Supplementary Information

Supplementary Table 1. Physical Climate Risk Score -Moody's ESG Solutions

Climate Risk Driver	Description	Spatial scale	Baseline period	Projection Period	Measurement
Floods	Change in rainfall conditions and size and frequency of possible floods	90 x 90 m (Flood) 25 x 25 km (Rainfall)	1975-2005 (Rainfall) 1985-2011 (Flood)	2030-2040 (Rainfall)	The flood score measures the severity and frequency of historical pluvial and fluvial floods, the frequency of future heavy rainfall events, and the intensity of prolonged periods of heavy rainfall. The flood frequency and severity indicators are based on a 1,000-year simulated history that was extrapolated from an observational history, and the rainfall indicators are based on global climate models.
Heat Stress	Increase in temperature	25 x 25 km	1975-2005	2030-2040	The heat stress score measures the relative change over time in the frequency and severity of hot days as well as in average temperature. Locations with high forecasted changes relative to recent history are most likely to be affected by temperatures unlike those previously experienced, even if these locations are not projected to experience the absolute warmest temperatures. Four Twenty Seven's analysis includes indicators related to changes in energy demand, changes in maximum temperature, and additional hot days.
Hurricanes and Typhoons	Exposure to past cyclones	25 x 25 km	1980-2016	N/A	The hurricanes & typhoons score captures geographic exposure to hurricanes or typhoons, also known as tropical cyclones. This cumulative measure reflects both the severity of storms with the highest maximum winds, but also the frequency with which an area has been subject to severe storms, excluding tornadoes and inland windstorms. Four Twenty Seven's uses a dataset of all recorded cyclones over the period 1980 and 2016. Only historical data is used, because global projection data is unavailable due to high uncertainty of how climate change influences tropical cyclone formation and intensity.
Sea Level Rise	Heightened storm surge, augmented by sea level rise	90 x 90 m	1986-2005	2040	The sea level rise score estimates the absolute and relative increase in the frequency of coastal floods. Estimates of sea level rise exposure are intended to capture: (1) the frequency of inundation due to a combination of sea level rise, storm surge, and high tides, and (2) change in the frequency of inundation between historical and projected periods. Estimates leverage global high resolution digital elevation model data as well as local storm surge and sea level rise estimates between 2017 and 2040. This analysis incorporates local flood risk statistics and local median sea level rise projections under carbon emissions scenario RCP 8.5.

Water Stress	Change in water supply and demand	Watershed	1950-2008	2040	The water stress score measures projected changes in drought-like patterns. It includes indicators that measure inter-annual variability, and absolute and relative percent changes in supply and demand for surface water (rainfall or rivers; not lakes or groundwater) available for consumptive use between the current period and 2040.
Wildfire	Change in water supply and demand	Change in fire potential	1975-2005	2030-2040	The wildfires score measures wildfire potential in absolute terms and relative change compared to the historical baseline, as well as the availability of burnable fuel in the form of land cover. It is not intended to project specific wildfire events, but rather the areas that are more likely to burn given existing land cover and projected climate conditions. The occurrence of individual wildfire events and their characteristics depend on many discrete factors, including but not limited to heat and humidity, an ignition source, wind, and fuel. This analysis focuses the evaluation of projected wildfire potential on precipitation and temperature.

Supplementary Table 2. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
CommittedCarbonEmissionsMT	586	46.82	125.55	0	1347.52
CapacityMW	587	443.45	701.14	0	5600
YearofCommissioning	569	2013.61	7.79	1961	2034
PhyClimateRiskScore	580	43.84	12.52	9.6	83.91
Heatstress Score	580	72.36	27.87	1.33	100
Waterstress Score	568	50.46	26.33	2.38	100
FloodsRisk Score	575	38.37	31.91	0	99.66
Sealevelrise Score	579	14.52	26.07	0	87.5
Wildfire Score	580	62.49	24.35	0	99.94
Hurricanes/Typhoons	580	24.91	34.85	0	99.85

