



CENTRE FOR RENEWABLE &
SUSTAINABLE ENERGY STUDIES



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Firm-Dispatchable Power and its Requirement in a Power System based on Variable Generation

Background



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“the Presidential Climate Commission (PCC) released its recommendations on South Africa’s electricity system, which indicated that a **least cost** approach would involve a massive scale-up in the building of **variable renewables**, supported primarily by **battery storage and gas peakers**”

Definitions

Peaking power: Enel defines peaking power as - “A peaking power plant (or “peaker plant” for short) is a power plant that grid operators call on at times of particularly high electricity demand on the grid.”

Firm power: The US EIA defines firm power as - “[Firm power is] Power or power-producing capacity, intended to be available at all times during the period covered by a guaranteed commitment to deliver, even under adverse conditions.”

Dispatchable Power: The University of Calgary defines dispatchable power as - “A dispatchable source of electricity refers to an electrical power system, such as a power plant, that can be turned on or off; in other words they can adjust their power output supplied to the electrical grid on demand.”

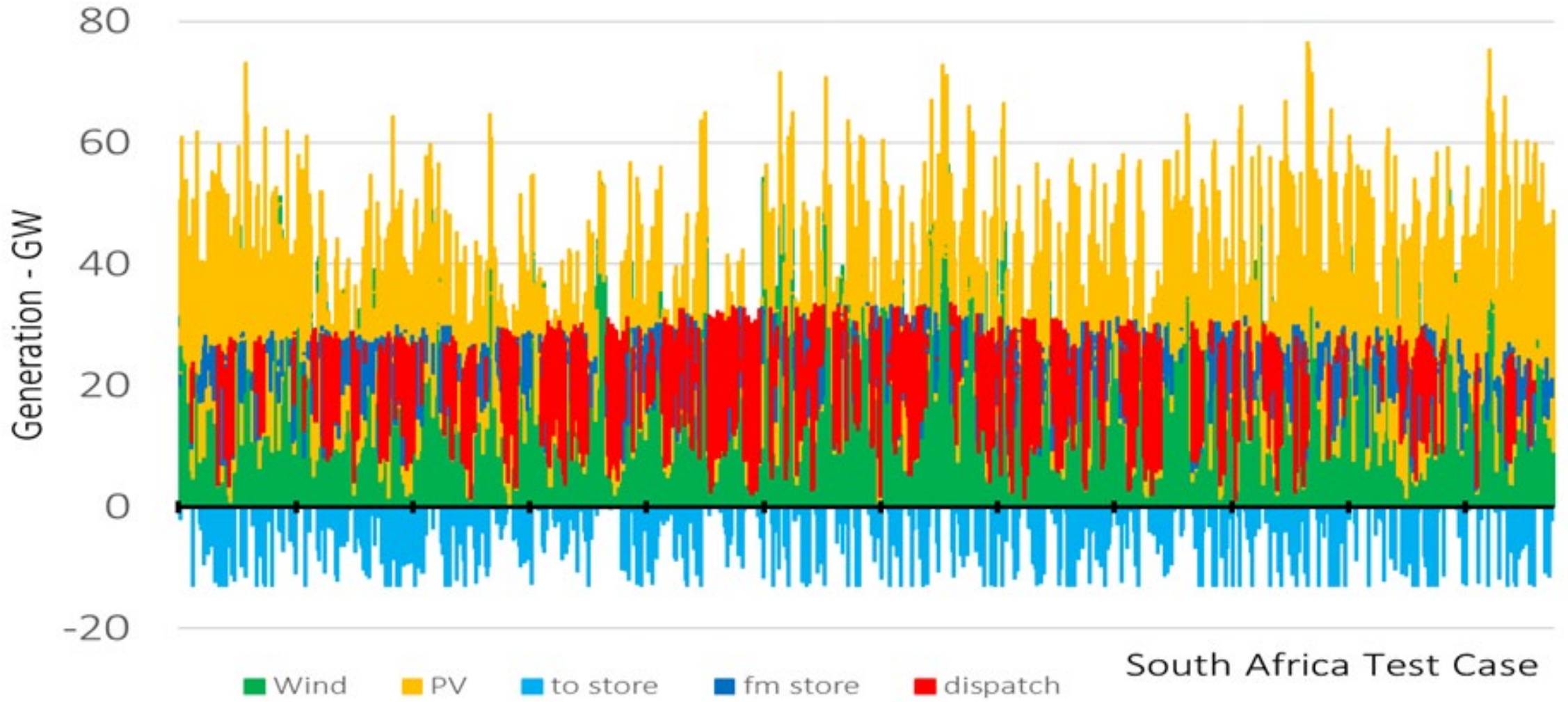
- Scenarios were created assuming a hypothetical system based on complete generation using wind and solar PV, with battery storage plus dispatchable generation to keep the system in balance.
- Models were constructed using hourly data from South Africa, Texas and the UK.
- Cases were based on actual 2022 demand and renewable generation profiles for Texas and the UK. For South Africa, 2019 was used to avoid load shedding considerations.
- Costing for least cost cases was based on NREL 2040 forecasts
 - Wind – 1200 USD /kW
 - PV – 1000 USD /kW
 - Dispatch – 800 USD /kW
- NREL forecast of 200 USD/kWh for energy storage were used for base cases.
- Test cases for low cost storage were also reviewed, with storage at 10 USD / KWh.

