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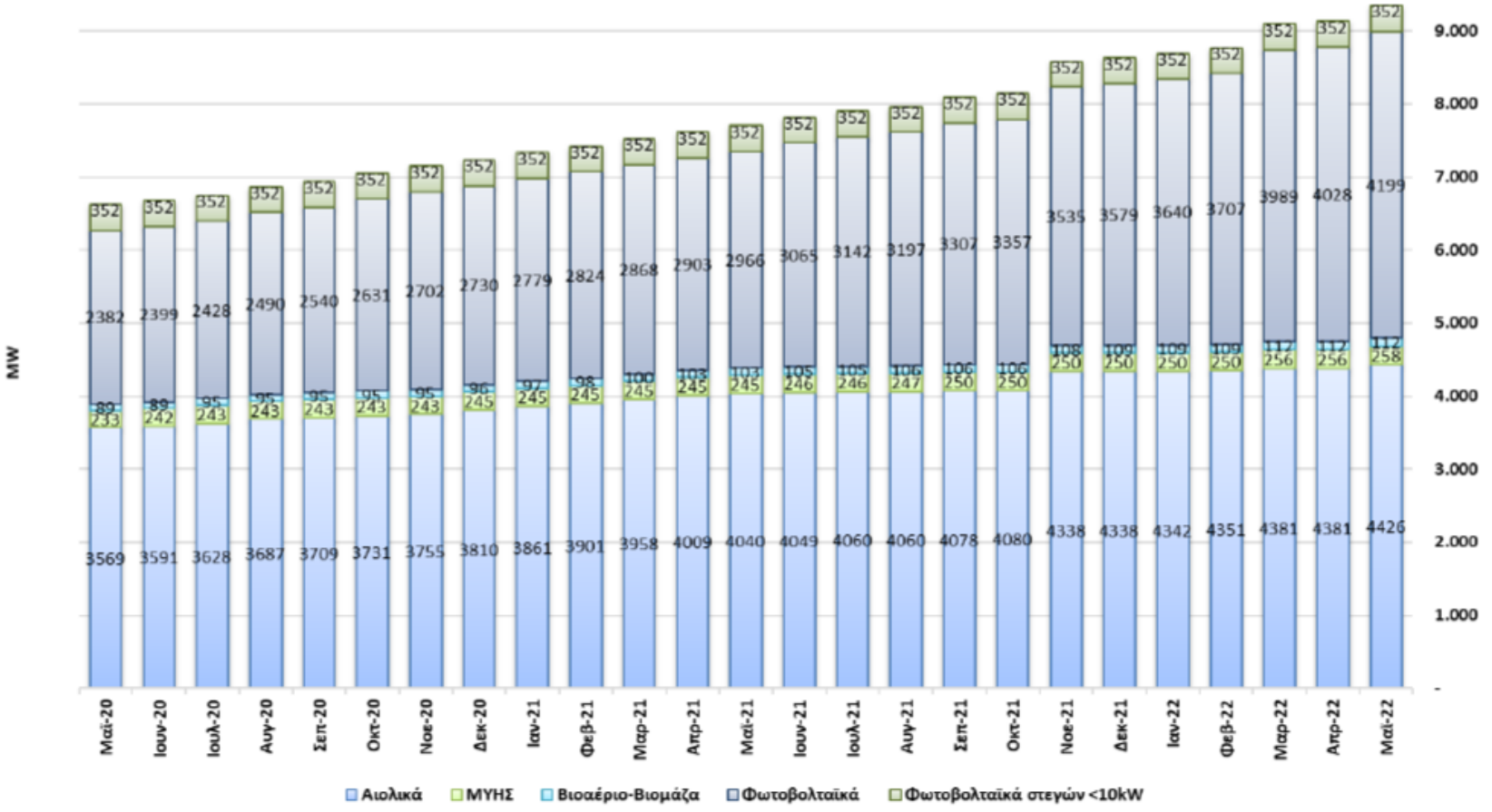