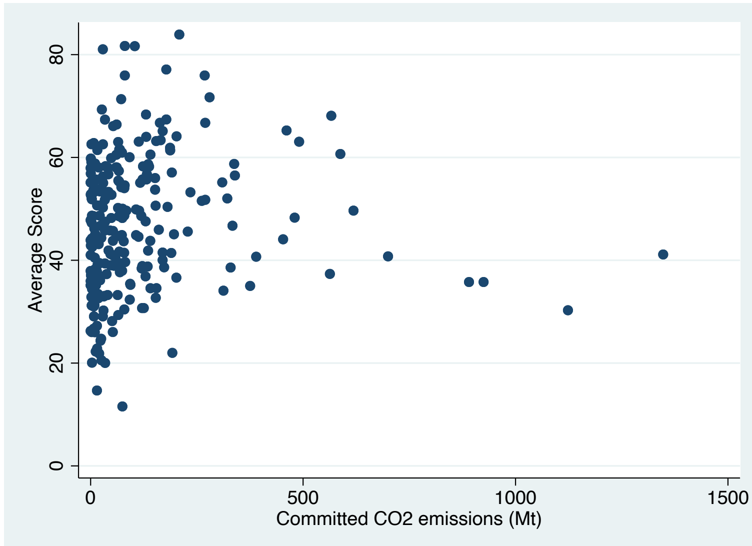
Supplementary Table 3. Replicating Table 2 by Using Alternative Carbon Emissions Intensity for Hydropower Projects

	CO2 Emissions	Climate RiskScore	Heat Stress	Water Stress	Floods	Sea levelrise	WildFire	Hurricanes/ Typhoons
Coal	1.076	0.85	-0.149	0.344	0.358	0.432	0.622	0.582
	[0.138]***	[0.154]***	[0.159]	[0.147]**	[0.147]**	[0.148]***	[0.152]***	[0.162]***
Hydro	-0.514	0.334	-0.12	-0.451	0.827	-0.87	0.941	0.38
	[0.128]***	[0.143]**	[0.148]	[0.137]***	[0.136]***	[0.137]***	[0.142]***	[0.151]**
Oil	-0.072	-0.303	-0.6	-0.101	0.017	-0.231	0.064	-0.067
	[0.186]	[0.208]	[0.214]***	[0.204]	[0.205]	[0.199]	[0.206]	[0.219]
Wind	-0.374	-0.427	-0.637	0.561	-0.371	-0.586	-0.144	0.1
	[0.126]***	[0.141]***	[0.145]***	[0.138]***	[0.134]***	[0.135]***	[0.139]	[0.148]
Solar	-0.391	0.107	-0.283	0.797	-0.362	-0.445	-0.067	0.569
	[0.144]***	[0.162]	[0.167]*	[0.155]***	[0.154]**	[0.155]***	[0.161]	[0.171]***
Nuclear	-0.689	0.535	-0.701	1.03	-0.136	0.66	-0.568	0.965
	[0.405]*	[0.452]	[0.467]	[0.428]**	[0.430]	[0.433]	[0.448]	[0.477]**
Geothermal	-0.579	-0.404	-0.288	-0.783	-0.071	-0.887	0.902	0.032
	[0.249]**	[0.277]	[0.286]	[0.264]***	[0.273]	[0.266]***	[0.275]***	[0.293]
Biofuel	-0.407	0.047	-0.193	0.108	-0.636	-0.902	0.835	0.832
	[0.496]	[0.553]	[0.571]	[0.524]	[0.527]	[0.529]*	[0.548]	[0.583]
Controls	Y	Y	Y	Y	Y	Y	Y	Y
N	567	565	565	553	560	564	565	565
r2	0.39	0.22	0.18	0.32	0.3	0.31	0.25	0.14

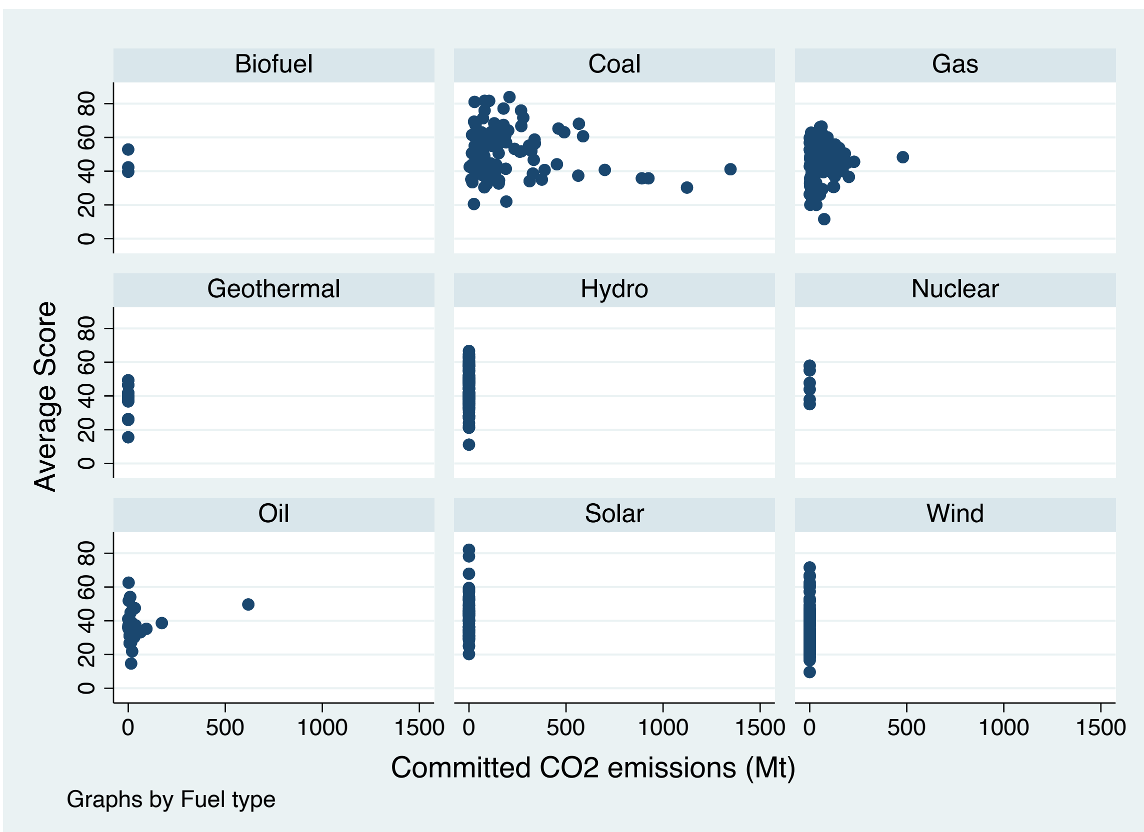
Notes:

1. We assume that hydropower projects in our sample have the median carbon emissions intensities of all global hydropower projects – i.e., 24 gCO_2e/kWh – estimated by the IPCC AR5. [1] It is also close to estimations from other recent studies such as Ubierna et al (2022), which is 23gCO_2e/kWh . [2]
2. $Ep=Gp\times CFp\times h\times Ip\times y$. Ep is lifetime committed CO_2 emissions, Gp is generation capacity (unit: MW), CFp is capacity factor, which can be interpreted as the fraction of hours that the power plant operates in 1 year, h is the number of hours in one year, which is 8,760 h, Ip is emission intensity (unit: Gt CO2/MWh), and *y* is the power plant/generator's lifetime in years, which equals 40 in our estimation.
3. The average capacity factor of hydropower projects is assumed to be 40%. [3]
4. The unit of analysis is at the project level. Outcome variables are CO_2 emissions and climate risk scores, standardized to a mean of 0 and a standard deviation of 1. Control variables include year of commission, financing country, and financing type. Standard errors are in parentheses. ***P<0.01, **P<0.05, *P<0.1

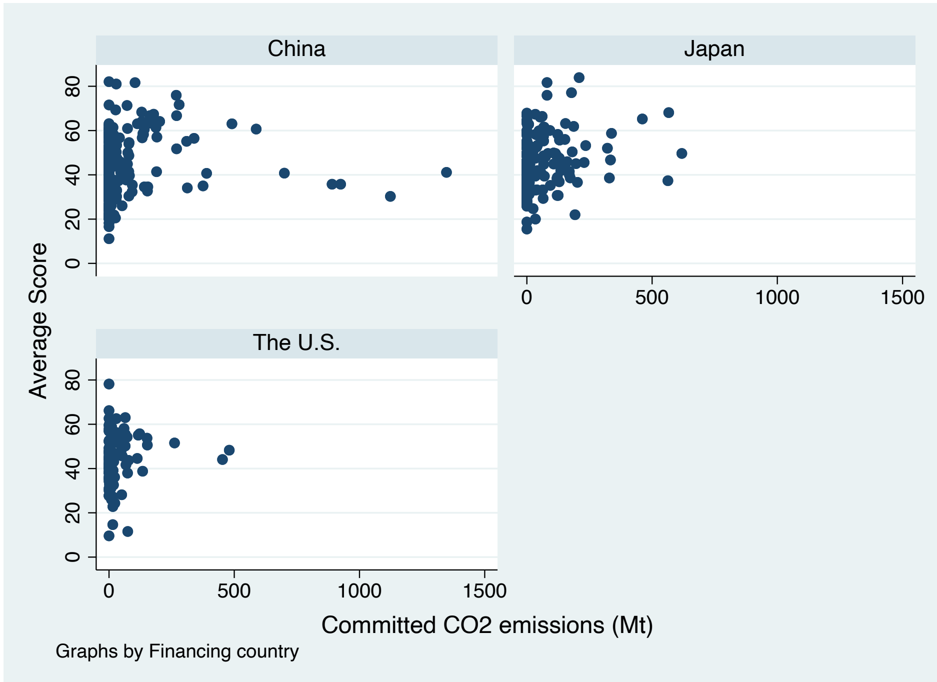
Supplementary Figure 1. Correlation between Climate Change Impact and Exposure – Excluding Renewable Energy Projects