South Africa Dispatchable Energy Requirement

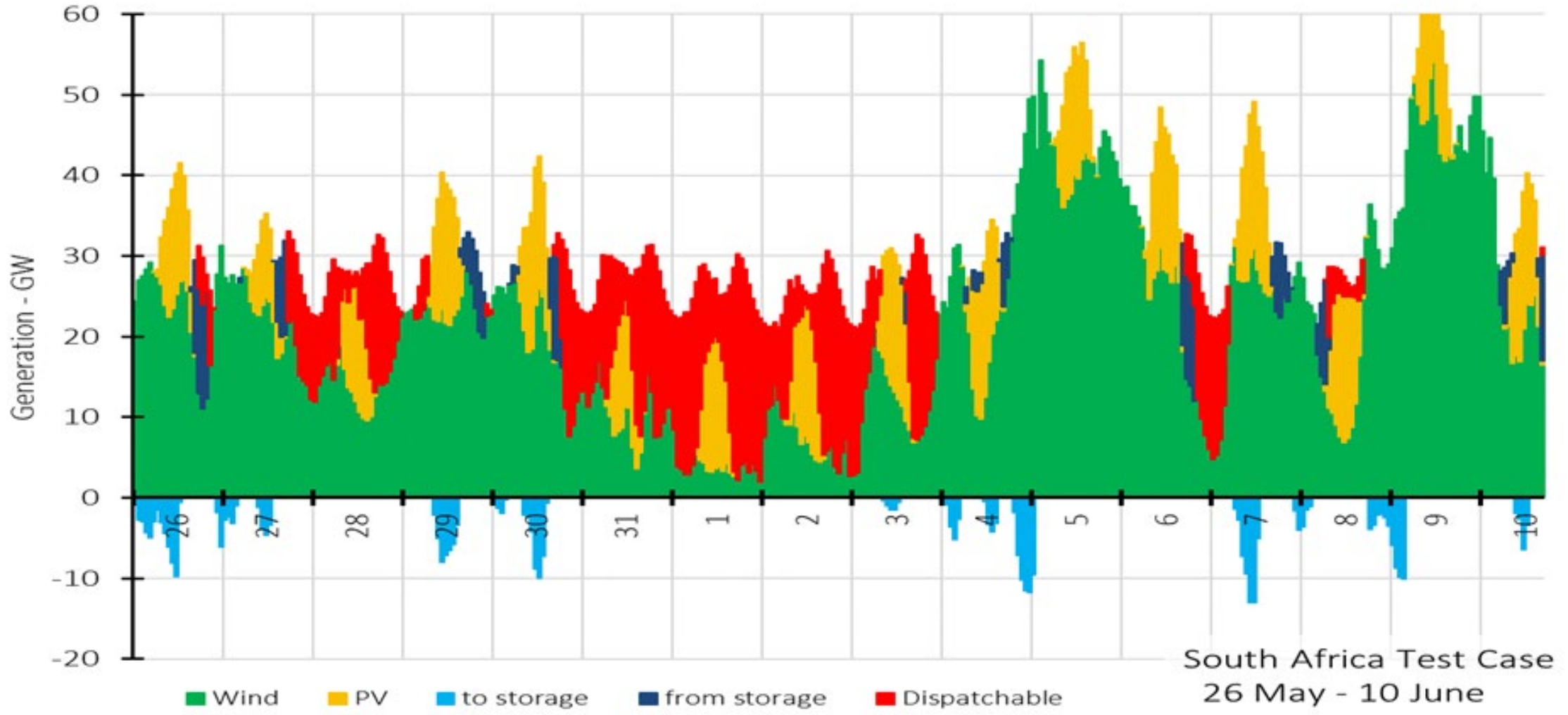


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South Africa Dispatchable Energy Requirement



Definition of Firm-Dispatchable Generation

Firm-Dispatchable Power is generating capacity (to replace the wind and solar sources completely) that is available at all times, that can be