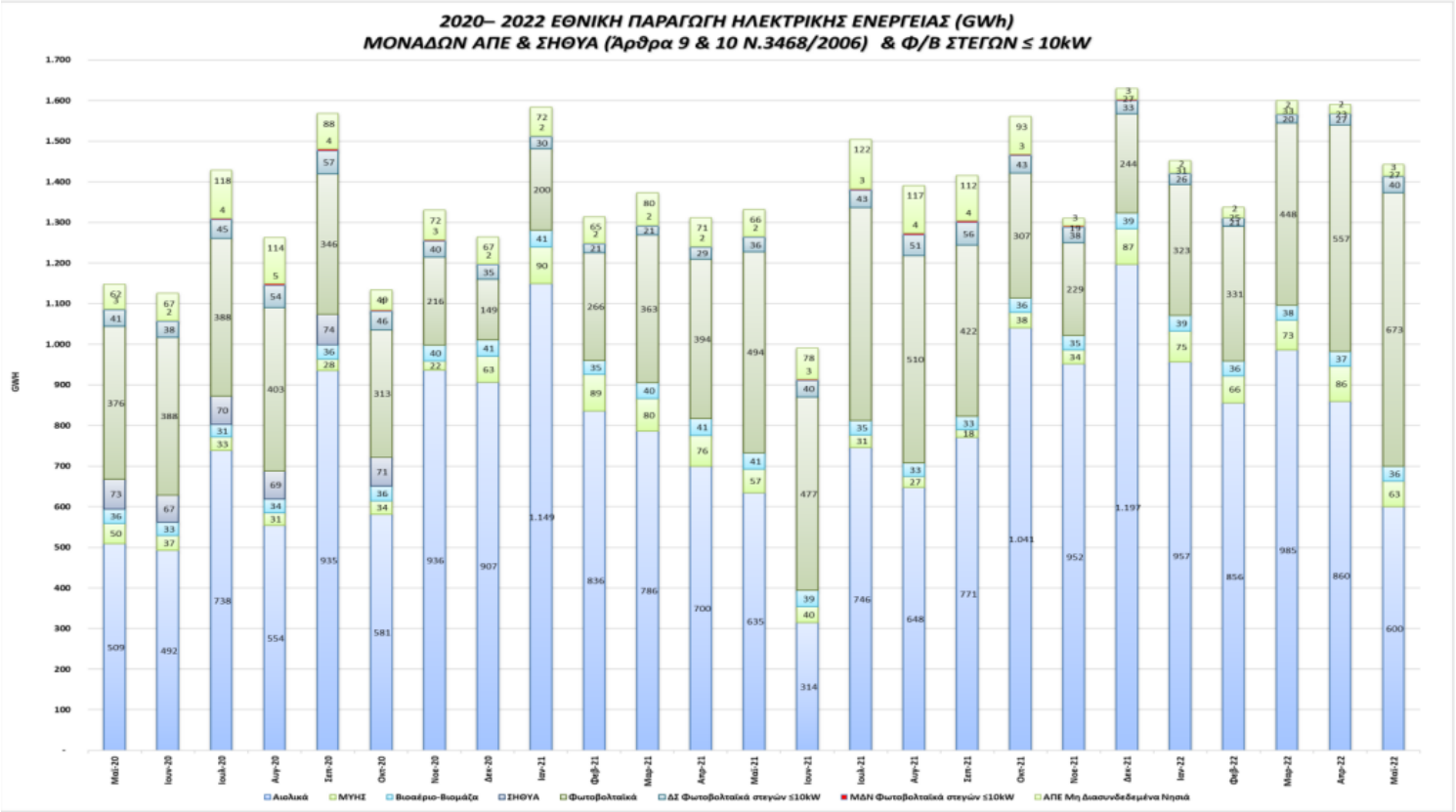
Evolution of RES capacity in Greece (interconnected system)



