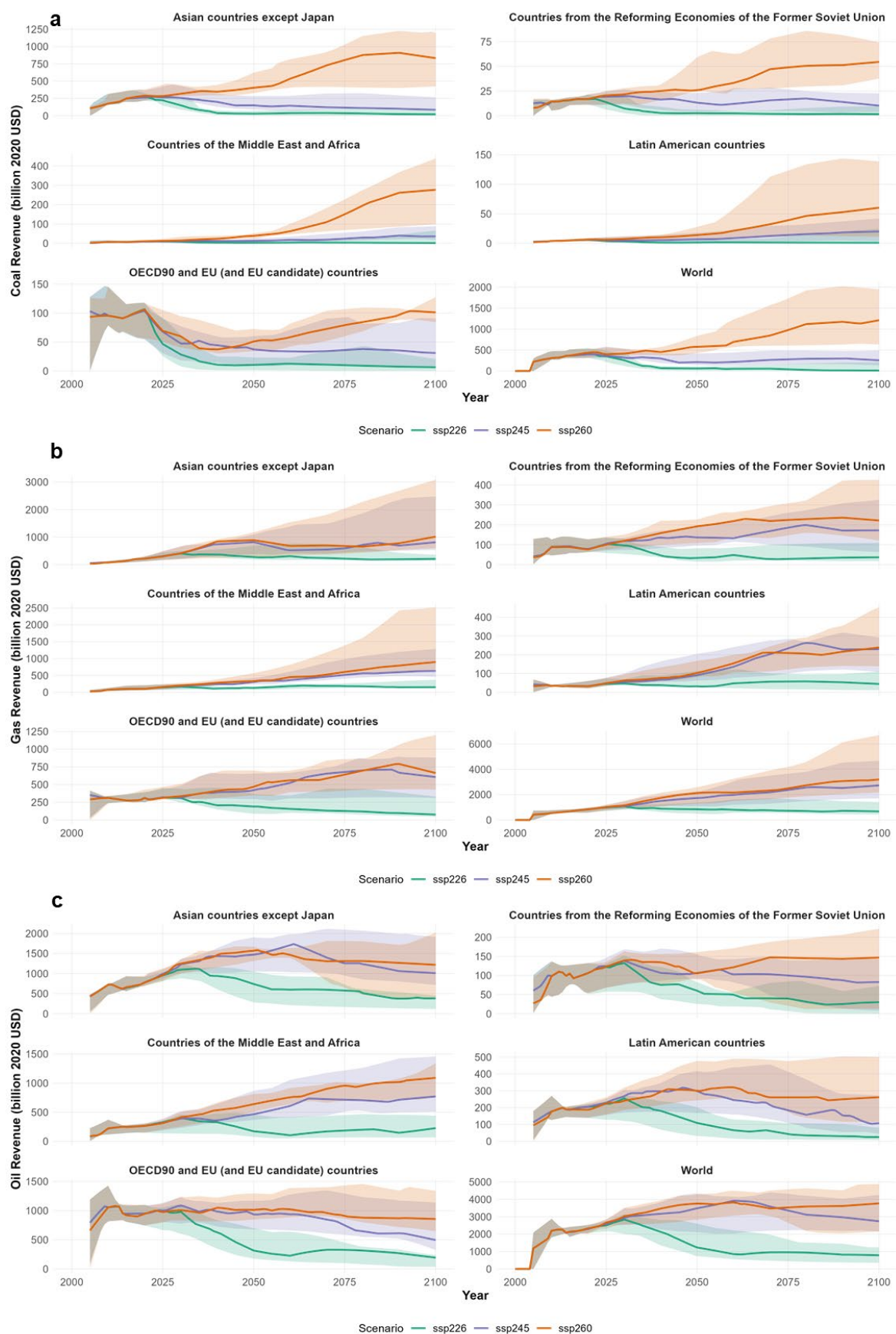


Quantifying assets for the geopolitics of climate change mitigation

In the format provided by the
authors and unedited

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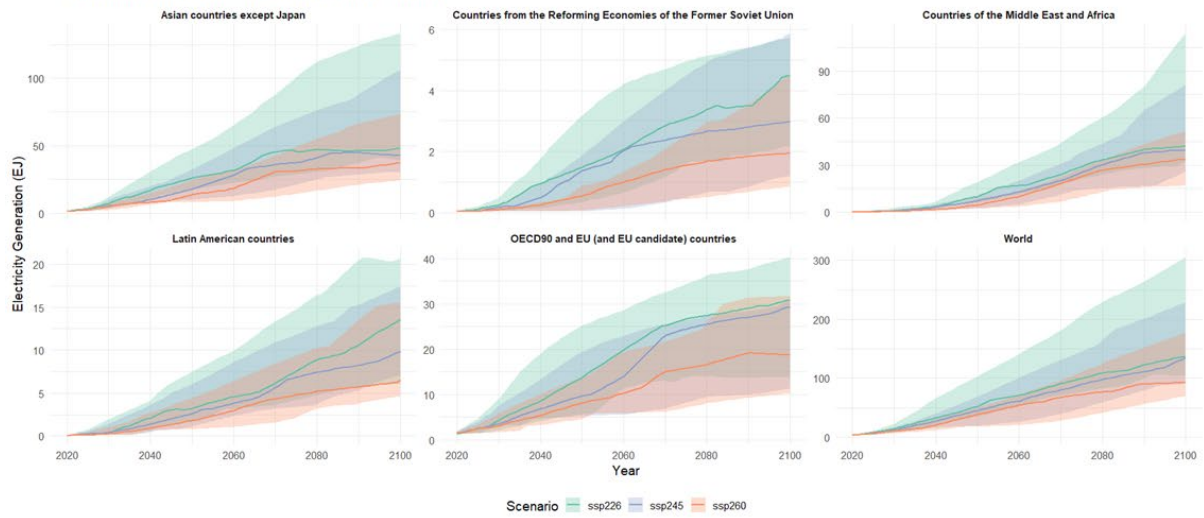
15 Supplementary Figures



17 **Supplementary Fig. 1: Fossil fuel revenues in AR6 R5 regions under two mitigation**
18 **scenarios and the baseline.** (a) Coal, (b) Gas, and (c) Oil revenues. Lines represent the multi-
19 model median, and shaded areas indicate the central 66.7% range across models.