turned on or off, or can adjust its power output according to market need.

International Comparisons

	South Africa- Eskom	Texas - ERCOT	UK - NG	units
Current Parameters based on 2022				
Annual Demand	231	431	230	TWh
Peak Rate	34	80	43	GW
Average Rate	26	49	26	GW

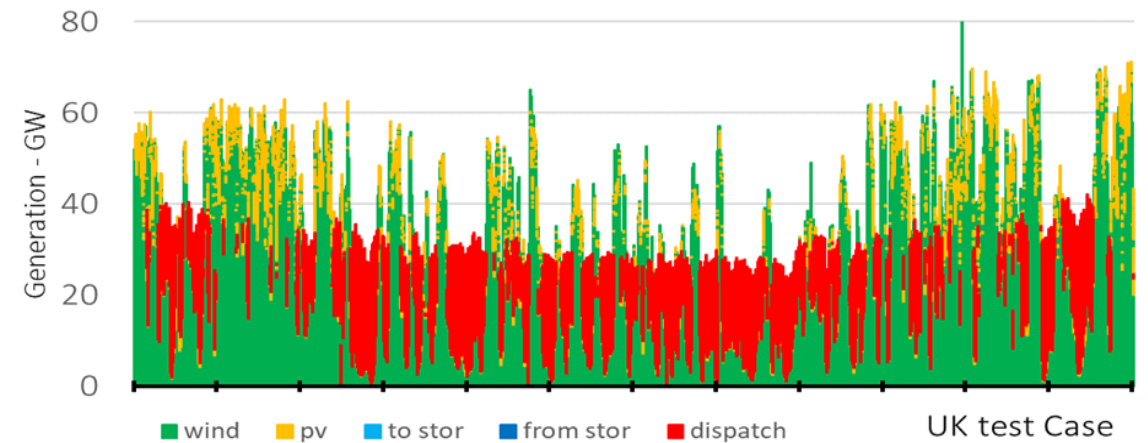
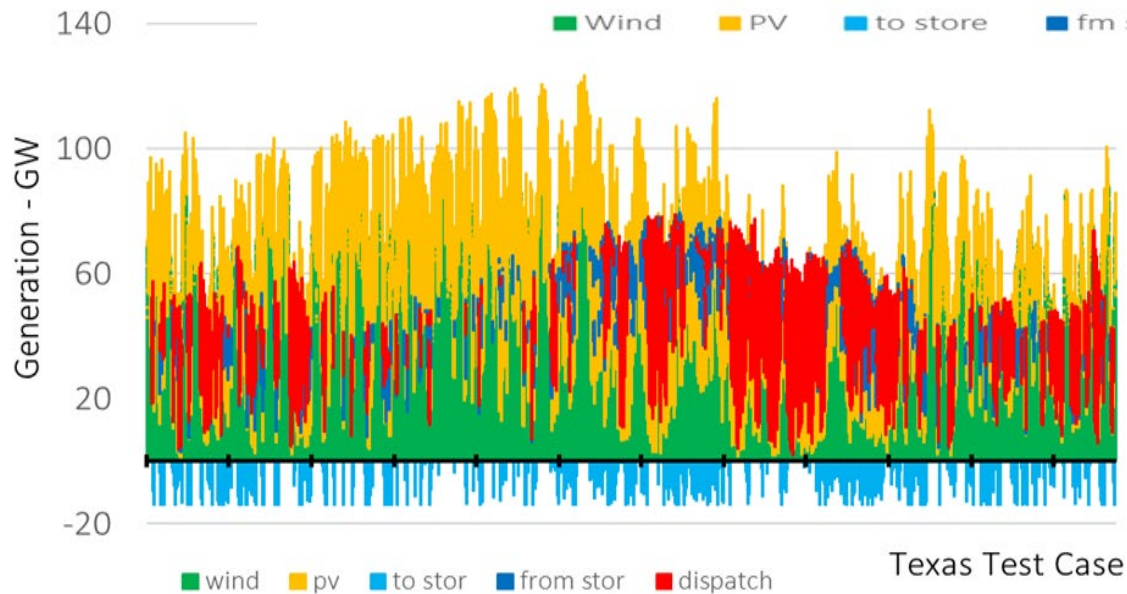
Low Cost Renewable Premises