Source: DAPEEP

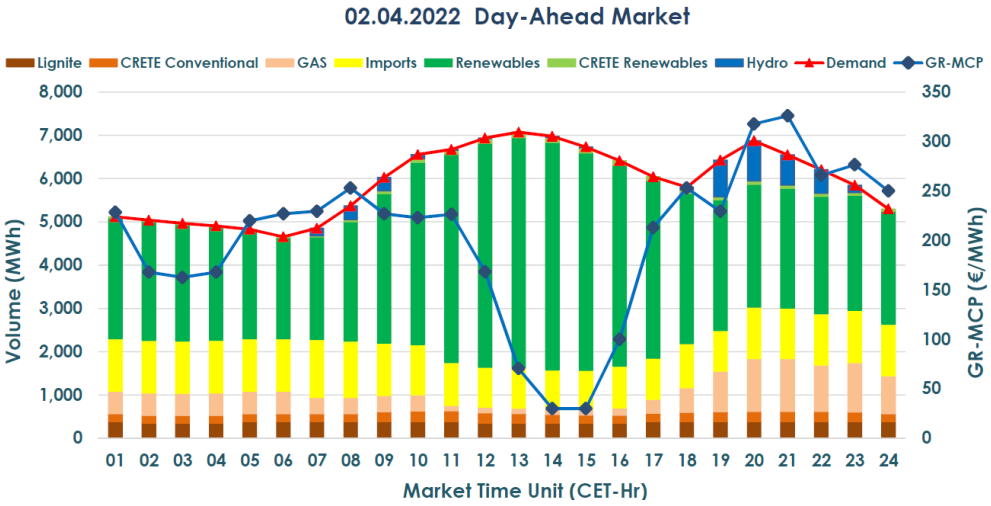
Evolution of RES energy (GWh) penetration in Greece



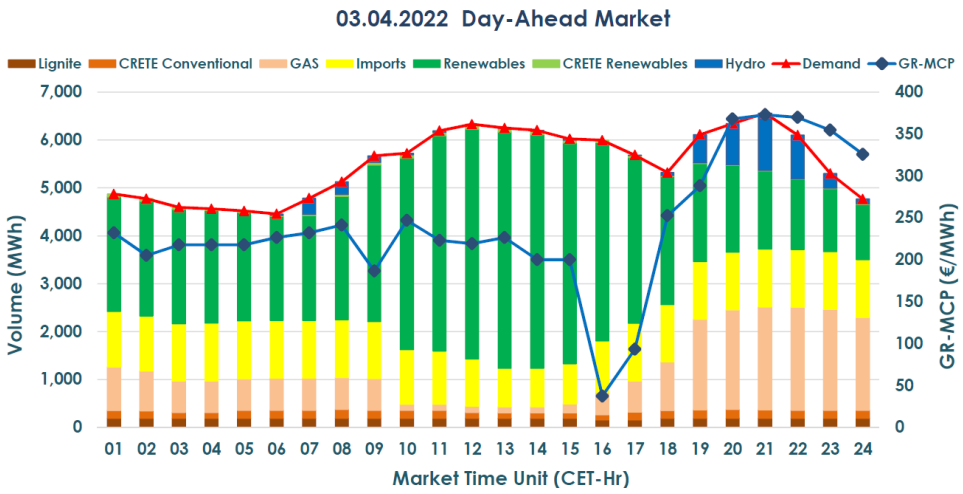
On annual basis RES penetration on demand might exceed ~45% during 2022 out of which

PVs ~13%, Wind ~19%, Big Hydro ~10% and the rest ~3%

RES curtailment took place for the first time in interconnected system during last April



