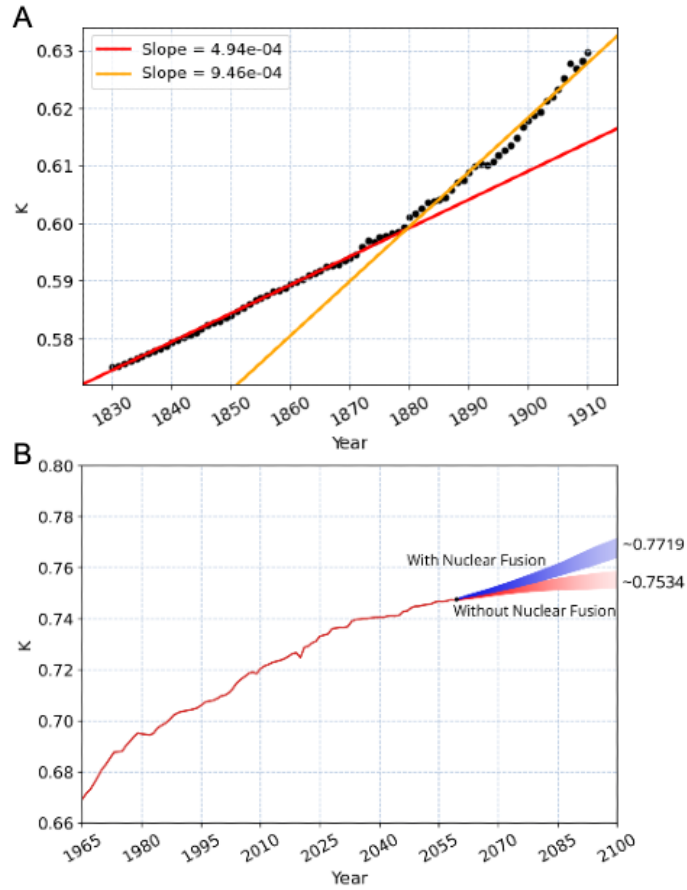**Supplementary Figure 1. Direct correlation of world's GDP and energy consumption.** The joint plot that describes the correlation of GDP and energy consumption is graphed, where the left of the blue dotted line is historical data, and the right is projected values.

Supplementary Figure 2. Potential impact of fusion energy. (A) The trend of K before and after the Second Industrial Revolution. The red and orange lines present the linear regression trending line of K before and after the Second Industrial Revolution, respectively. (B) The trend of the index K under two hypothetical scenarios, with (blue) and without (red) the advent of nuclear fusion in 2060, on mankind's development.
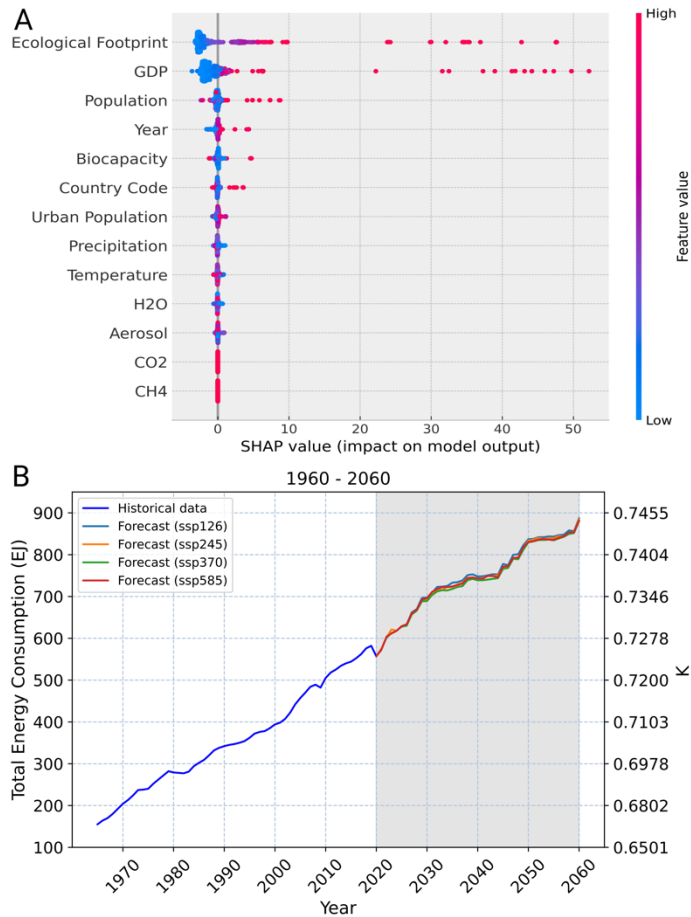
Supplementary Figure 3. Forecast of energy consumption and index K on the Kardashev Scale with additional impact factors (atmosphere mass content of water vapor, aerosol optical depth at 550nm, carbon dioxide mole fraction, and methane mole fraction) in the model. (A) The selected factors' impacts on the total energy consumption are measured by their SHAP values. The color of each individual dot represents the value of that feature. (B) Historical data and prediction.

Year	Energy Consumption (EJ)				K	
	SSP126	SSP245	SSP370	SSP585	Value	Annual Growth Rate
2025	643.96	643.61	644.39	643.44	0.73101	4.69×10^{-3}
2030	702.96	702.98	702.52	702.58	0.73481	5.20×10^{-3}
2035	731.15	731.14	731.19	731.07	0.73652	2.33×10^{-3}
2040	756.97	755.43	755.43	756.91	0.73803	2.05×10^{-3}
2045	774.31	775.25	775.46	775.24	0.73901	1.33×10^{-3}
2050	836.22	836.53	836.74	838.37	0.74235	4.52×10^{-3}
2055	839.86	840.74	841.56	839.84	0.74254	2.56×10^{-4}
2060	879.43	878.70	879.82	881.20	0.74454	2.69×10^{-3}

(Projected Values spans the Energy Consumption and K columns.)

Supplementary Table 1. **Forecasting results with additional impact factors (atmosphere mass content of water vapor, aerosol optical depth at 550nm, carbon dioxide mole fraction, and methane mole fraction) in the model.** The predicted value for energy consumption under four different presumed shared socioeconomic pathway scenarios, civilization development index K, as well as its growth rate from 2021 to 2060.

Parameter	Source	
	Training	**Forecasting**
Energy Consumption	bp Global	/
GDP	World Bank	Organization for Economic Co-operation and Development (OECD)
Population		United Nation (UN)
Urban Population		
Ecological Footprint	York University	ARIMA Forecasting
Biocapacity		
Temperature	Coupled Model Inter-comparison Project Phase 6 (CMIP 6)	
Precipitation		
Atmosphere Mass Content of Water Vapor		
Aerosol Optical Depth (500nm)		
Carbon Dioxide Mole Fraction		
Methane Mole Fraction		

Supplementary Table 2. **Data sources.**