	South Africa- Eskom	Texas - ERCOT	UK - NG	units
Lowest Cost Case Parameters with no Base Generation				
Installed Wind	64	130	95	GW
Wind Energy	204	392	256	TWh
Wind CF	36	34	31	%
Wind Percent of Peak Capacity	188	163	220	Percent of Peak Gen. Capacity
Installed PV	24	63	5	GW
PV Energy	54	129	4	TWh
PV CF	26	23	9	%
PV Percent of Peak Capacity	70	79	11	Percent of Peak Gen. Capacity
Battery Capacity	13	14	0	GW
Battery Hours	4	4	0	Hours

Low Cost Firm-Dispatchable Premises

	South Africa- Eskom	Texas - ERCOT	UK - NG	units
Installed Dispatch	29	58	30	GW
Dispatch Energy	21	45	51	TWh
Dispatchable Generation Parameters for Lowest Cost Case				
Dispatch CF	8.6	8.9	19.3	%
Percent of Peak demand	84	73	68	%
Percent of Average demand	109	118	110	%

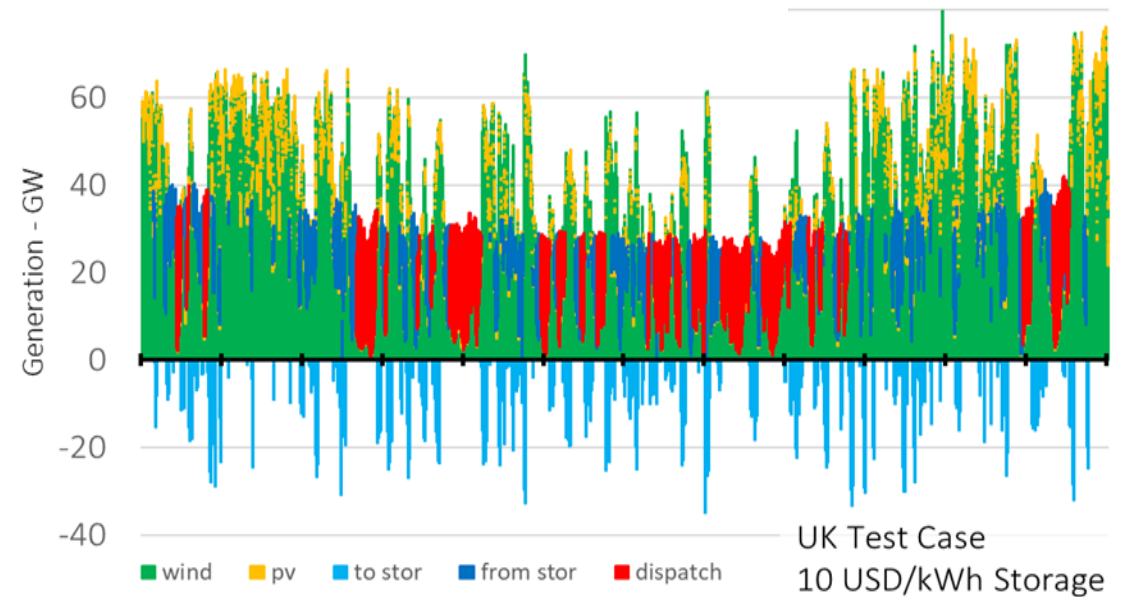
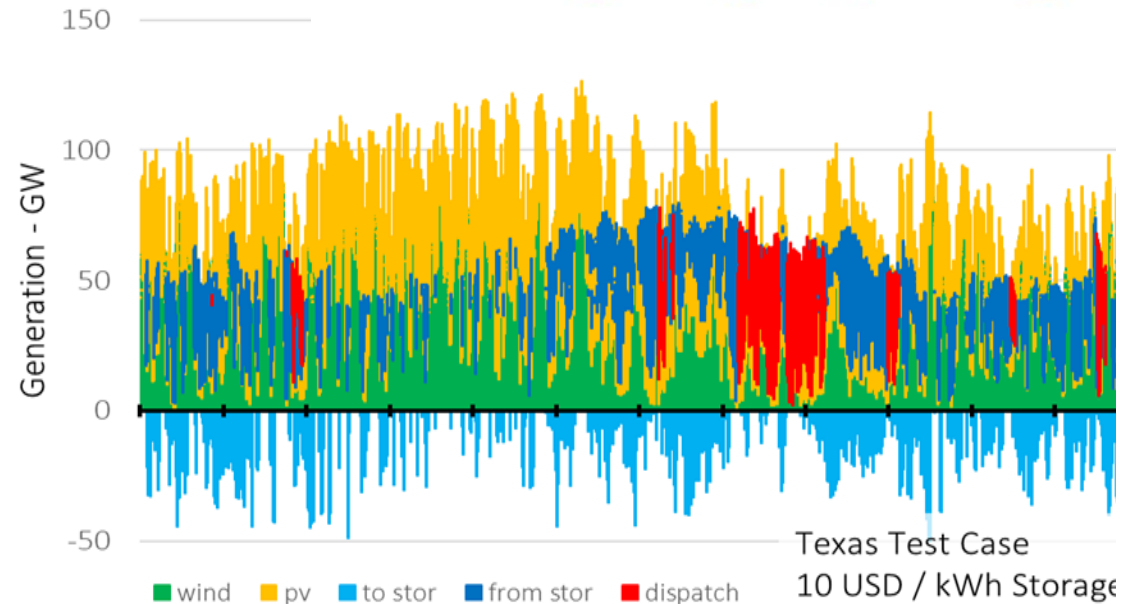
Annual Comparisons of Firm-Dispatch