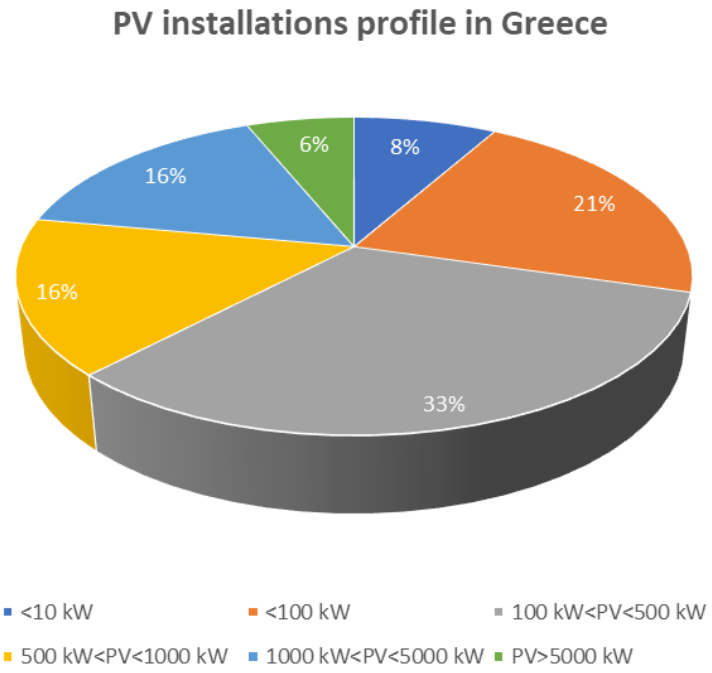
During noon time RES penetration reached **77%** of demand



During noon time RES penetration reached **80%** of demand

Decline in electricity demand due to the energy crisis will worsen the situation of RES curtailments, if storage not adequately present

Profile of PV installations in Greece in terms of capacity (MW) (May 2022)



The 2030 PV capacity target according to current NECP is 7,7 GW.

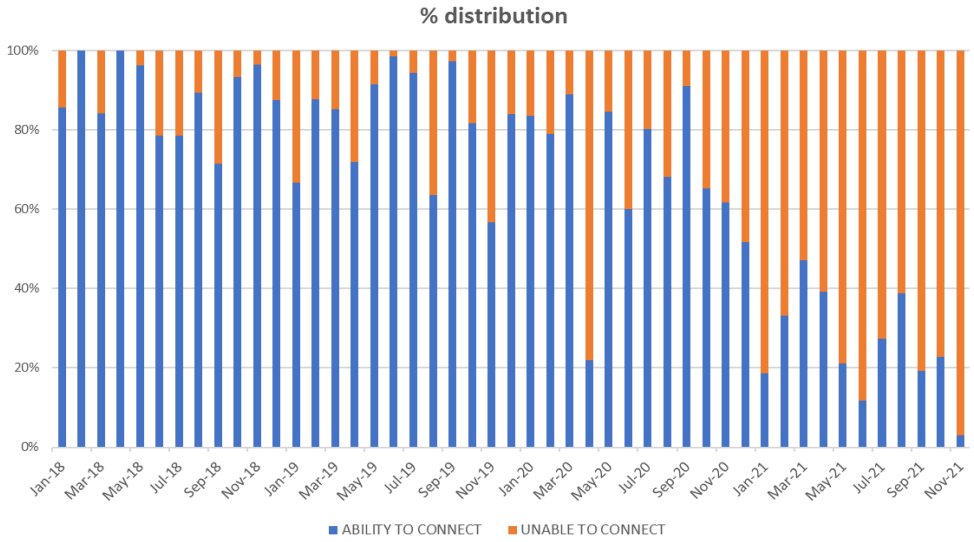
It is expected to exceed 10 GW at the revised plan.