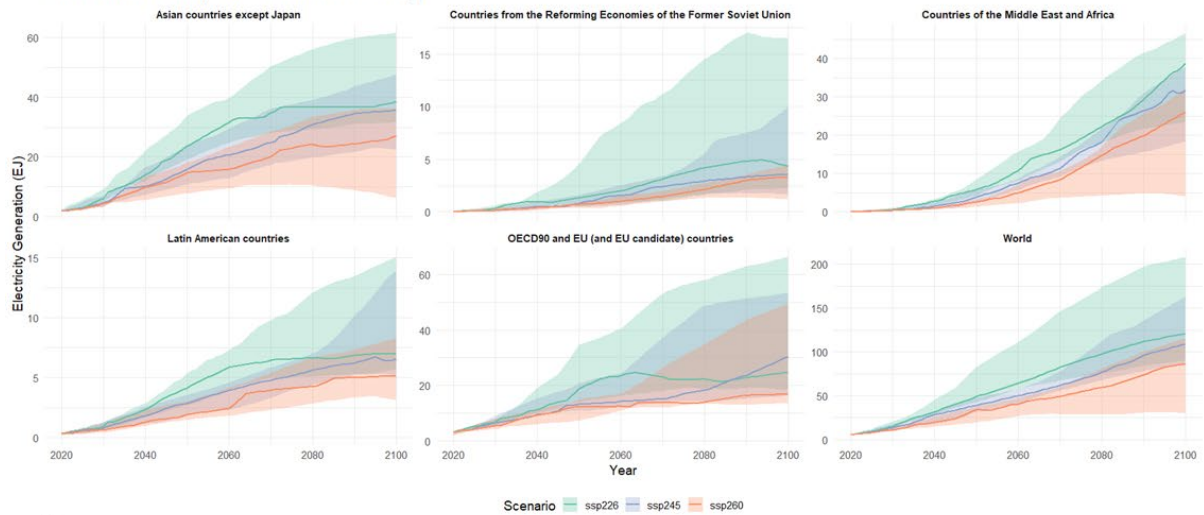
a

Solar Electricity Generation – Model Median and 2/3 Range



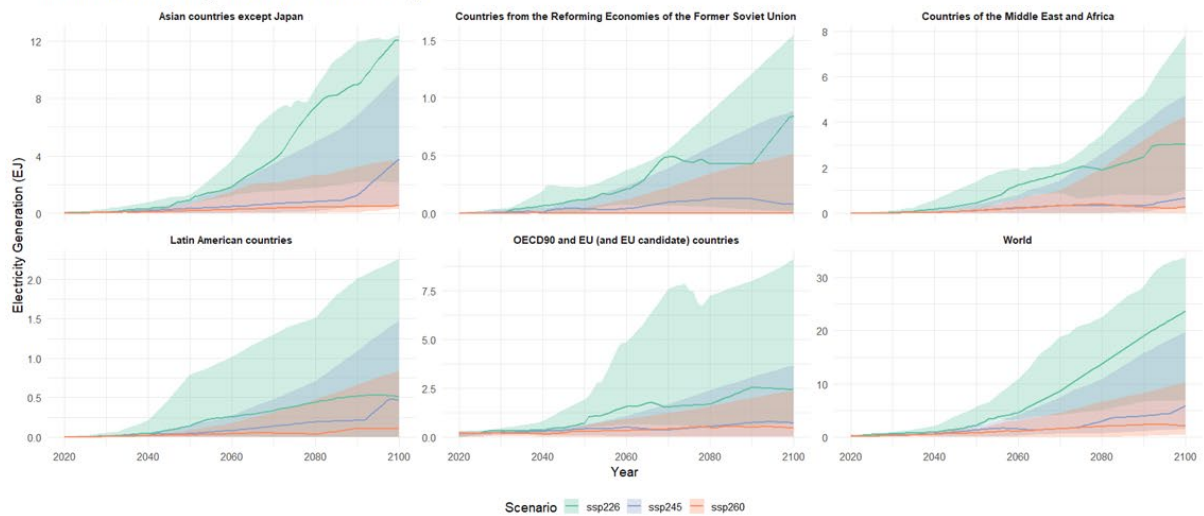
b

Onshore Wind Electricity – Model Median and 2/3 Range



c

Offshore Wind Electricity – Model Median and 2/3 Range



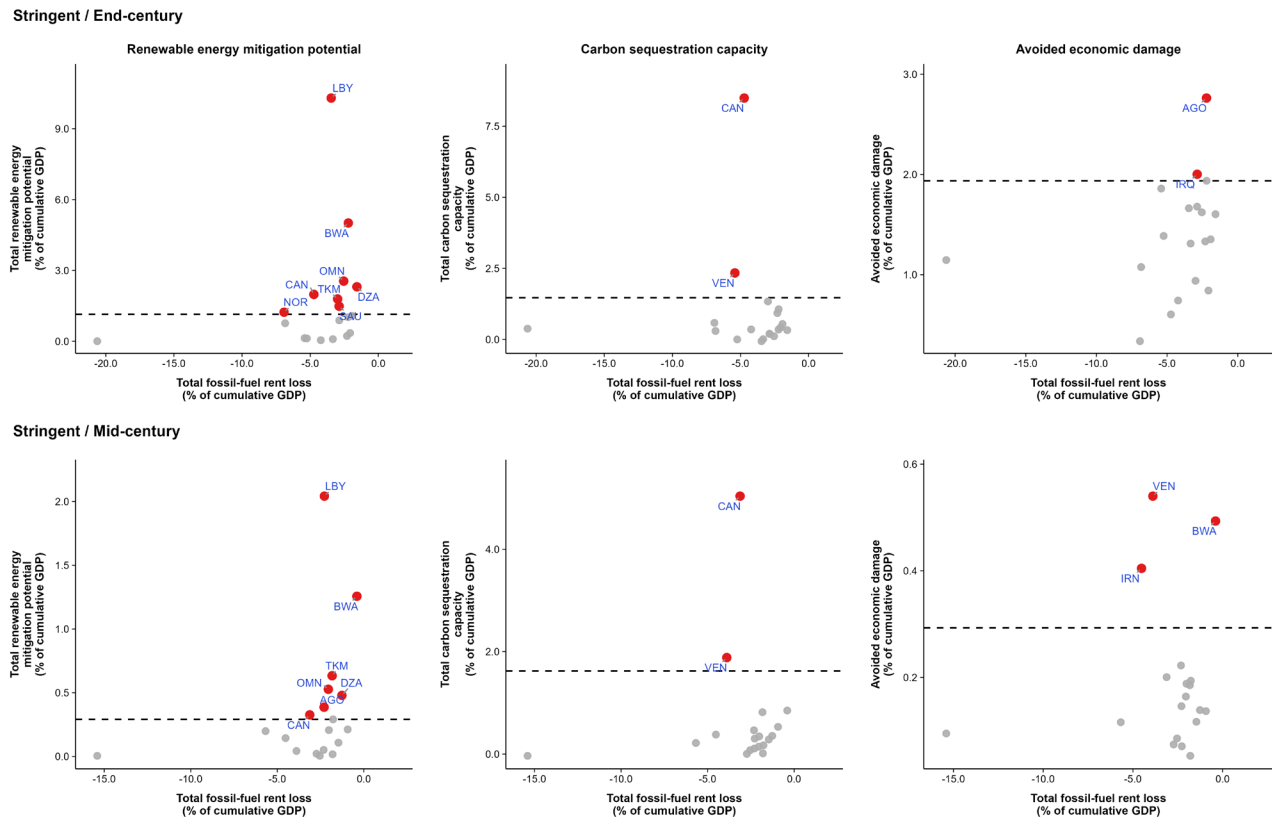
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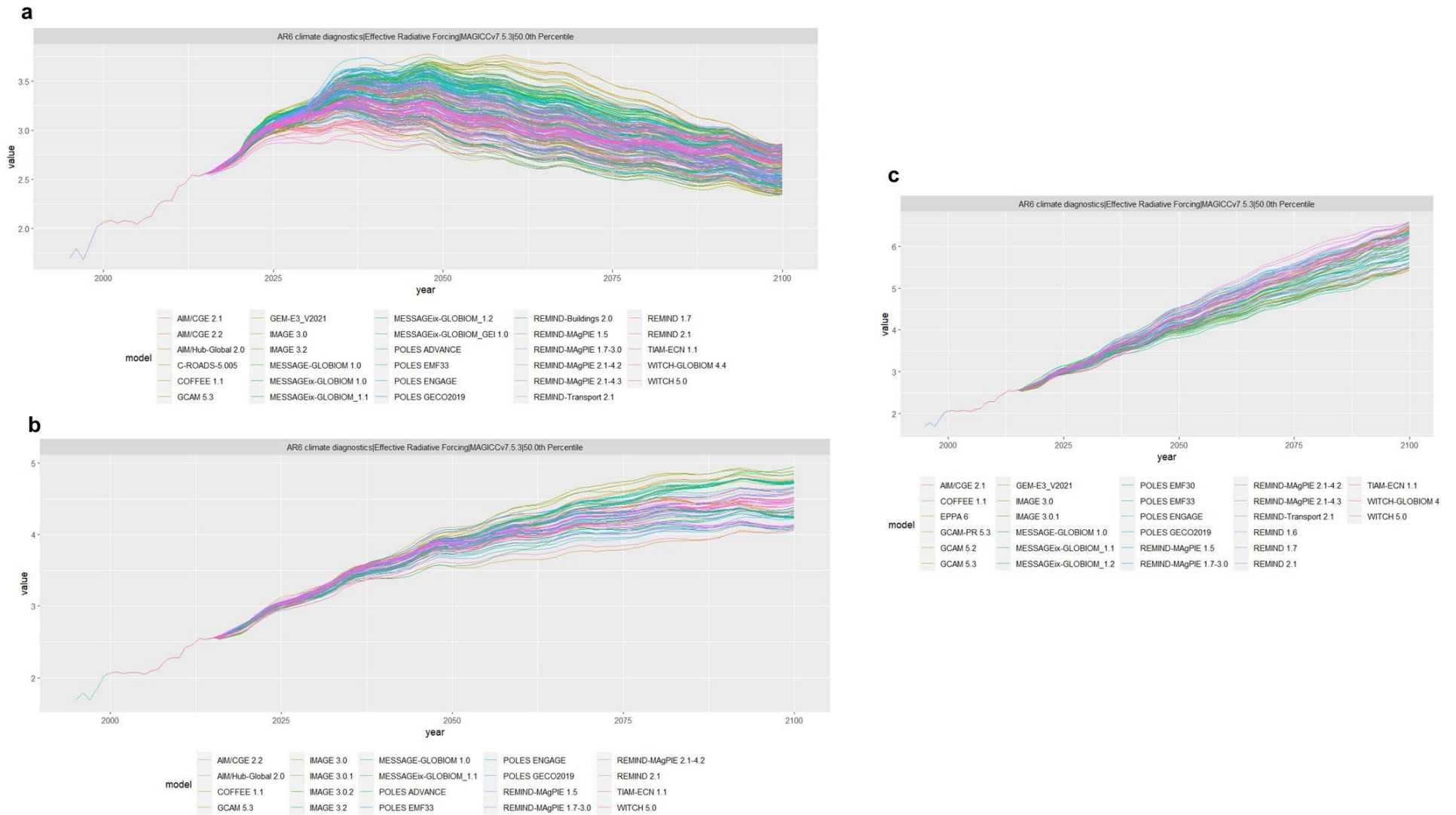
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Supplementary Fig. 2: Renewable electricity generation in AR6 R5 regions under two mitigation scenarios and the baseline. (a) Solar, (b) Onshore wind, and (c) Offshore wind

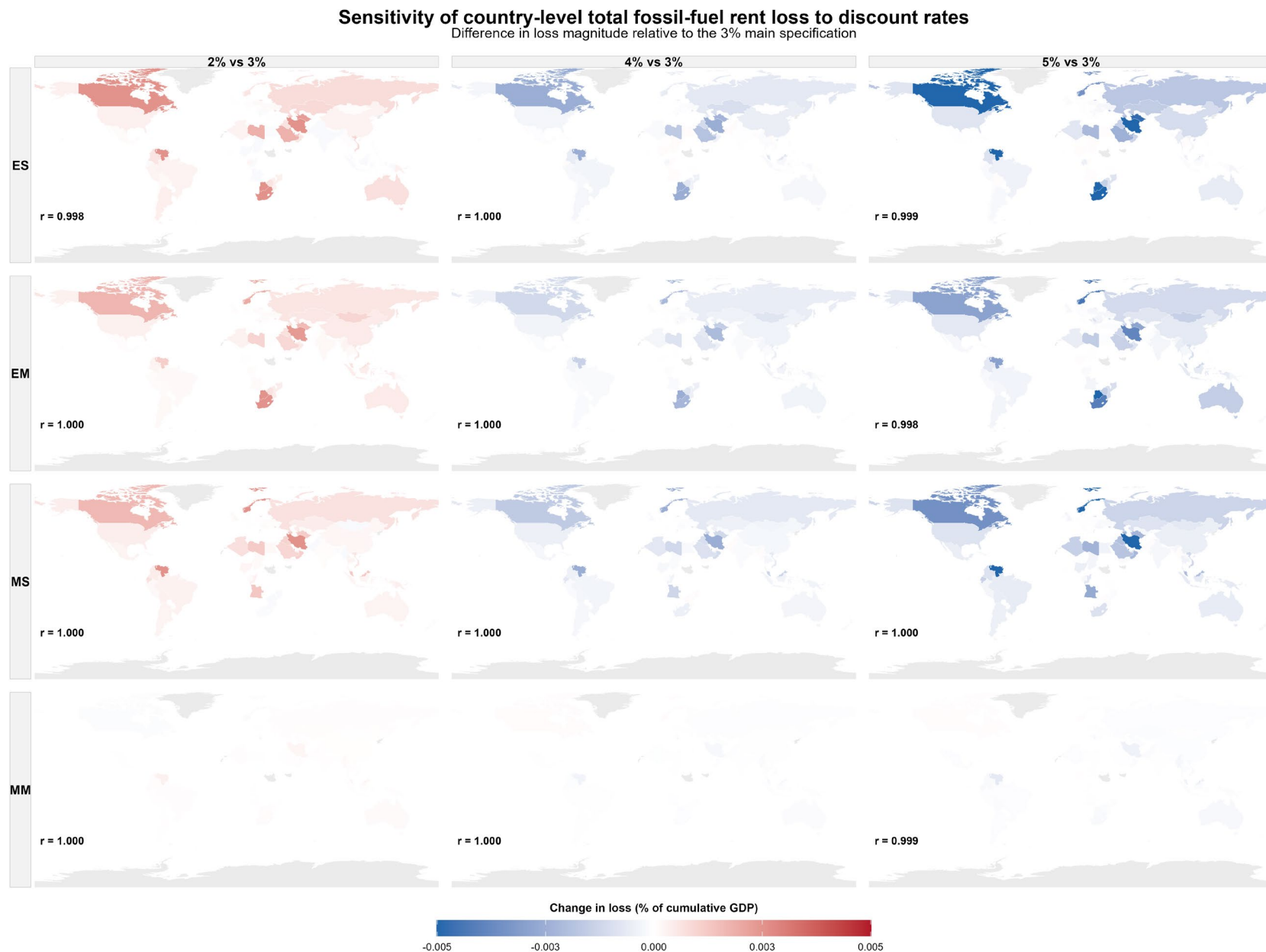
generation. Lines represent the multi-model median, and shaded areas indicate the central 66.7% range across models.



Supplementary Fig. 3: Fossil-fuel rent losses and mitigation opportunities among countries in the FFE cluster. Scatter plots compare total fossil-fuel rent losses (x-axis) with total renewable-energy mitigation potential, total land carbon-sequestration capacity, and avoided economic damages (y-axis), all expressed as percentages of each country's discounted cumulative GDP. The top row presents end-century results under the stringent mitigation scenario, and the bottom row presents corresponding mid-century results. Points represent countries in the FFE cluster ($n = 19$ countries). Dashed horizontal lines show the 75th percentile of the global distribution of each mitigation asset, calculated across countries in all clusters. FFE countries exceeding these global thresholds are highlighted in red and labeled using ISO 3166-1 alpha-3 country codes. Corresponding country names are provided in Supplementary Table 5.



Supplementary Fig. 4: Selection of SSP2 scenarios from the AR6 database. Scenarios are filtered based on global median forcing values that fall within $\pm 10\%$ of target forcing levels: (a) 2.6, (b) 4.5, and (c) 6.0 W/m², respectively. The figure presents all IAMs that meet the criteria for each scenario; however, only IAMs common across all three scenarios are retained for the subsequent analysis.

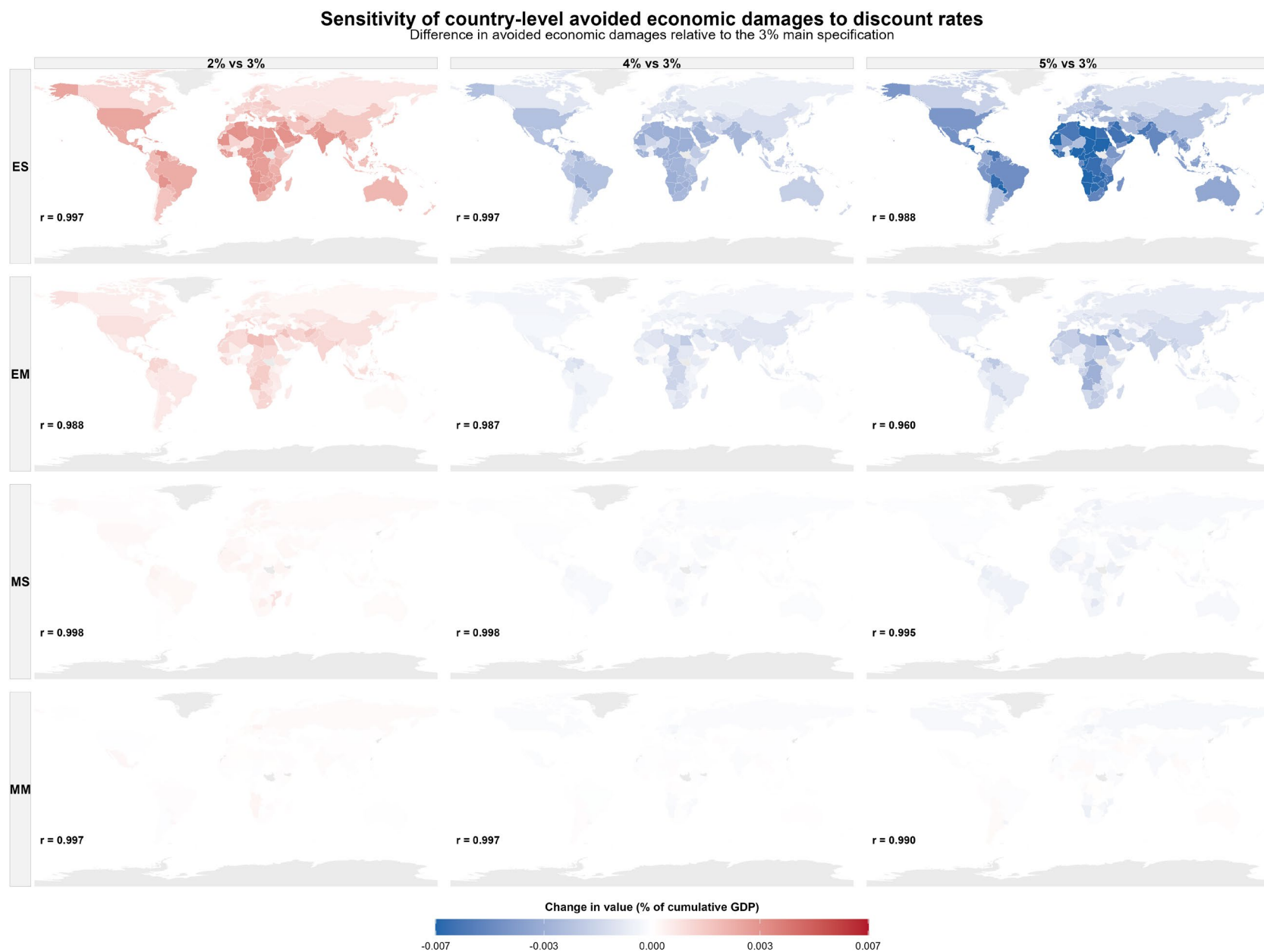


Supplementary Fig. 5.1: Sensitivity of country-level total fossil fuel rent losses to alternative discount rates. Maps show differences in rent-loss magnitude under discount rates of 2%, 4%, and 5% relative to the 3% main specification, measured as

percentage points of discounted cumulative GDP. Positive values indicate greater rent-loss magnitudes than under the 3% specification, whereas negative values indicate smaller rent-loss magnitudes. Pearson correlations (r ; $n = 169$ countries) compare uncapped country-level estimates under each alternative discount rate with the 3% specification. Capping at the 2.5th and 97.5th percentiles is applied only to map colors, separately for each alternative discount rate, while pooling periods and scenarios. ES, EM, MS, and MM denote end-century stringent, end-century moderate, mid-century stringent, and mid-century moderate, respectively. Country boundaries are from GADM version 3.6 (<https://gadm.org>).

