Table S2. Key parameters in the model. The values and the methods of calibration or parameterization are provided for key parameters in the model.

Symbol	Parameter	Value	Method of calibration or parameterization
$\boldsymbol{i_{s,t}}$	The optimal saving rate	0.2–0.4	The saving rate is optimized over time in the model under the principal of welfare maximization [1].
$\boldsymbol{i_{e,t}}$	The optimal fraction of investment allocated to produce energy	0–1	The fraction of investment allocated to produce energy is optimized over time in the model under the principal of welfare maximization [1].
$\boldsymbol{j_{e,t}}$	The optimal fraction of labor allocated to produce energy	0–1	The fraction of labor allocated to produce energy is optimized over time in the model under the principal of welfare maximization [1].
$\boldsymbol{i_{g,t}}$	The optimal fraction of investment in the energy sector allocated to produce renewable energy	0–1	The fraction of investment in the energy sector allocated to produce renewable energy is optimized over time in the model under the principal of welfare maximization [1].
$\boldsymbol{j_{g,t}}$	The optimal fraction of labor in the energy sector allocated to produce renewable energy	0–1	The fraction of labor in the energy sector allocated to produce renewable energy is optimized over time in the model under the principal of welfare maximization [1].
$\boldsymbol{\Delta T_{2020}}$	Global warming in 2020 relative to the pre-industrial levels	1.1±0.1°C (normal distribution)	I adopt the observed global warming of 1.1±0.1°C in 2020 relative to the pre-industrial levels [10].
$\boldsymbol{\varphi}$	The response of global warming due to CO_2 emissions	0.043±0.004°C per Gt CO_2 (normal distribution)	I calibrate φ to achieve the observed global warming of 1.1±0.1°C in 2020 relative to the pre-industrial levels with a lifetime of 400±200 years in the atmosphere [10].
$\boldsymbol{\beta_{g,0}}$	The initial efficiency of producing renewable energy in 2020	0.4±0.1 (uniform distribution)	I calibrate the initial efficiency of producing renewable energy by normalizing the initial output (Y_0=1), energy (E_0=1) and labour (L_0=1)
$\boldsymbol{\beta_{d,0}}$	The initial efficiency of producing fossil fuel in 2020	1.2±0.4 (uniform distribution)	I calibrate the ratio of the initial efficiency producing fossil fuel to the initial efficiency producing renewable energy ($\beta_{d,0}/\beta_{g,0}$) to achieve the share of renewable energy in the global energy consumption in 2000 (see *Fig 1.12* in International Energy Agency, 2022 [14]).

$\eta_{e,0}$	The initial energy-use efficiency in 2020	1.6±0.5 (uniform distribution)	I calibrate the efficiency of using energ based on the observed total output, the observed total capital, the observed total labor, the fraction of investment allocated to the energy sector, the fraction of investment in the energy sector allocated to producing renewable energy, and the efficiency of producing renewable energy.
$\beta_{b,0}$	The initial efficiency of producing non-energy product in 2020	2.6±0.5 (uniform distribution)	I calibrate the ratio of the initial efficiency producing renewable energy to the initial efficiency producing non-energy products ($\beta_{g,0}/\beta_{b,0}$) to achieve a 50% fraction of total investment allocated to the energy sectors ($i_{e,0}$=0.5) (see *Table 1* in Gaucher et al. [15]).
ρ	The pure rate of time preference	1.5–2.5% (uniform distribution)	I calibrate ρ from the growth-adjusted discounting rate of 3–4% based on the real rate of return during 1950–2015 on bonds and equity [16].
σ_Y	The elasticity of substitution between energy and non-energy products	0–1 (uniform distribution)	The elasticity of substitution between energy and non-energy services can be constrained by the rebound effect, which is defined as the reduction in the expected energy use from technologies that increase energy-use efficiency. A previous study suggested that 90% of the elasticity of substitution between energy and non-energy products constrained by the observed rebound effects in the literature falls in a range of 0 to 1 (see *Table S3* in Wang *et al*. [17]).
σ_E	The elasticity of substitution between fossil fuel and renewable energy	1–3 (uniform distribution)	I calibrate the elasticity of substitution between fossil fuel and renewable energy based on the reduction of GDP by 5–9% when reducing the supply of fossil fuel by 50% [18].
γ	The elasticity of output to capital	0.3–0.4 (uniform distribution)	I adopted the measured the elasticity of output to capital from the econometric studies. Fried et al. [19] reported a value of 0.36 for most of the economies, which consistent with the value (0.3) in the DICE model [4] and a study by Hassler et al. [20]. As a result, I apply a range of 0.3–0.4 for the elasticity of output to capital in this study.

θ	The rate of capital depreciation	0.1±0.01 (normal distribution)	I apply the rate of capital depreciation (0.1) used in the DICE model [4].
τ_R	The time of response in global warming to reducing CO_2 emissions	10±10 years (uniform distribution)	Observations and Earth system models suggested a time lag by at least two decades for global warming to take place in response to GHGs emissions [9], so I assume a lag of 10±10 years to observe the response in global warming to reducing CO_2 emissions.
τ_L	Atmospheric lifetime of CO_2	400±200 years (uniform distribution)	I adopt a lifetime of 400 years for CO_2 based on a meta analysis of Earth system models (see Table 2.2 in IPCC, 2021 [10]).
λ_w	The quadratic coefficient in the damage function calibrated to reach the observed damage when global warming is 1 °C	0.1–0.5% (uniform distribution)	A meta-analysis of the observed regional damage caused by climate change suggested that the damage of global warming had reached 0.267% of GDP [4], but the uncertainty is suggested to be 100% when compared to a recent study [21]. As a result, I adopted a damage of 0.1–0.5% for the damage caused by climate change to the economy when global warming reached 1 °C.
d_c	The maximal damage caused by climate change	50±25% (uniform distribution)	The damage caused by climate change when crossing a tipping point as a percentage to gross domestic product is projected to reach 10% for Greenland ice sheet collapse, 5% for West Antarctic ice sheet collapse, 10% for Labrador-Irminger seas SPG convection collapse, 5% for Amazon rainforest dieback, and 15% for Atlantic meridional overturning circulation collapse [6], so I assume a damage of 50±25% for the maximal damage caused by climate change to the economy.
T_{50}	The threshold of global warming leading to 50% of the maximal climatic damage	2±0.5°C (normal distribution)	I calibrate the threshold of global warming leading to 50% of the maximal climatic damage based on the target of mitigating global warming in the Paris Agreement [22].
k_p	The annual rate of growth in the productivity	0.5–1.5% (uniform distribution)	I calibrate the annual rate of growth in the efficiency of producing energy and non-energy product based on the rate of economic growth in the Shared Socioeconomic Pathway

			(SSP) scenarios [11].
k_u	The annual rate of growth in energy-use efficiency	1–5% (uniform distribution)	I calibrate the annual rate of growth in the efficiency of using energy based on the rate of change in energy intensity in the Shared Socioeconomic Pathway (SSP) scenarios [11].
k_l	The annual rate of growth in population	1–2% (uniform distribution)	I calibrate the annual rate of growth in population to be consistent with the projection that global total population will reach 10.5 billion by 2100 [4].
L_R	The rate of learning when deploying renewable energy	10±5% (normal distribution)	I apply a range of 15±10% for the learning rate based on the historical rates of decline in the prices of renewable energy to account for the effects of technological advances in reducing the costs of mitigation [12, 23].

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