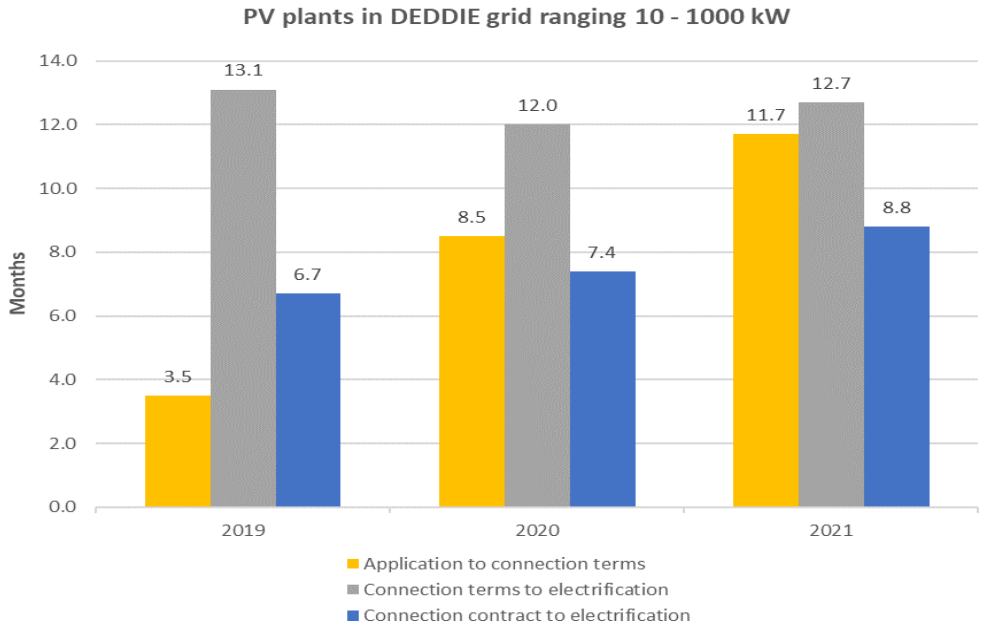
This capacity alone is higher than most of the demand peaks.

Rest RES should be also added.

Under this context storage units become a necessity in order to avoid significant curtailments in the new RES plants production.

Grid saturation under PV peak power conditions, limits the potential for new installations. Storage can relax this situation.





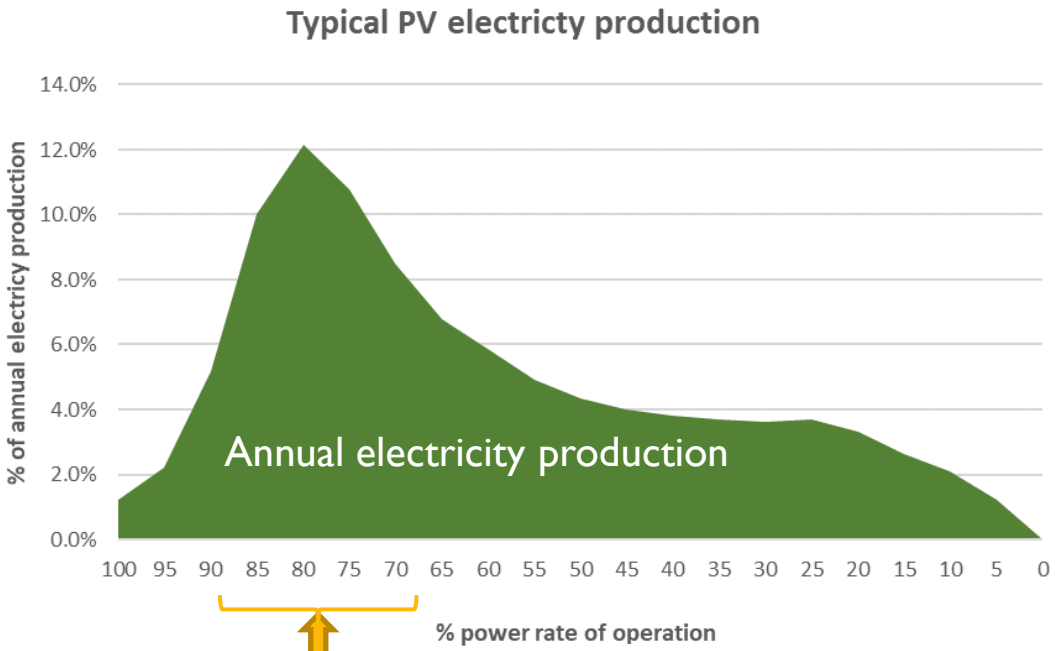
Grid saturation has become the ultimate obstacle for further PV penetration.