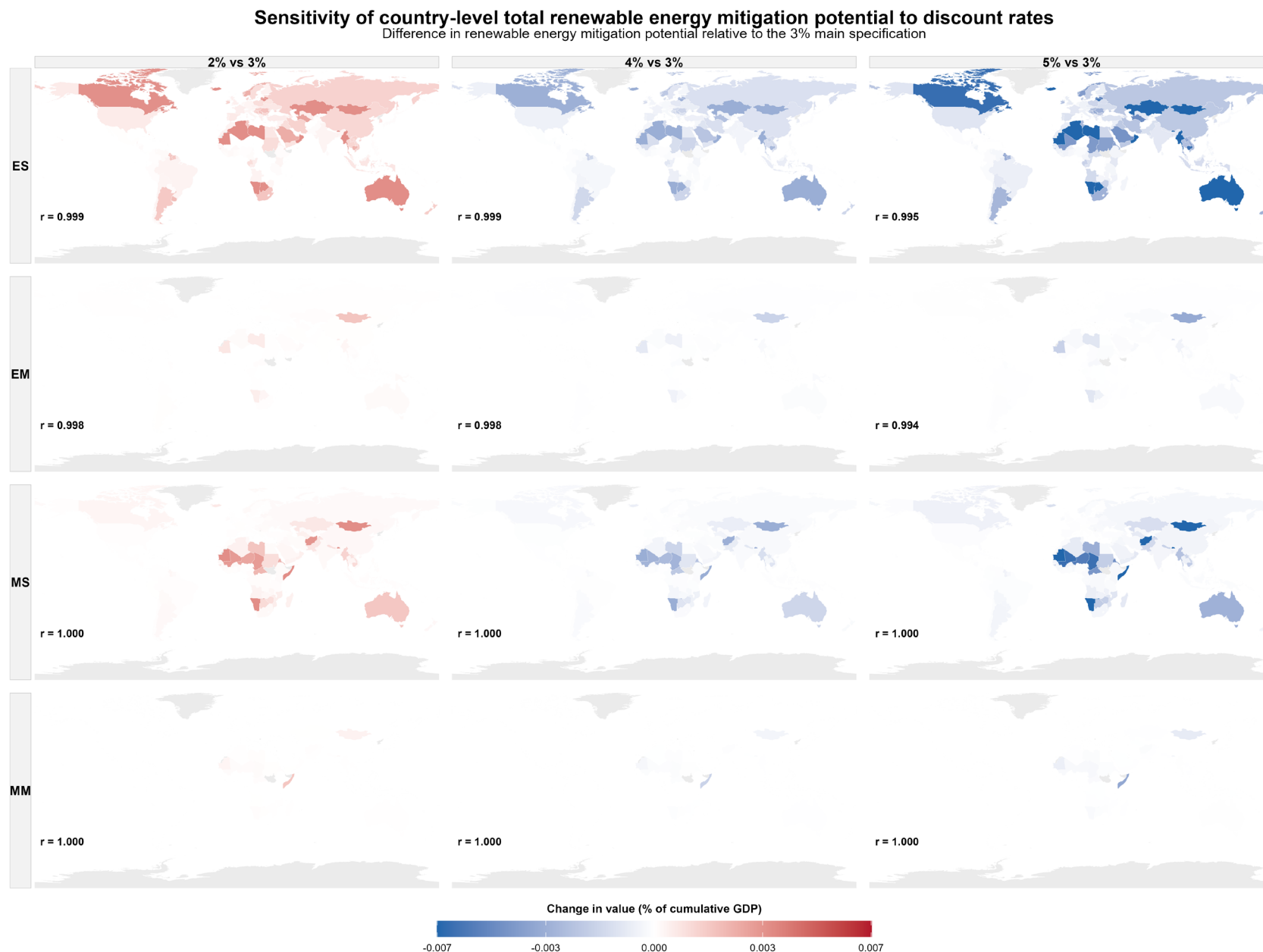
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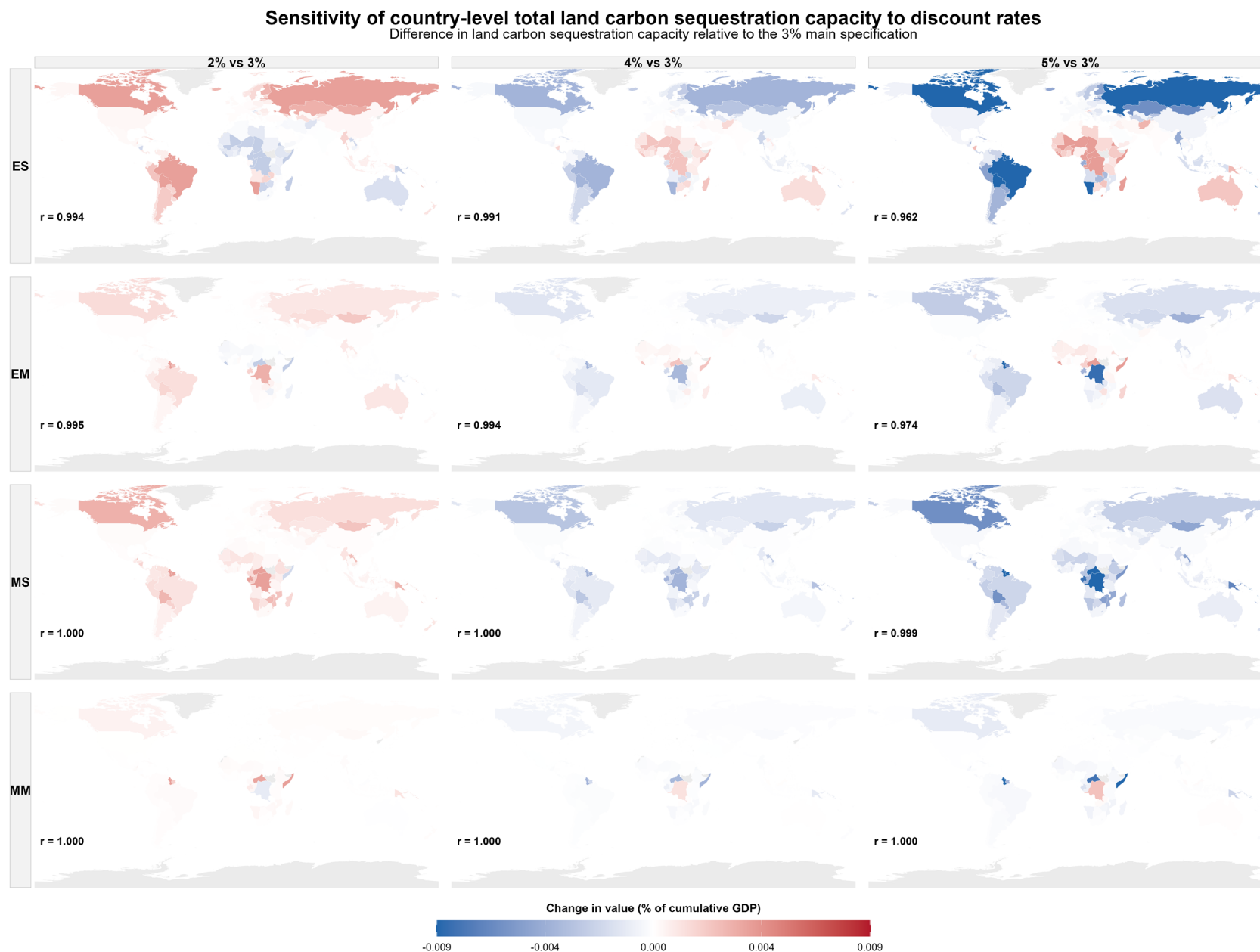
Supplementary Fig. 5.2: Sensitivity of country-level avoided economic damages to alternative discount rates. Maps show differences in avoided economic damages under discount rates of 2%, 4%, and 5% relative to the 3% main specification, measured as

percentage points of discounted cumulative GDP. Positive values indicate larger avoided-damage estimates than under the 3% specification, whereas negative values indicate smaller estimates. Pearson correlations (r ; $n = 169$ countries) compare uncapped country-level estimates under each alternative discount rate with the 3% specification. Capping at the 2.5th and 97.5th percentiles is applied only to map colors, separately for each alternative discount rate while pooling periods and scenarios. ES, EM, MS, and MM denote end-century stringent, end-century moderate, mid-century stringent, and mid-century moderate, respectively. Country boundaries are from GADM version 3.6 (<https://gadm.org>).



Supplementary Fig. 5.3: Sensitivity of country-level total renewable energy mitigation potential to alternative discount rates. Maps show differences in total renewable-energy mitigation potential under discount rates of 2%, 4%, and 5% relative to the 3% main

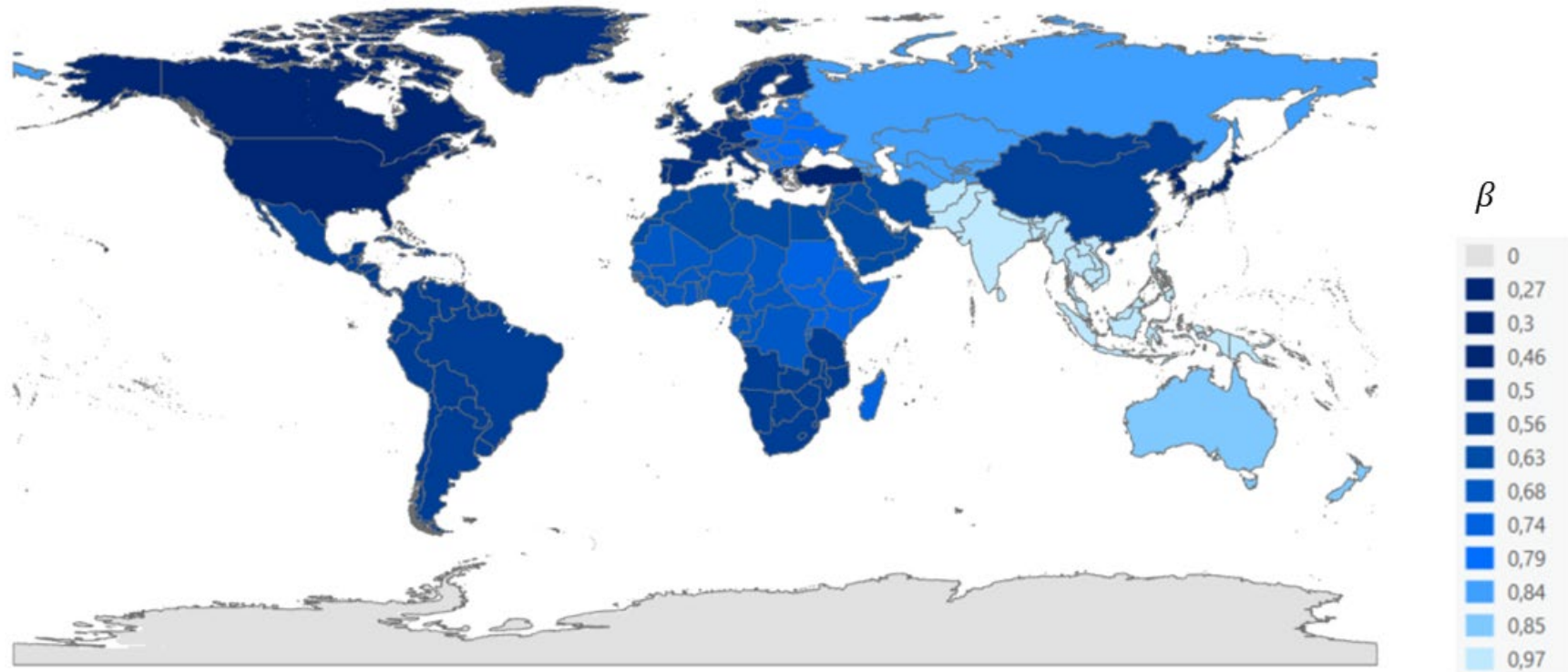
specification, measured as percentage points of discounted cumulative GDP. Positive values indicate larger estimates than under the 3% specification, whereas negative values indicate smaller estimates. Pearson correlations (r ; $n = 169$ countries) compare uncapped country-level estimates under each alternative discount rate with the 3% specification. Capping at the 2.5th and 97.5th percentiles is applied only to map colors, separately for each alternative discount rate while pooling periods and scenarios. ES, EM, MS, and MM denote end-century stringent, end-century moderate, mid-century stringent, and mid-century moderate, respectively. Country boundaries are from GADM version 3.6 (<https://gadm.org>).



Supplementary Fig. 5.4: Sensitivity of country-level total land carbon sequestration capacity to alternative discount rates. Maps show differences in total land carbon-sequestration capacity under discount rates of 2%, 4%, and 5% relative to the 3% main

specification, measured as percentage points of discounted cumulative GDP. Positive values indicate larger estimates than under the 3% specification, whereas negative values indicate smaller estimates. Pearson correlations (r ; $n = 169$ countries) compare uncapped country-level estimates under each alternative discount rate with the 3% specification. Capping at the 2.5th and 97.5th percentiles is applied only to map colors, separately for each alternative discount rate while pooling periods and scenarios. ES, EM, MS, and MM denote end-century stringent, end-century moderate, mid-century stringent, and mid-century moderate, respectively. Country boundaries are from GADM version 3.6 (<https://gadm.org>).

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45

46 **Supplementary Fig. 6: Region-specific coefficient β for converting floor area to roof area.** Country boundaries are from GADM version 3.6
 47 (<https://gadm.org>).

48

49 **Supplementary Tables**

50 **Supplementary Table 1: Five most similar countries for each country based on distance-**
 51 **based similarity analysis.** Similarity coefficient is calculated based on detailed sub-
 52 dimensional factors, including fossil fuel rent losses (coal, gas, oil), avoided economic damage,
 53 mitigation potential from solar and wind, and natural and managed carbon sequestration
 54 capacities.