Firm-dispatchable 10 USD /kWh storage

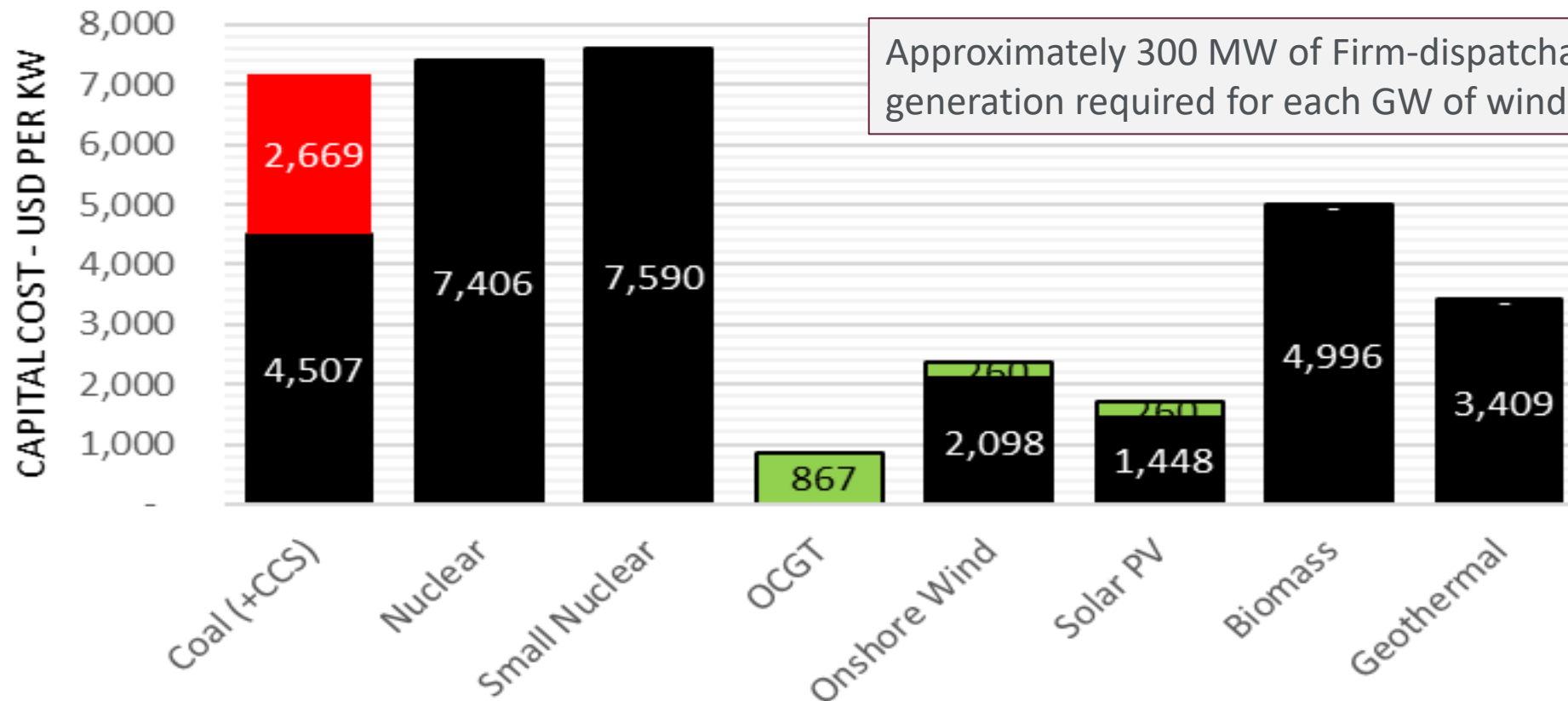
	South Africa- Eskom	Texas - ERCOT	UK - NG	units
Wind Percent of Peak Capacity	185	152	238	Percent of Peak Gen. Capacity
PV Percent of Peak Capacity	70	91	10	Percent of Peak Gen. Capacity
Battery Capacity	26	55	67	GW
Battery Hours	24	35	21	Hours
Installed Dispatch	28	51	30	GW
Dispatch Energy	7	17	28	TWh
Dispatch CF	2.6	3.7	10.5	%
Percent of Peak demand	82	64	68	%
Percent of Average demand	108	104	110	%

Cases with Very Low Cost Storage



Capital Cost for Firm-Dispatchable Power

Estimated 2023 Capital Costs



Firm-dispatchable Generation Technologies



Fuel Choices

- Natural Gas
- LPG
- Diesel

- Biofuels
- Hydrogen and derivatives
 - Hydrogen
 - Ammonia
 - E-fuels

Conclusions



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- **Firm-dispatchable generation is required to balance the supply and demand due to the variability of these generation sources.**
- **This firm-dispatchable generation will add some cost to the system, but its minimal usage will minimize its impact on the overall cost.**
- **Energy storage costs do not impact the requirement for the installation of firm-dispatchable generation but it does impact how much is used.**