According to official DEDDIE published data, processed by SPEF, new applications to DEDDIE for connection terms receive negative answer at almost 90% of the cases.

DEDDIE Connection Terms (if any) need 11.7 months to be issued from application, according with officially published raw data.

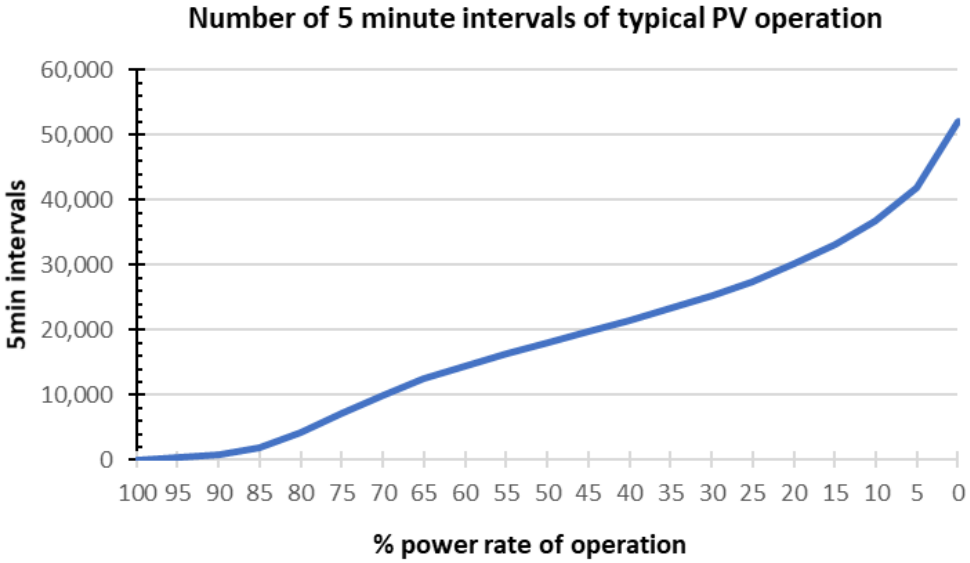
For ADMIE, Connection Terms pipeline and lead times, there are no officially published raw data available.