ISO3	Top1	Top2	Top3	Top4	Top5
AFG	NER (0.61)	MRT (0.56)	MLI (0.56)	NAM (0.52)	TCD (0.51)
AGO	IRQ (0.45)	SAU (0.45)	KWT (0.43)	ECU (0.42)	COG (0.4)
ALB	ITA (0.83)	SVK (0.82)	DNK (0.82)	FRA (0.81)	ESP (0.81)
ARE	MEX (0.67)	NGA (0.66)	ECU (0.66)	SYR (0.63)	THA (0.63)
ARG	UZB (0.7)	BGD (0.69)	USA (0.68)	SWE (0.68)	NZL (0.67)
ARM	FIN (0.84)	BLR (0.81)	CHL (0.79)	SWE (0.79)	EST (0.78)
AUS	BWA (0.51)	SRB (0.43)	KAZ (0.42)	CHN (0.4)	ZAF (0.39)
AFG	NER (0.61)	MRT (0.56)	MLI (0.56)	NAM (0.52)	TCD (0.51)
AUT	ITA (0.91)	CHE (0.91)	JPN (0.9)	LUX (0.9)	BEL (0.9)
AZE	DZA (0.6)	OMN (0.59)	TTO (0.57)	QAT (0.55)	TKM (0.55)
BDI	VUT (0.7)	FJI (0.62)	GMB (0.62)	PHL (0.61)	RWA (0.61)
BEL	LUX (0.98)	JPN (0.96)	CHE (0.96)	ITA (0.93)	SVK (0.92)
BEN	CIV (0.76)	RWA (0.75)	TZA (0.75)	GIN (0.75)	HTI (0.73)
BFA	TGO (0.76)	SWE (0.73)	HRV (0.72)	TJK (0.72)	MDA (0.71)
BGD	UZB (0.82)	NLD (0.78)	TUR (0.77)	GRC (0.76)	MDA (0.76)
BGR	MNE (0.86)	IND (0.76)	BIH (0.76)	POL (0.73)	UKR (0.73)
BHS	KEN (0.69)	SEN (0.68)	URY (0.67)	THA (0.66)	MDA (0.66)
BIH	MKD (0.8)	BGR (0.76)	CHN (0.75)	MNE (0.74)	IND (0.72)
BLR	SVK (0.88)	FRA (0.88)	ESP (0.87)	MDA (0.87)	PRT (0.87)
BLZ	PRY (0.79)	CMR (0.64)	NIC (0.64)	HND (0.6)	PER (0.6)
BOL	PER (0.52)	PRY (0.51)	BLZ (0.51)	PNG (0.51)	GAB (0.48)
BRA	PER (0.73)	PAN (0.65)	MEX (0.65)	JAM (0.63)	ECU (0.62)
BRN	IRN (0.48)	TTO (0.45)	NOR (0.43)	VEN (0.4)	QAT (0.39)
BTN	NPL (0.55)	AFG (0.47)	PAK (0.47)	BGD (0.43)	SDN (0.42)

ISO3	Top1	Top2	Top3	Top4	Top5
BWA	AUS (0.51)	ZAF (0.48)	ZWE (0.47)	SRB (0.44)	MOZ (0.43)
CAF	SOM (0.36)	ERI (0.34)	MDG (0.33)	GAB (0.33)	COG (0.32)
CAN	VEN (0.47)	NOR (0.46)	MYS (0.46)	SAU (0.43)	IRQ (0.43)
CHE	JPN (0.96)	LUX (0.96)	BEL (0.96)	PYF (0.93)	ITA (0.92)
CHL	GHA (0.9)	FIN (0.9)	SVK (0.88)	KOR (0.88)	ESP (0.87)
CHN	BIH (0.75)	MKD (0.74)	IND (0.73)	BGR (0.68)	MNE (0.66)
CIV	RWA (0.84)	HTI (0.84)	GTM (0.83)	GIN (0.82)	MAR (0.82)
CMR	BLZ (0.64)	BEN (0.61)	LBR (0.6)	PER (0.6)	HND (0.6)
COD	MDG (0.42)	NIC (0.41)	PRY (0.41)	COG (0.41)	BLZ (0.4)
COG	GAB (0.56)	NIC (0.54)	PRY (0.54)	MDG (0.53)	BLZ (0.53)
COL	IDN (0.58)	CHN (0.58)	IND (0.57)	MKD (0.56)	BIH (0.55)
CPV	PRI (0.88)	CYP (0.87)	TJK (0.87)	PYF (0.85)	PRT (0.85)
CRI	PAN (0.87)	LKA (0.84)	DOM (0.84)	JAM (0.83)	KEN (0.81)
CUB	GNQ (0.79)	KEN (0.77)	CRI (0.75)	WSM (0.72)	PAN (0.71)
CYP	PYF (0.89)	ITA (0.88)	CPV (0.87)	LBN (0.86)	SVN (0.86)
CZE	DEU (0.88)	TUR (0.88)	GRC (0.86)	POL (0.86)	SVN (0.85)
DEU	SVN (0.92)	TUR (0.89)	CZE (0.88)	BEL (0.88)	LUX (0.88)
DJI	YEM (0.8)	TUN (0.72)	GMB (0.71)	SWZ (0.7)	MAR (0.69)
DNK	IRL (0.86)	HRV (0.84)	MDA (0.82)	HUN (0.82)	ALB (0.82)
DOM	JAM (0.9)	PAN (0.86)	CRI (0.84)	LKA (0.83)	CPV (0.83)
DZA	OMN (0.62)	AZE (0.6)	USA (0.56)	ARG (0.55)	PAK (0.55)
ECU	ARE (0.66)	VNM (0.64)	MEX (0.63)	BRA (0.62)	THA (0.62)
EGY	ISR (0.8)	SYR (0.74)	MEX (0.73)	JOR (0.73)	PSE (0.72)
ERI	NAM (0.51)	NER (0.5)	MRT (0.49)	MLI (0.48)	KHM (0.47)
ESP	FRA (0.96)	KOR (0.94)	SVK (0.94)	BEL (0.9)	HRV (0.89)
EST	BLR (0.85)	HRV (0.84)	ESP (0.84)	KOR (0.83)	FRA (0.83)
ETH	SLE (0.69)	UGA (0.68)	MDG (0.65)	HND (0.63)	MWI (0.62)
FIN	CHL (0.9)	GHA (0.86)	ARM (0.84)	BLR (0.83)	SVK (0.83)

ISO3	Top1	Top2	Top3	Top4	Top5
FJI	VUT (0.75)	BDI (0.62)	PER (0.59)	BRA (0.59)	GEO (0.58)
FRA	ESP (0.96)	SVK (0.94)	KOR (0.93)	BEL (0.92)	LUX (0.92)
GAB	PRY (0.59)	NIC (0.56)	COG (0.56)	BLZ (0.55)	PNG (0.51)
GBR	KOR (0.81)	GHA (0.81)	NLD (0.8)	AUT (0.8)	CHL (0.8)
GEO	AUT (0.78)	EST (0.77)	CHE (0.74)	ITA (0.73)	JPN (0.73)
GHA	CHL (0.9)	KOR (0.87)	FIN (0.86)	SVK (0.85)	ESP (0.85)
GIN	CIV (0.82)	GTM (0.77)	SLE (0.77)	MWI (0.76)	RWA (0.76)
GMB	MAR (0.84)	RWA (0.81)	PHL (0.79)	HTI (0.79)	TUN (0.79)
GNB	KHM (0.57)	BHS (0.53)	LTU (0.51)	TLS (0.49)	SEN (0.49)
GNQ	KEN (0.82)	CRI (0.81)	SWZ (0.79)	CUB (0.79)	TZA (0.78)
GRC	TUR (0.91)	SVN (0.89)	DEU (0.87)	CZE (0.86)	PRT (0.86)
GTM	HTI (0.9)	MAR (0.85)	RWA (0.85)	SLV (0.84)	CIV (0.83)
GUY	SUR (0.72)	PNG (0.43)	FJI (0.4)	GAB (0.39)	VUT (0.37)
HND	CIV (0.76)	HTI (0.73)	SLE (0.72)	GIN (0.72)	GTM (0.72)
HRV	MDA (0.91)	IRL (0.9)	ESP (0.89)	SVK (0.88)	KOR (0.87)
HTI	GTM (0.9)	SLV (0.88)	MAR (0.88)	RWA (0.87)	CIV (0.84)
HUN	HRV (0.86)	IRL (0.86)	MDA (0.85)	TUR (0.83)	EST (0.83)
IDN	CHN (0.6)	COL (0.58)	MKD (0.57)	SRB (0.55)	BIH (0.55)
IND	BGR (0.76)	MNE (0.75)	MKD (0.74)	CHN (0.73)	BIH (0.72)
IRL	HRV (0.9)	MDA (0.87)	DNK (0.86)	HUN (0.86)	ESP (0.85)
IRN	TTO (0.6)	QAT (0.52)	NOR (0.49)	BRN (0.48)	OMN (0.48)
IRQ	SAU (0.79)	KWT (0.74)	MYS (0.64)	ECU (0.55)	ARE (0.54)
ISL	LTU (0.63)	LVA (0.62)	ROU (0.53)	IRL (0.53)	HUN (0.53)
ISR	EGY (0.8)	LBN (0.78)	MEX (0.76)	CYP (0.75)	SYR (0.75)
ITA	JPN (0.93)	BEL (0.93)	PYF (0.93)	LUX (0.92)	CHE (0.92)
JAM	DOM (0.9)	PAN (0.9)	CPV (0.83)	CRI (0.83)	PRI (0.82)
JOR	SYR (0.9)	PSE (0.89)	LKA (0.82)	SWZ (0.82)	LBN (0.81)
JPN	CHE (0.96)	LUX (0.96)	BEL (0.96)	ITA (0.93)	PYF (0.93)

ISO3	Top1	Top2	Top3	Top4	Top5
KAZ	CHN (0.52)	BIH (0.51)	IND (0.5)	SRB (0.5)	MKD (0.49)
KEN	GNQ (0.82)	CRI (0.81)	TZA (0.81)	SWZ (0.79)	PAN (0.77)
KGZ	TGO (0.74)	AUT (0.73)	GEO (0.72)	GHA (0.72)	SVN (0.71)
KHM	GNB (0.57)	BHS (0.56)	SDN (0.54)	THA (0.53)	LTU (0.53)
KOR	ESP (0.94)	FRA (0.93)	SVK (0.92)	BEL (0.9)	JPN (0.89)
KWT	IRQ (0.74)	SAU (0.73)	MYS (0.66)	ECU (0.57)	ARE (0.55)
LAO	KAZ (0.45)	SRB (0.45)	BIH (0.43)	MKD (0.42)	CHN (0.42)
LBN	CYP (0.86)	CPV (0.82)	PSE (0.82)	DOM (0.81)	JOR (0.81)
LBR	CMR (0.6)	BEN (0.58)	BDI (0.56)	VUT (0.56)	CIV (0.53)
LBY	SAU (0.45)	IRQ (0.43)	DZA (0.41)	MYS (0.4)	CAN (0.4)
LKA	SYR (0.85)	PAN (0.85)	CRI (0.84)	DOM (0.83)	MAR (0.83)
LSO	ETH (0.6)	UGA (0.59)	TZA (0.59)	SLE (0.58)	KEN (0.57)
LTU	LVA (0.78)	IRL (0.74)	HUN (0.73)	DNK (0.71)	ROU (0.7)
LUX	BEL (0.98)	JPN (0.96)	CHE (0.96)	ITA (0.92)	PYF (0.92)
LVA	LTU (0.78)	ROU (0.7)	HUN (0.7)	EST (0.7)	IRL (0.69)
MAR	HTI (0.88)	GTM (0.85)	GMB (0.84)	SLV (0.84)	RWA (0.84)
MDA	HRV (0.91)	PRT (0.88)	BLR (0.87)	IRL (0.87)	ESP (0.87)
MDG	ETH (0.65)	LSO (0.56)	SLE (0.55)	COG (0.53)	HND (0.53)
MEX	DOM (0.77)	ISR (0.76)	JAM (0.76)	LBN (0.75)	PAN (0.75)
MKD	BIH (0.8)	IND (0.74)	CHN (0.74)	BGR (0.71)	MNE (0.7)
MLI	NER (0.69)	TCD (0.61)	AFG (0.56)	MRT (0.55)	ERI (0.48)
MMR	ARG (0.48)	DZA (0.47)	KHM (0.45)	NZL (0.45)	TKM (0.45)
MNE	BGR (0.86)	POL (0.77)	IND (0.75)	BIH (0.74)	UKR (0.74)
MNG	AUS (0.34)	BWA (0.33)	LAO (0.33)	NER (0.31)	MOZ (0.31)
MOZ	ZAF (0.48)	ZWE (0.46)	BWA (0.43)	SRB (0.41)	COL (0.38)
MRT	NAM (0.6)	AFG (0.56)	MLI (0.55)	NER (0.53)	TCD (0.53)
MWI	GTM (0.8)	HTI (0.78)	GIN (0.76)	SLE (0.76)	CIV (0.76)
MYS	KWT (0.66)	IRQ (0.64)	SAU (0.61)	ECU (0.53)	VNM (0.5)

