind installations are designed to work in synchronization with the electricity grid and can not be used “off grid”, even with batteries installed, unless especially designed for “off grid” use (most are

not). Radio and television national broadcasting stations have, in most cases, back up generators but the problems will occur at the receiving end.

Some installations have back up systems or are running on systems who are using the grid in case of failure of their own generation, some can be manually operated. But even those systems will be affected by cascading effects and may have to shut down.

Conclusion:

At this moment I think that personnel working in 'vital key sectors" is vaccinated for Covid (more or less "obliged") but a worse case scenario is that a new variant is not affected by the current vaccines.

A whole new pandemic of an other nature is, of course, also possible. The main causes, very dense human population and unlimited fast traveling around the world are not likely to change in the near future.

How do we calculate or estimate robustness of our society against a pandemic taking into account the vulnerability of the electricity system. How to manage a "slow" degradation that can take many months in the case of a pandemic.
A detailed plan and trained practical execution of lower production and load in steps, at least to handle a "slow" degeneration of the whole (national) electrical system, depending on the estimated robustness in regard with the threat at hand, seems necessary to me in order to avoid a chaotic and total collapse of our society. As far as I know a centralized, specific and detailed management of the load, (who and how much for each customer), is not available at this moment. Load shedding programs do exist but not at individual level for the common customer or small businesses, preferably in several steps, what will be necessary in order to have an acceptable livable system for a long period of time (may be many months).
Management of the electricity grid demands a continuous balance between power production and load. The reference for such a balance is the frequency who has to be stable in very narrow limits (50 Hz in Europe).

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References:

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https://www.epa.gov/sites/default/files/2019-11/documents/191126-incidentactionchecklist-po-form_508c.pdf

- An old story Dec. 20, 1978 (personal experiences)
https://www.nytimes.com/1978/12/20/archives/power-blackout-spreads-disruption-across-france.html ..
Hundreds of Parisians were unable to leave apartments whose doors open electrically. Hundreds were caught in elevators. Traffic lights were out, snarling traffic and delaying firemen who were responding to calls for help on behalf of those marooned in elevators.Two workers in the Bank of France were locked for two hours in the electrically controlled vault. Many cafes closed for lack of heat on a cold day, and because they also lacked the current for espresso machines. ...

- more recently NOV 15, 2006 (cascading effects) : Human Error To Blame For Europe Blackout | IndustryWeek https://www.industryweek.com/operations/energy-management/article/21953258/human-error-to-blame-for-europe-blackout

.. Germany's biggest power supplier said on Nov. 15 that human error was to blame for the electricity cut that plunged parts of Western Europe into darkness on November 4. E.ON said the switching-off of an electricity line over the Ems River in western Germany to allow a cruise ship to pass through, coupled with the outage of a second transmission line, "set off the domino effect which led to the temporary disconnection of the European inter-connected power grid." ..

- The Texas black out Cascading risks: Understanding the 2021 winter blackout in Texas - ScienceDirect https://www.sciencedirect.com/science/article/pii/S2214629621001997

- dg_ener_electricity_market_data_-_final_report_-_22032018.pdf (europa.eu) EU https://ec.europa.eu/energy/sites/ener/files/documents/dg_ener_electricity_market_data_-_final_report_-_22032018.pdf

Study on the quality of electricity market data of transmission system operators, electricity supply disruptions, and their impact on the European electricity markets

….

4.4.3 Conclusions:

Disruptions are costly to society, as for every disruption, consumers willing to pay the price for electricity do not have the opportunity to consume it. That limits the production of commercial consumers and the use of leisure of private consumers, and can in addition lead to damages of products or machinery. The value of lost load (VoLL) is an estimate for those costs.

….

Those estimates show that the disruptions in Europe in the period 2010 to 2014 gave rise to a socio-economic loss of approximately 10 to 25 billion EUR annually.

- https://www.hurriyetdailynews.com/new-nuclear-plants-are-for-dictators-politician-31086

“Nuclear plants will only be built in dictatorships or semi-dictatorships,” said Cem Özdemir, co-chairman of the German Green Party.

The alleged relationship between nuclear power plants and dictatorship is not new. But in most cases it was related to the political notion of “democracy” (demos kratia) or, more recently, to the impossibility of protecting effectively nuclear power plants against terrorist attacks without dictatorial control and protection systems in place. The latter argument is even more pertinent in connection to the recent discussion about the use of more “small capacity” and decentralized “new generation” nuclear power plants,

This hypothesis adds also a possible new element to the relationship of dictatorship and nuclear power plants.