PV electricity production distribution Vs operation % rate

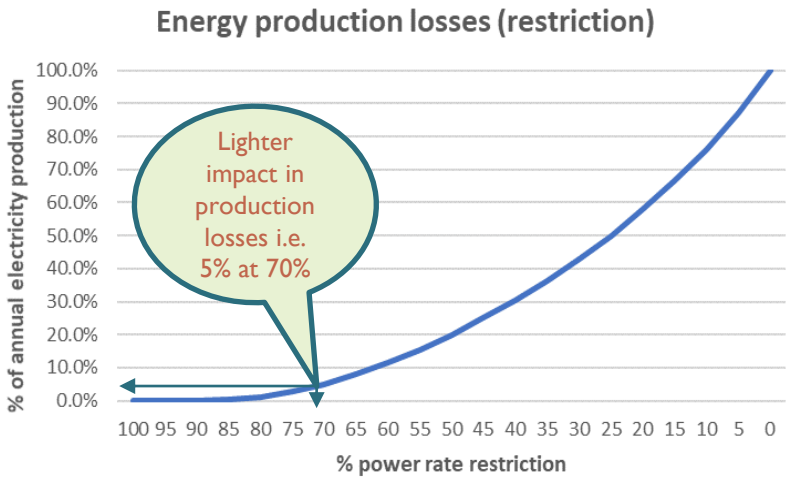


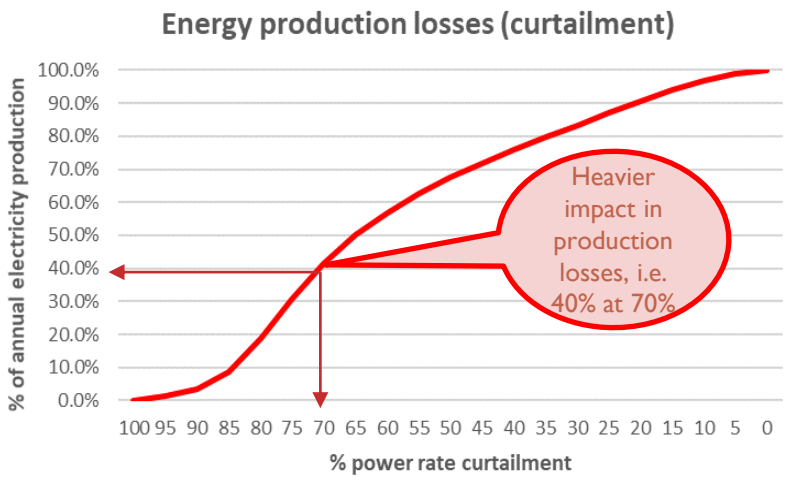
Most of annual electricity production of a typical PV plant*.

*Typical PV plant means fixed basis, 25° inclination and 1,500 MWh/MW specific annual production



Energy production losses Vs % power rate restriction or curtailment in a typical PV plant



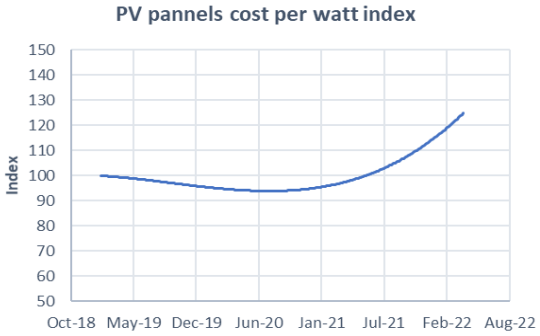


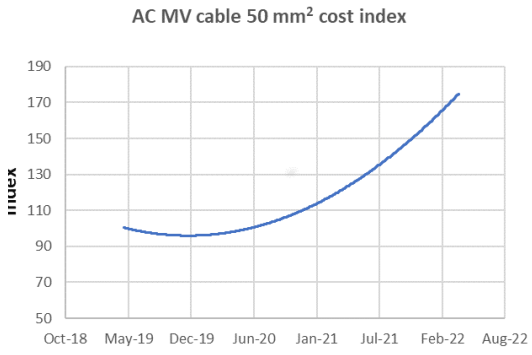
The Ministry of Energy aiming to fully exploit electrical space in the grids has introduced for new connection contracts a mechanism for restricting or curtailing their operation in cases of congestion. Annual energy losses should not exceed 5%. Storage evolution in the coming years will play a key role for reversing or at least not worsening this situation for new RES projects.

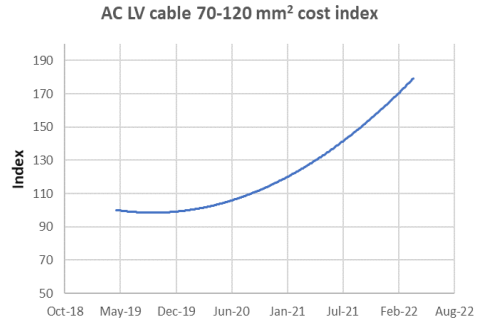
Power rate restriction scenario (left chart) means that under specific conditions of congestion in the grid, the grid administrator limits PV plant's operation up to a specific level of its power rate i.e. 70%. However, the plant continues to operate, as it is not disconnected from the grid. On annual basis such a restriction at full implementation would lead to an energy production loss of ~5%.