ISO3	Top1	Top2	Top3	Top4	Top5
NAM	MRT (0.6)	AFG (0.52)	ERI (0.51)	SDN (0.48)	NER (0.47)
NCL	SLB (0.45)	ETH (0.45)	URY (0.44)	MDG (0.44)	CUB (0.44)
NER	MLI (0.69)	AFG (0.61)	TCD (0.58)	MRT (0.53)	ERI (0.5)
NGA	MEX (0.72)	EGY (0.71)	RWA (0.71)	MAR (0.7)	GMB (0.7)
NIC	PRY (0.67)	BLZ (0.64)	CMR (0.57)	GAB (0.56)	COG (0.54)
NLD	JPN (0.89)	LUX (0.89)	BEL (0.89)	CHE (0.89)	ITA (0.88)
NOR	TTO (0.58)	IRN (0.49)	OMN (0.49)	AZE (0.47)	VEN (0.46)
NPL	PAK (0.65)	BGD (0.63)	MDA (0.6)	UZB (0.6)	BLR (0.6)
NZL	SWE (0.72)	IRL (0.7)	HRV (0.7)	DNK (0.69)	ROU (0.69)
OMN	DZA (0.62)	AZE (0.59)	TTO (0.55)	QAT (0.51)	TKM (0.51)
PAK	BGD (0.68)	EGY (0.68)	UZB (0.67)	TUN (0.67)	NPL (0.65)
PAN	JAM (0.9)	CRI (0.87)	DOM (0.86)	LKA (0.85)	CPV (0.78)
PER	BRA (0.73)	PAN (0.66)	JAM (0.65)	MEX (0.65)	ARM (0.63)
PHL	SYR (0.81)	JOR (0.8)	MAR (0.8)	GMB (0.79)	RWA (0.79)
PNG	FJI (0.54)	GAB (0.51)	BOL (0.51)	BLZ (0.51)	CMR (0.5)
POL	CZE (0.86)	UKR (0.84)	TUR (0.81)	DEU (0.8)	GRC (0.79)
PRI	LUX (0.89)	BEL (0.88)	JPN (0.88)	CPV (0.88)	PRT (0.88)
PRT	FRA (0.9)	ITA (0.9)	SVK (0.89)	ESP (0.89)	MDA (0.88)
PRY	BLZ (0.79)	NIC (0.67)	GAB (0.59)	CMR (0.59)	HND (0.56)
PSE	JOR (0.89)	SYR (0.87)	LBN (0.82)	LKA (0.81)	TUN (0.81)
PYF	CHE (0.93)	JPN (0.93)	ITA (0.93)	BEL (0.92)	LUX (0.92)
QAT	TKM (0.56)	TTO (0.55)	AZE (0.55)	IRN (0.52)	OMN (0.51)
ROU	HUN (0.8)	EST (0.77)	UKR (0.76)	DNK (0.76)	IRL (0.76)
RUS	AZE (0.5)	USA (0.49)	ROU (0.48)	BGR (0.47)	DZA (0.47)
RWA	HTI (0.87)	GTM (0.85)	CIV (0.84)	MAR (0.84)	GMB (0.81)
SAU	IRQ (0.79)	KWT (0.73)	MYS (0.61)	ECU (0.56)	ARE (0.54)
SDN	DJI (0.65)	YEM (0.6)	PAK (0.57)	TUN (0.56)	GIN (0.56)
SEN	MDA (0.79)	HUN (0.79)	PRT (0.77)	HRV (0.77)	CYP (0.76)

ISO3	Top1	Top2	Top3	Top4	Top5
SLB	NCL (0.45)	ZMB (0.43)	COD (0.39)	ETH (0.39)	MDG (0.39)
SLE	GIN (0.77)	MWI (0.76)	HND (0.72)	CIV (0.72)	TZA (0.71)
SLV	HTI (0.88)	GTM (0.84)	MAR (0.84)	RWA (0.8)	CIV (0.79)
SOM	CAF (0.36)	ERI (0.3)	MRT (0.29)	NAM (0.28)	NER (0.28)
SRB	BIH (0.64)	MKD (0.63)	CHN (0.62)	IDN (0.55)	BGR (0.54)
SUR	GUY (0.72)	PNG (0.44)	GAB (0.44)	PRY (0.4)	FJI (0.4)
SVK	FRA (0.94)	ESP (0.94)	BEL (0.92)	KOR (0.92)	ITA (0.91)
SVN	DEU (0.92)	JPN (0.91)	ITA (0.91)	BEL (0.9)	PYF (0.9)
SWE	BLR (0.84)	HRV (0.84)	MDA (0.83)	FIN (0.83)	CHL (0.82)
SWZ	SYR (0.83)	JOR (0.82)	LKA (0.81)	PSE (0.79)	GNQ (0.79)
SYR	JOR (0.9)	PSE (0.87)	LKA (0.85)	SWZ (0.83)	MAR (0.81)
TCD	MLI (0.61)	NER (0.58)	MRT (0.53)	AFG (0.51)	ERI (0.45)
TGO	GHA (0.82)	CHL (0.8)	FIN (0.8)	SVK (0.8)	SWE (0.79)
THA	TUN (0.71)	MEX (0.71)	SEN (0.68)	DNK (0.68)	KEN (0.67)
TJK	CPV (0.87)	PRI (0.84)	SVK (0.82)	PRT (0.81)	JPN (0.81)
TKM	QAT (0.56)	AZE (0.55)	OMN (0.51)	DZA (0.5)	TTO (0.45)
TLS	TUN (0.59)	GMB (0.58)	BHS (0.57)	DJI (0.57)	THA (0.56)
TTO	IRN (0.6)	NOR (0.58)	AZE (0.57)	QAT (0.55)	OMN (0.55)
TUN	PSE (0.81)	MAR (0.8)	GMB (0.79)	SYR (0.78)	JOR (0.78)
TUR	GRC (0.91)	DEU (0.89)	CZE (0.88)	SVN (0.87)	FRA (0.87)
TZA	KEN (0.81)	SWZ (0.79)	GNQ (0.78)	GTM (0.78)	CRI (0.77)
UGA	MWI (0.7)	SLE (0.69)	GNQ (0.68)	ETH (0.68)	TZA (0.68)
UKR	POL (0.84)	CZE (0.82)	TUR (0.81)	GRC (0.8)	DEU (0.77)
URY	WSM (0.74)	SWE (0.72)	BFA (0.7)	TJK (0.68)	MDA (0.67)
USA	MEX (0.73)	UZB (0.7)	BGD (0.69)	ARG (0.68)	ALB (0.68)
UZB	BGD (0.82)	NLD (0.78)	TJK (0.76)	TUR (0.76)	CPV (0.75)
VEN	MYS (0.48)	CAN (0.47)	IRQ (0.47)	NOR (0.46)	TTO (0.46)
VNM	THA (0.65)	ECU (0.64)	USA (0.62)	MEX (0.6)	ARE (0.6)

ISO3	Top1	Top2	Top3	Top4	Top5
VUT	FJI (0.75)	BDI (0.7)	PER (0.59)	BRA (0.58)	PHL (0.58)
WSM	TJK (0.76)	URY (0.74)	SWE (0.73)	CUB (0.72)	JAM (0.71)
YEM	DJI (0.8)	SWZ (0.74)	SYR (0.73)	PHL (0.72)	JOR (0.72)
ZAF	SRB (0.53)	MOZ (0.48)	BWA (0.48)	MKD (0.47)	BIH (0.46)
ZMB	UGA (0.5)	ETH (0.47)	TZA (0.47)	SLE (0.47)	MWI (0.47)

Note: Countries are identified using ISO 3166-1 alpha-3 codes. Corresponding names are provided in Supplementary Table 5.

Supplementary Table 2: Regional AR6 IAM model runs used in this study. The table lists all AR6 IAMs used in this study. Crosses indicate the availability of each model for the corresponding AR6 variable group. For fossil fuel rent loss, each fuel was used only when both its production and price variables were available. For renewable energy mitigation potential, a model was used only when the relevant renewable electricity generation variable, baseline fossil fuel electricity generation variables, and regional carbon price were available. For land carbon sequestration capacity, all models marked in the carbon price column were used.

IAM	Fossil fuel production	Fossil fuel price	Renewable electricity generation	Baseline fossil fuel electricity generation	Carbon price
COFFEE 1.1	×	×	×	×	×
GCAM 5.3	×	×	×	×	×
IMAGE 3.0	×	×	×	×	×
MESSAGE-GLOBIOM 1.0	×	×	×	×	×
MESSAGEix-GLOBIOM_1.1	×	×	×	×	×
POLES EMF33	×	×			
POLES ENGAGE	×	×	×	×	×
POLES GECO2019	×	×	×	×	×
REMIND 2.1	×	×	a	×	×
REMIND-MAgPIE 1.5	×	×	a	×	×
REMIND-MAgPIE 1.7-3.0	×	×	a	×	×
REMIND-MAgPIE 2.1-4.2	×	×	a	×	×

IAM	Fossil fuel production	Fossil fuel price	Renewable electricity generation	Baseline fossil fuel electricity generation	Carbon price
TIAM-ECN 1.1	×	×	×	×	×
WITCH 5.0	×	×	×	×	×

Note: × indicates that the variable was reported in the AR6 regional dataset across the relevant scenarios used in this study. ^a REMIND was used for solar electricity generation but not for wind electricity generation because only aggregate wind electricity generation was reported in the AR6 regional dataset. We did not use aggregate wind electricity generation because many IAMs report onshore and offshore wind separately, and these technologies exhibit distinct spatial distributions and country-level resource endowments. Using aggregate wind generation would require combining onshore and offshore wind potential when calculating country shares, which could disproportionately affect countries with very large onshore or offshore resources. To maintain consistency across IAMs and technologies, we therefore use only IAM runs that report onshore and offshore wind separately.

Supplementary Table 3: CMIP6 General Circulation Models (GCMs) employed in this study. The table lists the GCMs used as climate inputs for near-surface air temperature, solar radiation, and near-surface wind speed. Because we compare mitigation scenarios with the baseline scenario, we retain only GCMs with available data across all three climate scenarios.

GCM	RCP26 (SSP126)	RCP45 (SSP245)	RCP60 (SSP460)
CanESM5	×	×	×
CanESM5-1	×	×	×
FGOALS-g3	×	×	×
IPSL-CM6A-LR	×	×	×
MIROC6	×	×	×
MRI-ESM2-0	×	×	×

Supplementary Table 4: The land suitability factors of different land or sea pixel types, based on Gernaat et al.'s study¹. These factors are applied to the corresponding land-use fractions in each grid cell to estimate suitable area for utility-scale solar PV, onshore wind, and offshore wind technical potential.

Land/Sea pixel type	LSF (Utility PV, %)	LSF (Onshore Wind, %)	LSF (Offshore wind, %)
Forest	0	10	-
Tropical forest	0	0	-
Barren land	5	100	-
Shrubland	1	50	-
Tropical shrubland	0	0	-

Land/Sea pixel type	LSF (Utility PV, %)	LSF (Onshore Wind, %)	LSF (Offshore wind, %)
Extensive grassland	5	80	-
grassland	1	80	-
Cropland	1	70	-
Biofuel land	0	70	-
Urban area	0	0	-
Pixel with urban fraction > 90%	0	0	-
Average elevation > 2km	0	0	-
Average slope > 5 degree	0	0	-
Environmental protected area	0	0	-
Marine protected area	-	-	0
Shipping lanes	-	-	85
Exclusive economic zone (EEZ)	-	-	100
Sea area outside the EEZ	-	-	0
Sea area covered with permanent ice and snow	-	-	0
See depth > 1km	-	-	0

82 **Supplementary Table 5: ISO 3166-1 alpha-3 country codes and corresponding country**
83 **names**

ISO3	Country name	ISO3	Country name	ISO3	Country name
AFG	Afghanistan	GIN	Guinea	NPL	Nepal
AGO	Angola	GMB	Gambia	NZL	New Zealand
ALB	Albania	GNB	Guinea-Bissau	OMN	Oman
ARE	United Arab Emirates	GNQ	Equatorial Guinea	PAK	Pakistan
ARG	Argentina	GRC	Greece	PAN	Panama
ARM	Armenia	GTM	Guatemala	PER	Peru
AUS	Australia	GUY	Guyana	PHL	Philippines
AUT	Austria	HND	Honduras	PNG	Papua New Guinea
AZE	Azerbaijan	HRV	Croatia	POL	Poland
BDI	Burundi	HTI	Haiti	PRI	Puerto Rico
BEL	Belgium	HUN	Hungary	PRT	Portugal
BEN	Benin	IDN	Indonesia	PRY	Paraguay

ISO3	Country name	ISO3	Country name	ISO3	Country name
BFA	Burkina Faso	IND	India	PSE	State of Palestine
BGD	Bangladesh	IRL	Ireland	PYF	French Polynesia
BGR	Bulgaria	IRN	Iran	QAT	Qatar
BHS	Bahamas	IRQ	Iraq	ROU	Romania
BIH	Bosnia and Herzegovina	ISL	Iceland	RUS	Russia
BLR	Belarus	ISR	Israel	RWA	Rwanda
BLZ	Belize	ITA	Italy	SAU	Saudi Arabia
BOL	Bolivia	JAM	Jamaica	SDN	Sudan
BRA	Brazil	JOR	Jordan	SEN	Senegal
BRN	Brunei Darussalam	JPN	Japan	SLB	Solomon Islands
BTN	Bhutan	KAZ	Kazakhstan	SLE	Sierra Leone
BWA	Botswana	KEN	Kenya	SLV	El Salvador
CAF	Central African Republic	KGZ	Kyrgyzstan	SOM	Somalia
CAN	Canada	KHM	Cambodia	SRB	Serbia
CHE	Switzerland	KOR	Republic of Korea	SUR	Suriname
CHL	Chile	KWT	Kuwait	SVK	Slovakia
CHN	China	LAO	Lao People's Democratic Republic	SVN	Slovenia
CIV	Côte d'Ivoire	LBN	Lebanon	SWE	Sweden
CMR	Cameroon	LBR	Liberia	SWZ	Eswatini
COD	Democratic Republic of the Congo	LBY	Libya	SYR	Syrian Arab Republic
COG	Republic of the Congo	LKA	Sri Lanka	TCD	Chad
COL	Colombia	LSO	Lesotho	TGO	Togo
CPV	Cabo Verde	LTU	Lithuania	THA	Thailand
CRI	Costa Rica	LUX	Luxembourg	TJK	Tajikistan
CUB	Cuba	LVA	Latvia	TKM	Turkmenistan
CYP	Cyprus	MAR	Morocco	TLS	Timor-Leste
CZE	Czechia	MDA	Republic of Moldova	TTO	Trinidad and Tobago
DEU	Germany	MDG	Madagascar	TUN	Tunisia
DJI	Djibouti	MEX	Mexico	TUR	Türkiye
DNK	Denmark	MKD	North Macedonia	TZA	United Republic of Tanzania
DOM	Dominican Republic	MLI	Mali	UGA	Uganda
DZA	Algeria	MMR	Myanmar	UKR	Ukraine
ECU	Ecuador	MNE	Montenegro	URY	Uruguay
EGY	Egypt	MNG	Mongolia	USA	United States
ERI	Eritrea	MOZ	Mozambique	UZB	Uzbekistan
ESP	Spain	MRT	Mauritania	VEN	Venezuela
EST	Estonia	MWI	Malawi	VNM	Viet Nam
ETH	Ethiopia	MYS	Malaysia	VUT	Vanuatu
FIN	Finland	NAM	Namibia	WSM	Samoa
FJI	Fiji	NCL	New Caledonia	YEM	Yemen
FRA	France	NER	Niger	ZAF	South Africa

ISO3	Country name	ISO3	Country name	ISO3	Country name
GAB	Gabon	NGA	Nigeria	ZMB	Zambia
GBR	United Kingdom	NIC	Nicaragua	ZWE	Zimbabwe
GEO	Georgia	NLD	Netherlands		
GHA	Ghana	NOR	Norway		

Supplementary Sections

S1. Sensitivity check of time-varying weighting approach

We assess the robustness of country-level fossil fuel rent loss estimates to the time-varying weighting approach used to disaggregate regional AR6 fossil fuel production to countries. As described in Methods, the approach combines recent country-level production shares with proved reserve shares, allowing allocation weights to shift gradually from production-based to reserve-based over time.