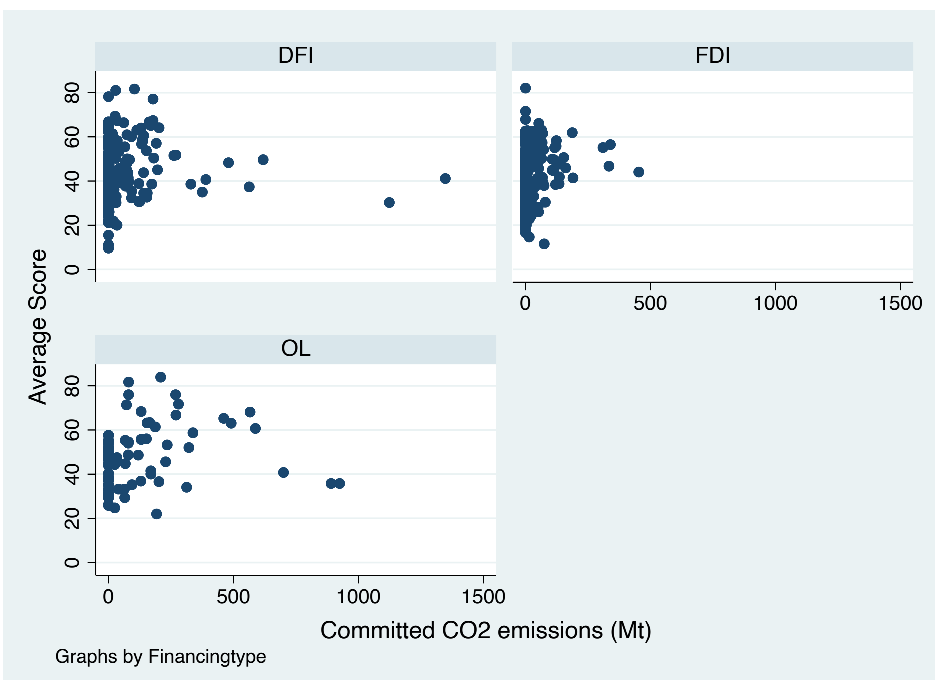
Supplementary Figure 2. Correlation between Climate Change Impact and Exposure by Fuel Type



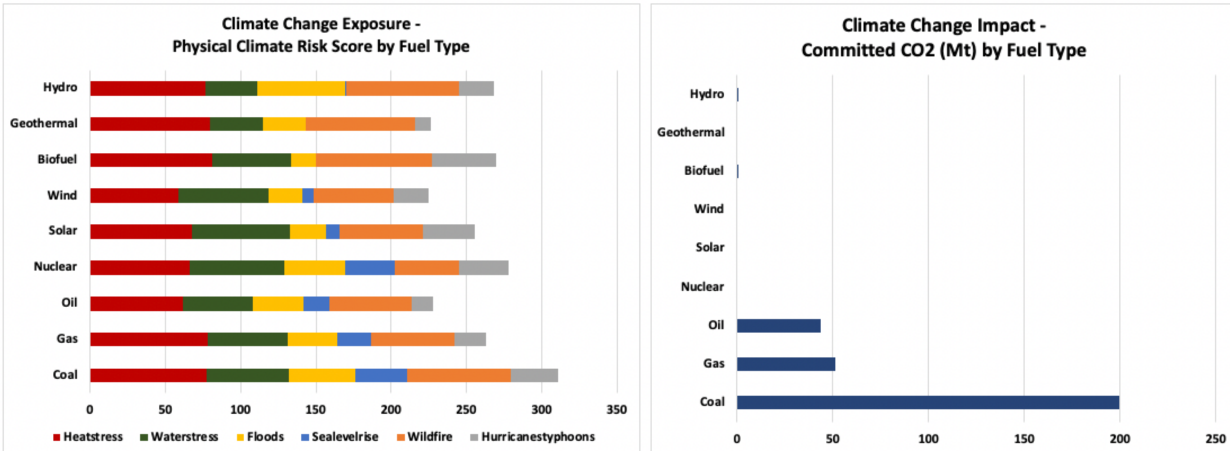
Supplementary Figure 3. Correlation between Climate Change Impact and Exposure by Financing Country



Supplementary Figure 4. Correlation between Climate Change Impact and Exposure by Financing Type



Supplementary Figure 5. Replicating Figure 1 by Using Alternative Carbon Emissions Intensity for Hydropower Projects



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3. The average capacity factor of hydropower projects is assumed to be 40% based on EIA historical data. [3]

References

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