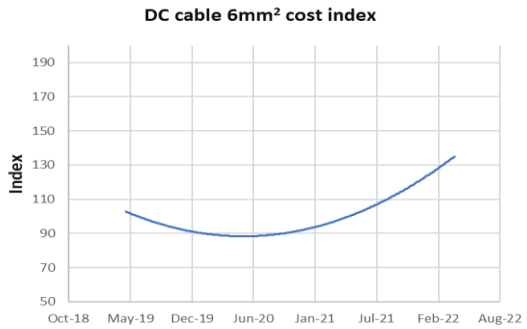
Power rate curtailment scenario (right chart) means that under specific conditions of congestion in the grid, the grid administrator curtails PV plant's operation if a specific level of power rate i.e. 70% is achieved. On annual basis such a scenario at full implementation would lead to a catastrophic energy production loss of 40%.

Cost increases (indexed) in PV projects has dropped Project IRR below 6% and do not leave space for production curtailments









- PV Panel cost/watt has increased by 35% vs beginning of 2021
- AC cable cost has increased up to 75% and DC cable cost up to 35%
- LV/MV Substation cost has increased by 20%
- There is no sign for cost reduction in the near future.
- On the contrary financing costs also increase.

		Tariffs in Euros/MWh														
INDEXED CAPEX	CAPEX for a typical PV of 400 kWp	65.74	67	68	69	70	71	72	73	74	75	76	77	78	79	80
96	270,000	7.8%	8.1%	8.3%	8.5%	8.8%	9.0%	9.2%	9.4%	9.6%	9.8%	10.0%	10.2%	10.4%	10.6%	10.8%
100	280,000	7.4%	7.6%	7.9%	8.1%	8.3%	8.5%	8.7%	8.9%	9.1%	9.3%	9.5%	9.7%	9.9%	10.1%	10.3%
104	290,000	7.0%	7.2%	7.4%	7.6%	7.8%	8.0%	8.3%	8.4%	8.6%	8.8%	9.0%	9.2%	9.4%	9.6%	9.8%
107	300,000	6.5%	6.8%	7.0%	7.2%	7.4%	7.6%	7.8%	8.0%	8.2%	8.4%	8.6%	8.8%	9.0%	9.2%	9.3%
111	310,000	6.2%	6.4%	6.6%	6.8%	7.0%	7.2%	7.4%	7.6%	7.8%	8.0%	8.2%	8.3%	8.5%	8.7%	8.9%
114	320,000	5.8%	6.0%	6.2%	6.4%	6.6%	6.8%	7.0%	7.2%	7.4%	7.6%	7.8%	7.9%	8.1%	8.3%	8.5%
118	330,000	5.5%	5.7%	5.9%	6.1%	6.3%	6.5%	6.6%	6.8%	7.0%	7.2%	7.4%	7.6%	7.7%	7.9%	8.1%
121	340,000	5.1%	5.4%	5.6%	5.7%	5.9%	6.1%	6.3%	6.5%	6.7%	6.8%	7.0%	7.2%	7.4%	7.5%	7.7%

Challenges of storage for PV producers

- Non vertical RES producers are vulnerable in production curtailments since they are remunerated mainly with tariffs that do not offer adequate margin to cover the loss. So, access for them to storage units is significant. It should be underlined, however, that current PV remuneration regimes (tariffs) do not offer the margin to pay for it.
- In principle, vertical participants enjoy the opportunity of acquiring significant profits for their RES production since they have direct access to high retail prices (i.e. through intercompany PPA's) that can cover the loss of curtailments, the cost of storage and even more.
- Combined PV production with storage needs a special / separated remuneration regime, offering the necessary margin.
- A 2-hour combined typical storage (with batteries) for a typical PV plant, almost doubles the installation overall cost per MW for the investor.


IENE WORKSHOP
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for Maximum RES Penetration

THANK YOU !