Country-level fossil fuel production data are taken from Global Energy Monitor (GEM). We use the most recent available country-level fossil-fuel production data from GEM, constructed primarily from the 2024 GEM release^{2,3} and supplemented with the 2026 GEM release^{4,5} where country-fuel production observations are missing in the 2024 data. Non-missing observations from the 2024 release are retained unchanged. Coal production is derived from GEM's Global Coal Mine Tracker. Oil and gas production are derived from GEM's Global Oil and Gas Extraction Tracker. These GEM datasets provide asset-level information on fossil-fuel extraction activities and associated production measures.

Country-level fossil fuel reserve data are based primarily on proved fossil fuel reserves in 2020 from the Our World in Data fossil-fuel database⁶⁻⁸. The reserve variable refers to proved reserves, defined as quantities that can be recovered in the future from known reservoirs or deposits under existing economic and operating conditions, based on available geological and engineering information⁹. For countries with missing or zero reserve observations in the main reserve dataset, we supplement reserve values with CIA World Factbook records for the most recent available year¹⁰⁻¹². These supplementary CIA values are used only to fill missing or zero reserve observations. Existing non-zero 2020 reserve observations from the main reserve dataset are not overwritten.

Supplementary Table 6: Country-fuel data sources used to construct production and reserve shares for the time-varying weighting approach. Each row reports a country-fuel observation identified by ISO3 code, fuel type, production data source, and reserve data source. Production data are primarily from the 2024 Global Energy Monitor (GEM) release, with missing country-fuel observations supplemented from the 2026 GEM release where available. Reserve data are based on 2020 proved reserves from Our World in Data (OWID), with missing or zero reserve observations supplemented using CIA World Factbook 2018 estimates. NA in the production source column indicates that no GEM production was available and production was set to zero in the calculation.

ISO3	Fuel	Production source	Reserve source
AFG	Coal	GEM 2024	CIA World Factbook 2019
AGO	Gas	GEM 2024	CIA World Factbook 2018
AGO	Oil	GEM 2024	OWID 2020
ALB	Oil	GEM 2024	CIA World Factbook 2018
ARE	Gas	GEM 2024	OWID 2020
ARE	Oil	GEM 2024	OWID 2020

ISO3	Fuel	Production source	Reserve source
ARG	Gas	GEM 2024	OWID 2020
ARG	Oil	GEM 2024	OWID 2020
AUS	Coal	GEM 2024	OWID 2020
AUS	Gas	GEM 2024	OWID 2020
AUS	Oil	GEM 2024	OWID 2020
AUT	Oil	GEM 2024	CIA World Factbook 2018
AZE	Gas	GEM 2024	OWID 2020
AZE	Oil	GEM 2024	OWID 2020
BGD	Coal	GEM 2024	CIA World Factbook 2019
BGD	Gas	GEM 2024	OWID 2020
BGD	Oil	GEM 2024	CIA World Factbook 2018
BGR	Coal	GEM 2024	OWID 2020
BHR	Gas	GEM 2024	OWID 2020
BHR	Oil	GEM 2024	CIA World Factbook 2018
BIH	Coal	GEM 2024	CIA World Factbook 2019
BOL	Gas	GEM 2024	OWID 2020
BOL	Oil	GEM 2024	CIA World Factbook 2018
BRA	Coal	GEM 2024	OWID 2020
BRA	Gas	GEM 2024	OWID 2020
BRA	Oil	GEM 2024	OWID 2020
BRB	Gas	GEM 2024	CIA World Factbook 2018
BRN	Gas	GEM 2024	OWID 2020
BRN	Oil	GEM 2024	OWID 2020
BWA	Coal	GEM 2024	CIA World Factbook 2019
CAN	Coal	GEM 2024	OWID 2020
CAN	Gas	GEM 2024	OWID 2020
CAN	Oil	GEM 2024	OWID 2020
CHL	Gas	GEM 2024	CIA World Factbook 2018
CHN	Coal	GEM 2024	OWID 2020
CHN	Gas	GEM 2024	OWID 2020
CHN	Oil	GEM 2024	OWID 2020
CIV	Gas	GEM 2024	CIA World Factbook 2018
CMR	Gas	GEM 2024	CIA World Factbook 2018
COG	Oil	GEM 2024	OWID 2020
COL	Coal	GEM 2024	OWID 2020
COL	Gas	GEM 2024	OWID 2020
COL	Oil	GEM 2024	OWID 2020
CUB	Oil	GEM 2024	CIA World Factbook 2018
CZE	Coal	GEM 2024	OWID 2020
DEU	Coal	GEM 2024	OWID 2020
DEU	Gas	GEM 2024	OWID 2020
DEU	Oil	GEM 2024	CIA World Factbook 2018
DNK	Gas	GEM 2024	OWID 2020
DNK	Oil	GEM 2024	OWID 2020
DZA	Gas	GEM 2024	OWID 2020
DZA	Oil	GEM 2024	OWID 2020
ECU	Gas	GEM 2024	CIA World Factbook 2018

ISO3	Fuel	Production source	Reserve source
ECU	Oil	GEM 2024	OWID 2020
EGY	Gas	GEM 2024	OWID 2020
EGY	Oil	GEM 2024	OWID 2020
ESP	Coal	GEM 2026	OWID 2020
GAB	Oil	GEM 2024	OWID 2020
GBR	Coal	GEM 2024	OWID 2020
GBR	Gas	GEM 2024	OWID 2020
GBR	Oil	GEM 2024	OWID 2020
GNQ	Oil	NA	OWID 2020
GRC	Coal	GEM 2024	OWID 2020
HUN	Coal	GEM 2024	OWID 2020
HUN	Gas	GEM 2024	CIA World Factbook 2018
HUN	Oil	GEM 2024	CIA World Factbook 2018
IDN	Coal	GEM 2024	OWID 2020
IDN	Gas	GEM 2024	OWID 2020
IDN	Oil	GEM 2024	OWID 2020
IND	Coal	GEM 2024	OWID 2020
IND	Gas	GEM 2024	OWID 2020
IND	Oil	GEM 2024	OWID 2020
IRL	Gas	GEM 2024	CIA World Factbook 2018
IRN	Coal	GEM 2024	CIA World Factbook 2019
IRN	Gas	GEM 2024	OWID 2020
IRN	Oil	GEM 2024	OWID 2020
IRQ	Gas	GEM 2024	OWID 2020
IRQ	Oil	GEM 2024	OWID 2020
ISR	Gas	GEM 2024	OWID 2020
ITA	Gas	GEM 2024	OWID 2020
ITA	Oil	GEM 2024	OWID 2020
JPN	Coal	GEM 2026	OWID 2020
JPN	Gas	GEM 2024	CIA World Factbook 2018
KAZ	Coal	GEM 2024	OWID 2020
KAZ	Gas	GEM 2024	OWID 2020
KAZ	Oil	GEM 2024	OWID 2020
KGZ	Coal	GEM 2024	CIA World Factbook 2019
KOR	Coal	GEM 2026	OWID 2020
KWT	Gas	GEM 2024	OWID 2020
KWT	Oil	GEM 2024	OWID 2020
LAO	Coal	GEM 2024	CIA World Factbook 2019
LBY	Gas	GEM 2024	OWID 2020
LBY	Oil	GEM 2024	OWID 2020
MEX	Coal	GEM 2024	OWID 2020
MEX	Gas	GEM 2024	OWID 2020
MEX	Oil	GEM 2024	OWID 2020
MKD	Coal	GEM 2024	CIA World Factbook 2019
MMR	Coal	GEM 2024	CIA World Factbook 2019
MMR	Gas	GEM 2024	OWID 2020
MNE	Coal	GEM 2024	CIA World Factbook 2019

ISO3	Fuel	Production source	Reserve source
MNG	Coal	GEM 2024	OWID 2020
MOZ	Coal	GEM 2024	CIA World Factbook 2019
MYS	Coal	GEM 2024	CIA World Factbook 2019
MYS	Gas	GEM 2024	OWID 2020
MYS	Oil	GEM 2024	OWID 2020
NER	Coal	GEM 2024	CIA World Factbook 2019
NGA	Gas	GEM 2024	OWID 2020
NGA	Oil	GEM 2024	OWID 2020
NLD	Gas	GEM 2024	OWID 2020
NLD	Oil	GEM 2024	CIA World Factbook 2018
NOR	Gas	GEM 2024	OWID 2020
NOR	Oil	GEM 2024	OWID 2020
NZL	Coal	GEM 2026	OWID 2020
NZL	Gas	GEM 2024	CIA World Factbook 2018
NZL	Oil	GEM 2024	CIA World Factbook 2018
OMN	Gas	GEM 2024	OWID 2020
OMN	Oil	GEM 2024	OWID 2020
PAK	Coal	GEM 2024	OWID 2020
PAK	Gas	GEM 2024	OWID 2020
PAK	Oil	GEM 2024	CIA World Factbook 2018
PER	Gas	GEM 2024	OWID 2020
PER	Oil	GEM 2024	OWID 2020
PHL	Coal	GEM 2024	CIA World Factbook 2019
PHL	Gas	GEM 2024	CIA World Factbook 2018
PHL	Oil	GEM 2024	CIA World Factbook 2018
PNG	Gas	GEM 2024	OWID 2020
PNG	Oil	GEM 2024	CIA World Factbook 2018
POL	Coal	GEM 2024	OWID 2020
POL	Gas	GEM 2024	OWID 2020
POL	Oil	GEM 2024	CIA World Factbook 2018
PRK	Coal	GEM 2024	CIA World Factbook 2019
QAT	Gas	GEM 2024	OWID 2020
QAT	Oil	GEM 2024	OWID 2020
ROU	Coal	GEM 2024	OWID 2020
ROU	Gas	GEM 2024	OWID 2020
ROU	Oil	GEM 2024	OWID 2020
RUS	Coal	GEM 2024	OWID 2020
RUS	Gas	GEM 2024	OWID 2020
RUS	Oil	GEM 2024	OWID 2020
SAU	Gas	GEM 2024	OWID 2020
SAU	Oil	GEM 2024	OWID 2020
SDN	Oil	NA	OWID 2020
SRB	Coal	GEM 2024	OWID 2020
SVN	Coal	GEM 2024	CIA World Factbook 2019
SYR	Gas	GEM 2026	OWID 2020
SYR	Oil	GEM 2024	OWID 2020
TCD	Oil	GEM 2024	OWID 2020

ISO3	Fuel	Production source	Reserve source
THA	Coal	GEM 2024	OWID 2020
THA	Gas	GEM 2024	OWID 2020
THA	Oil	GEM 2024	OWID 2020
TKM	Gas	GEM 2024	OWID 2020
TKM	Oil	GEM 2024	OWID 2020
TTO	Gas	GEM 2024	OWID 2020
TTO	Oil	GEM 2024	OWID 2020
TUN	Gas	GEM 2024	CIA World Factbook 2018
TUN	Oil	GEM 2024	OWID 2020
TUR	Coal	GEM 2024	OWID 2020
TUR	Gas	GEM 2024	CIA World Factbook 2018
TUR	Oil	GEM 2024	CIA World Factbook 2018
TZA	Gas	GEM 2024	CIA World Factbook 2018
UKR	Coal	GEM 2024	OWID 2020
UKR	Gas	GEM 2024	OWID 2020
USA	Coal	GEM 2024	OWID 2020
USA	Gas	GEM 2024	OWID 2020
USA	Oil	GEM 2024	OWID 2020
UZB	Coal	GEM 2024	OWID 2020
UZB	Gas	GEM 2026	OWID 2020
UZB	Oil	GEM 2026	OWID 2020
VEN	Coal	GEM 2024	OWID 2020
VEN	Gas	GEM 2024	OWID 2020
VEN	Oil	GEM 2024	OWID 2020
VNM	Coal	GEM 2024	OWID 2020
VNM	Gas	GEM 2024	OWID 2020
VNM	Oil	GEM 2024	OWID 2020
YEM	Gas	GEM 2026	OWID 2020
YEM	Oil	GEM 2026	OWID 2020
ZAF	Coal	GEM 2024	OWID 2020
ZWE	Coal	GEM 2024	OWID 2020

Note: Countries are identified using ISO 3166-1 alpha-3 codes.
Corresponding names are provided in Supplementary Table 5.

118 In the main specification, the reserve weight increases linearly from 0 in 2020 to 0.6 in 2100.
119 To test sensitivity to this assumption, we vary both the terminal reserve weight and transition
120 pathway, considering λ_{2100} values of 0.4, 0.6, and 0.8 under linear, exponential, and logistic
121 paths. These alternative parameterizations present different assumptions regarding the pace and
122 magnitude of the transition from production-based to reserve-based allocation.

123 Even in long-term assessments, fossil fuel dynamics are typically characterized by a
124 combination of reserves, projected production, and infrastructure, rather than reserves alone¹³.
125 Accordingly, the main specification adopts intermediate reserve weights rather than a fully
126 reserve-driven allocation framework. Results remain highly consistent across alternative
127 parameterizations for both total fossil fuel rent losses (Supplementary Fig. 7) and individual
128 fossil fuel types (Supplementary Table 7), indicating that the estimated country-level fossil fuel
129 rent losses are robust to plausible variations in both the level and trajectory of reserve
130 dependence.

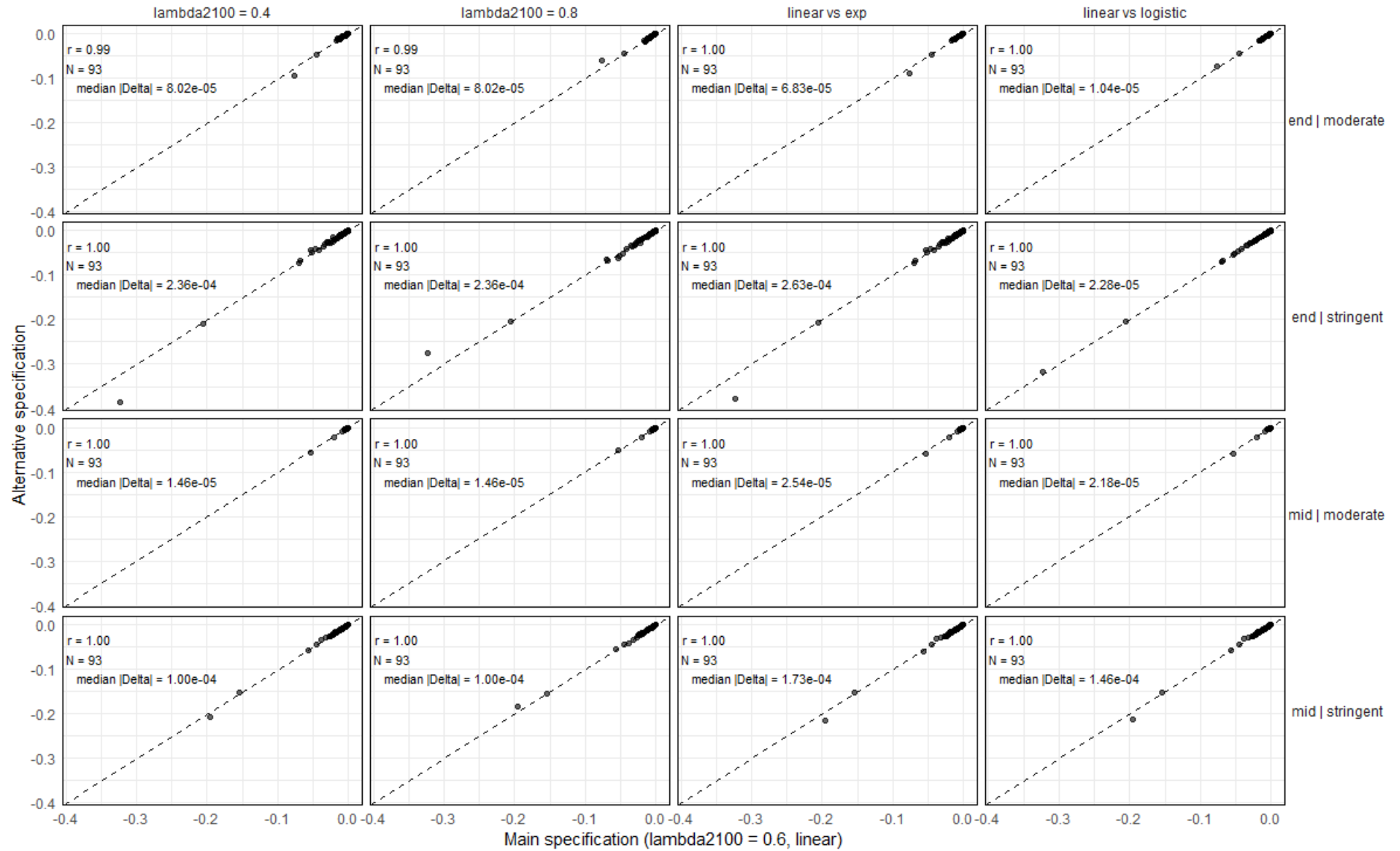
131 Additionally, we consider extreme pathways in which the reserve weight reaches unity,
132 representing fully reserve-based allocation. We examine cases in which the reserve weight
133 reaches unity by 2050, 2075, or 2100, corresponding to early, intermediate, and late attainment
134 of full reserve dependence. Results remain highly consistent with the main specification as
135 reserve dependence increases gradually, including the case in which the reserve weight reaches
136 unity by 2100. Earlier attainment of full reserve dependence leads to larger deviations,
137 indicating that the timing of reserve dependence plays an important role in shaping country-
138 level outcomes.

139 For total fossil fuel rent losses, the overall spatial patterns remain broadly consistent across
140 stress-test specifications (Supplementary Fig. 8). For individual fossil fuel types, coal and oil
141 rent losses remain highly correlated with the main specification across all stress-test scenarios
142 (Supplementary Table 8). Larger deviations are observed for gas rent losses under the most
143 extreme assumption in which the reserve weight reaches unity by 2050, particularly in end-
144 century moderate and stringent mitigation scenarios. However, correlations increase
145 substantially when full reserve dependence is reached later (e.g., by 2075 or 2100). Because a
146 fully reserve-based allocation by 2050 represents an intentionally extreme and less realistic
147 assumption, these results suggest that the main specification provides a reasonable and robust
148 representation of long-term fossil fuel allocation dynamics.

149 Taken together, these results support our choice of an intermediate reserve weight in the main
150 specification, which captures the increasing importance of reserves over time while avoiding
151 the unrealistic assumption that fossil fuel production becomes fully determined by reserve
152 endowments alone.

Sensitivity of country-level total fossil fuel rent loss

Restricted to countries with non-zero fossil fuel rent losses



Supplementary Fig. 7: Sensitivity analysis of country-level total fossil fuel rent loss under alternative allocation specifications. Scatterplots compare country-level total fossil fuel rent losses under alternative parameterizations of the fossil fuel allocation scheme against the main specification

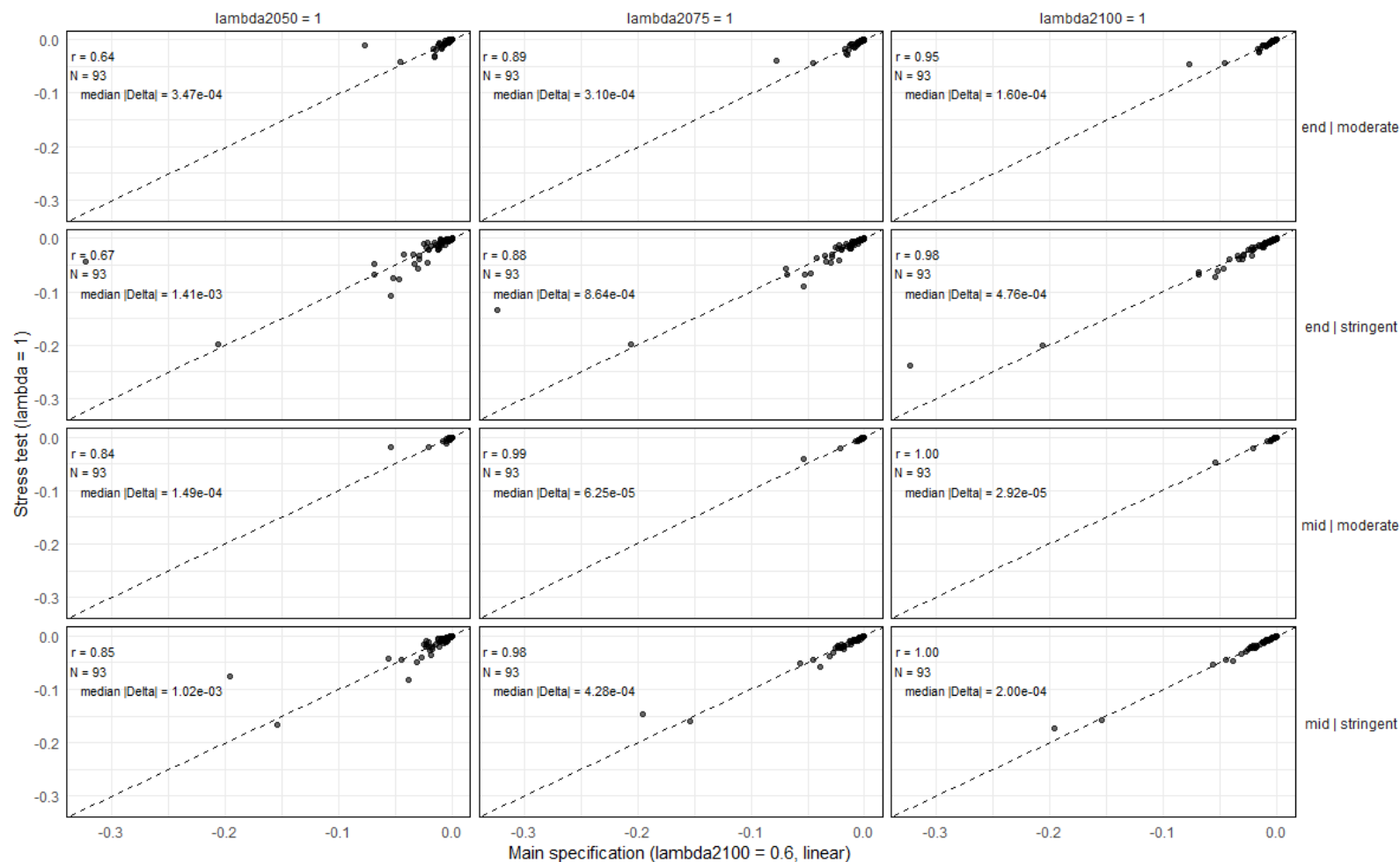
157 ($\lambda_{2100} = 0.6$, linear transition). Results are shown separately for mid-century and end-century periods under moderate and stringent mitigation scenarios.
158 For comparisons of alternative functional forms (“linear vs exp” and “linear vs logistic”), the terminal reserve weight is fixed at $\lambda_{2100} = 0.6$. For
159 comparisons of alternative terminal reserve weights ($\lambda_{2100} = 0.4$ and $\lambda_{2100} = 0.8$), the transition pathway is fixed to the linear specification. Only
160 countries with non-zero fossil fuel rent losses are included in the analysis, as countries with zero values in both specifications would artificially inflate
161 correlation statistics without contributing meaningful variation to the comparison. The dashed line indicates the 1:1 relationship. r denotes the Pearson
162 correlation coefficient, N represents the number of countries with non-zero fossil fuel rent losses, and median $|\Delta|$ denotes the median absolute difference
163 in country-level total fossil fuel rent loss between the alternative and main specifications.
164

Supplementary Table 7: Sensitivity analysis of country-level fossil fuel rent losses for individual fossil fuel types under alternative allocation specifications. Pearson correlation coefficients (r) between the main allocation specification ($\lambda_{2100} = 0.6$, linear transition) and alternative parameterizations are reported separately for coal, gas, and oil rent losses. Alternative specifications include exponential and logistic transition pathways with fixed $\lambda_{2100} = 0.6$, as well as linear pathways with alternative terminal reserve weights ($\lambda_{2100} = 0.4$ and $\lambda_{2100} = 0.8$). Results are shown for end-century moderate mitigation (EM), end-century stringent mitigation (ES), mid-century moderate mitigation (MM), and mid-century stringent mitigation (MS) scenarios. N denotes the number of countries with non-zero fossil fuel rent losses included in each comparison. Only countries with non-zero values are included to avoid artificially inflating correlation statistics through shared zero values across specifications.

Type	Period-Scenario	$\lambda_{2100} = 0.6$, exponential	$\lambda_{2100} = 0.6$, logistic	$\lambda_{2100} = 0.4$, linear	$\lambda_{2100}=0.8$, linear
coal	EM	r=0.99 N=49	r=1 N=49	r=0.98 N=49	r=0.99 N=49
	ES	r=0.99 N=49	r=1 N=49	r=0.99 N=49	r=0.99 N=49
	MM	r=0.99 N=49	r=0.99 N=49	r=1 N=49	r=1 N=49
	MS	r=1 N=49	r=1 N=49	r=1 N=49	r=1 N=49
gas	EM	r=1 N=65	r=1 N=65	r=1 N=65	r=1 N=65
	ES	r=1 N=65	r=1 N=65	r=1 N=65	r=1 N=65
	MM	r=1 N=65	r=1 N=65	r=1 N=65	r=1 N=65
	MS	r=1 N=65	r=1 N=65	r=1 N=65	r=1 N=65
oil	EM	r=1 N=64	r=1 N=64	r=1 N=64	r=1 N=64
	ES	r=1 N=64	r=1 N=64	r=1 N=64	r=1 N=64
	MM	r=1 N=64	r=1 N=64	r=1 N=64	r=1 N=64
	MS	r=1 N=64	r=1 N=64	r=1 N=64	r=1 N=64

Stress test: full reserve dependence at different timings

Restricted to countries with non-zero fossil fuel rent losses



177

178 **Supplementary Fig. 8: Stress tests of country-level total fossil fuel rent losses under full reserve-dependence pathways.**

179 Scatterplots compare country-level total fossil fuel rent losses under extreme reserve-dependence stress tests against the main

180 specification ($\lambda_{2100} = 0.6$, linear transition). In all stress-test cases, a linear transition pathway is assumed, while the reserve-

181 weight parameter λ_t reaches 1 by 2050, 2075, or 2100, implying a fully reserve-based allocation after the corresponding year.
182 Results are shown separately for mid-century and end-century periods under moderate and stringent mitigation scenarios. Only
183 countries with non-zero fossil fuel rent losses are included in the comparison, as shared zero values across specifications would
184 artificially inflate correlation statistics without contributing meaningful variation. The dashed line indicates the 1:1 relationship.
185 r denotes the Pearson correlation coefficient, N represents the number of countries with non-zero fossil fuel rent losses, and
186 median $|\Delta|$ denotes the median absolute difference in country-level total fossil fuel rent loss between the stress-test and main
187 specifications. Despite stronger deviations under early full reserve dependence (particularly when $\lambda_t = 1$ by 2050), the overall
188 spatial pattern of fossil fuel rent losses remains broadly consistent across scenarios.

Supplementary Table 8: Stress tests of country-level fossil fuel rent losses for individual fossil fuel types under full reserve-dependence pathway. Pearson correlation coefficients (r) between the main allocation specification ($\lambda_{2100} = 0.6$, linear transition) and stress-test specifications are reported separately for coal, gas, and oil rent losses. In all stress-test cases, a linear transition pathway is assumed, while the reserve-weight parameter λ_t reaches 1 by 2050, 2075, or 2100, implying a fully reserve-based allocation after the corresponding year. Results are shown for end-century moderate mitigation (EM), end-century stringent mitigation (ES), mid-century moderate mitigation (MM), and mid-century stringent mitigation (MS) scenarios. N denotes the number of countries with non-zero fossil fuel rent losses included in each comparison. Only countries with non-zero values are included to avoid artificially inflating correlation statistics through shared zero values across specifications. Correlations remain high for most fossil fuel types and scenarios, although larger deviations are observed for gas rent losses under early full reserve dependence, particularly in end-century scenarios.

Type	Period-Scenario	$\lambda_{2050} = 1$	$\lambda_{2075} = 1$	$\lambda_{2100} = 1$
coal	EM	$r=0.93$ $N=49$	$r=0.94$ $N=49$	$r=0.97$ $N=49$
	ES	$r=0.91$ $N=49$	$r=0.93$ $N=49$	$r=0.97$ $N=49$
	MM	$r=0.90$ $N=49$	$r=0.93$ $N=49$	$r=0.99$ $N=49$
	MS	$r=0.95$ $N=49$	$r=0.99$ $N=49$	$r=1$ $N=49$
gas	EM	$r=0.56$ $N=65$	$r=0.95$ $N=65$	$r=0.98$ $N=65$
	ES	$r=0.56$ $N=65$	$r=0.93$ $N=65$	$r=0.99$ $N=65$
	MM	$r=0.94$ $N=65$	$r=1$ $N=65$	$r=1$ $N=65$
	MS	$r=0.89$ $N=65$	$r=0.99$ $N=65$	$r=1$ $N=65$
oil	EM	$r=0.94$ $N=64$	$r=0.97$ $N=64$	$r=0.99$ $N=64$
	ES	$r=0.96$ $N=64$	$r=0.98$ $N=64$	$r=0.99$ $N=64$
	MM	$r=0.96$ $N=64$	$r=0.99$ $N=64$	$r=1$ $N=64$
	MS	$r=0.96$ $N=64$	$r=0.99$ $N=64$	$r=1$ $N=64$

S2. Climate damage functions and aggregation

S2.1. Avoided damage and aggregation

We estimate avoided climate damages using an ensemble of empirical damage functions linking temperature exposure to economic output, productivity, or GDP growth. We use reference GDP from the SSP2 socioeconomic pathway consistently across climate scenarios. The RCP scenarios vary climate exposure and estimated damages, while the GDP denominator is held fixed under the reference SSP2 pathway.

The avoided damage is defined as the difference in discounted damages between the baseline scenario, SSP2-RCP6.0, and two mitigation scenarios, SSP2-RCP4.5 and SSP2-RCP2.6. Results are expressed as a share of cumulative discounted reference GDP. For country i , climate model c , damage function f , scenario s , and discount rate ρ , the cumulative discounted damage is:

$$D_{i,c,f,s,\rho} = \sum_t \frac{y_{i,t}^0 \cdot pop_{i,t} - y_{i,c,f,t,s}^{cc} \cdot pop_{i,t}}{(1 + \rho)^{t-2020}}$$

where $y_{i,t}^0$ is GDP per capita along the reference SSP2 pathway and $y_{i,c,f,t,s}^{cc}$ is climate-affected GDP per capita estimated by damage function f under climate model c and scenario s . Avoided damage from mitigation scenario m is defined as the reduction in cumulative climate damages relative to the baseline scenario SSP2-RCP6.0, expressed as a share of cumulative discounted reference SSP2 GDP:

$$AD_{i,c,f,m,\rho} = \frac{D_{i,c,f,SSP2-RCP6.0,\rho} - D_{i,c,f,m,\rho}}{\sum_t \frac{GDP_{i,t}^{SSP2}}{(1 + \rho)^{t-2020}}}$$

where $m \in \{SSP2 - RCP4.5, SSP2 - RCP2.6\}$ and $GDP_{i,t}^{SSP2}$ is reference GDP from the SSP2 socioeconomic pathway. Positive values indicate avoided damage under mitigation.

S2.2. Damage functions

The damage functions differ in how temperature enters the economic projection. BHM and DJO are implemented as growth-based functions, where temperature affects the annual growth rate and GDP evolves recursively. Hope and Tol are implemented as level-based functions, where temperature affects annual GDP relative to the reference SSP2 pathway. Kalkuhl-Wenz is grouped with the level-based functions because it is implemented as a multiplicative adjustment to annual subnational GDP before aggregation to the country level, although its coefficients are estimated from annual changes in log gross regional product. These differences motivate treating damage-function choice as a separate source of uncertainty in the final aggregation.

Supplementary Table 9: Comparison of damage function specifications

Damage function	Type	Temperature input	Interpretation	Heterogeneity	Lag structure
BHM 0-lag	Growth	T_t	Effect of annual temperature on GDP growth	Rich/Poor	No lag
BHM 5-lag	Growth	T_t	Effect of annual temperature level on GDP growth, using 5-lag BHM coefficients	Rich/Poor	5-lag
DJO	Growth	$T_t - T_{t-1}$	Effect of annual temperature change on	Rich/Poor	Cumulative 5-lag coefficients

			GDP growth, using cumulative 5-lag DJO coefficients		applied to annual ΔT
Kalkuhl- Wenz	Level	$T_{t-1}, \Delta T_t, \Delta T_{t-1}$	Effect of annual temperature changes on the subnational output path, conditional on lagged temperature level	None	Annual panel model with contemporane- ous and one- year lagged ΔT
Tol	Level	$T_t - T^{base}$	Linear effect of warming relative to baseline on annual GDP level	None	No lag
Hope	Level	$T_t - T^{base}$	Piecewise effect of warming relative to baseline on annual GDP level	None	No lag

235 Unless otherwise stated in this section, temperature variables refer to population-weighted
236 annual mean temperature.

237 **BHM 0-Lag¹⁴**

238 The Burke-Hsiang-Miguel 0-lag damage function estimates the effect of annual temperature
239 on GDP growth using a quadratic temperature-growth response. For bootstrap draw r , the rich-
240 country response is:

$$241 \quad f_{rich}^0(T_{i,t}; \theta_r) = \beta_{1,r}^0 T_{i,t} + \beta_{2,r}^0 T_{i,t}^2$$

242 and the poor-country response is:

$$243 \quad f_{poor}^0(T_{i,t}; \theta_r) = (\beta_{1,r}^0 + \beta_{1p,r}^0) T_{i,t} + (\beta_{2,r}^0 + \beta_{2p,r}^0) T_{i,t}^2$$

244 Equivalently, let k denote the income group, where k is either rich or poor. The annual climate-
245 growth effect is measured relative to baseline temperature:

$$246 \quad g_{i,t}^{BHM0} = f_k^0(T_{i,t}; \theta_r) - f_k^0(T_i^{base}; \theta_r)$$

247 where $T_{i,t}$ is projected annual mean temperature, T_i^{base} is the 1985-2014 average historical
248 temperature for country, and θ_r is one of 1000 bootstrap parameter draws. Climate-affected
249 GDP per capita evolves recursively as:

$$250 \quad y_{i,t}^{cc} = y_{i,t-1}^{cc} (1 + g_{i,t}^0 + g_{i,t}^{BHM0})$$

251 where $g_{i,t}^0$ is the reference SSP2 GDP per capita growth rate. For each country, climate model,
252 and discounted rate, we first summarize the 1000 BHM 0-lag bootstrap draws by their median.
253 The resulting BHM 0-lag estimate is then combined with other damage functions in the final
254 aggregation

255 **BHM 5-Lag¹⁴**

256 Unlike the BHM 0-lag model, which uses same-year temperature to estimate contemporaneous
257 effects on economic growth, the BHM 5-lag model incorporates temperature exposure from
258 the current and previous five years. It therefore captures delayed or persistent economic
259 responses to temperature shocks. In the projection, we use the long-run temperature-growth
260 response from the 5-lag model. For bootstrap draw r , the long-run rich-country response is:

$$261 \quad f_{rich}^{LR}(T_{i,t}; \theta_r) = \beta_{1,r}^{LR} T_{i,t} + \beta_{2,r}^{LR} T_{i,t}^2$$

and the long-run poor-country response is:

$$f_{\text{poor}}^{LR}(T_{i,t}; \theta_r) = (\beta_{1,r}^{LR} + \beta_{1p,r}^{LR})T_{i,t} + (\beta_{2,r}^{LR} + \beta_{2p,r}^{LR})T_{i,t}^2$$

The annual climate-growth effect is:

$$g_{i,t}^{\text{BHM5}} = f_k^{LR}(T_{i,t}; \theta_r) - f_k^{LR}(T_i^{\text{base}}; \theta_r)$$

and climate-affected GDP per capita evolves recursively as:

$$y_{i,t}^{cc} = y_{i,t-1}^{cc}(1 + g_{i,t}^0 + g_{i,t}^{\text{BHM5}})$$

As with the 0-lag model, the 1000 bootstrap draws are summarized by their median for each country, climate model, and discount rate before aggregation with other damage functions.

DJO¹⁵

The Dell-Jones-Olken damage function estimates the effect of annual temperature changes on GDP growth. This differs from BHM, which relates the level of annual temperature to GDP growth and measures the effect relative to historical baseline temperature. DJO instead uses the change in temperature from the previous year:

$$\Delta T_{i,t} = T_{i,t} - T_{i,t-1}$$

We apply the cumulative 5-lag temperature coefficients reported by Dell, Jones, and Olken to this annual temperature change. The annual climate-growth effect is:

$$g_{i,t}^{\text{DJO}} = \begin{cases} -0.00191\Delta T_{i,t}, & \text{rich} \\ -0.01041\Delta T_{i,t}, & \text{poor} \end{cases}$$

Here, rich and poor countries are distinguished using the GDP per capita threshold from the DJO replication data. The coefficients correspond to cumulative 5-lag growth effects of -0.191% and -1.041% per 1 °C increase in annual temperature for rich and poor countries, respectively. Climate-affected GDP per capita evolves recursively as:

$$y_{i,t}^{cc} = y_{i,t-1}^{cc}(1 + g_{i,t}^0 + g_{i,t}^{\text{DJO}})$$

where $g_{i,t}^0$ is the reference SSP2 GDP per capita growth rate.

Kalkuhl-Wenz¹⁶

The Kalkuhl-Wenz specification is based on a subnational annual panel model in which the dependent variable is the annual change in log gross regional product. In our projection, we implement the preferred annual panel specification using contemporaneous and one-year lagged annual temperature changes, conditional on lagged annual temperature level. Although the coefficients are estimated from changes in log gross regional product, the effect is applied as a multiplicative adjustment to annual subnational GDP and then aggregated to the country level using population weights. Annual temperature change of subnational region a is defined as:

$$\Delta T_{a,t} = T_{a,t} - T_{a,t-1}$$

and the lagged annual temperature change is:

$$\Delta T_{a,t-1} = T_{a,t-1} - T_{a,t-2}$$

The Kalkuhl-Wenz productivity effect is:

$$\omega_{a,t}^{KW} = 0.00641\Delta T_{a,t} + 0.00345\Delta T_{a,t-1} - 0.00109T_{a,t-1}\Delta T_{a,t} - 0.000718T_{a,t-1}\Delta T_{a,t-1}$$

where $T_{a,t-1}$ is lagged annual mean temperature in subnational region a. The climate-affected GDP per capita is:

$$y_{a,t}^{cc} = y_{a,t-1}^{cc}(1 + g_{i,t}^0)(1 + \omega_{a,t}^{KW})$$

where $g_{i,t}^0$ is the reference SSP2 GDP per capita growth rate for country i. Subnational damages are then aggregated to the country level.

304 **Tol¹⁷**

The Tol's meta-analysis function is implemented as a GDP-level damage function using warming relative to historical baseline temperature. Annual temperature change of country i is defined as:

$$\Delta T_{i,t} = T_{i,t} - T_i^{base}$$

where T_i^{base} is the historical baseline temperature for country i. The Tol's meta-analysis damage function is:

$$\omega_{i,t}^{Tol} = -0.0141\Delta T_{i,t} + 0.0218, \quad \Delta T_{i,t} > 1.01$$

The climate affected GDP per capita is calculated as:

$$y_{i,t}^{cc} = y_{i,t}^0(1 + \omega_{i,t}^{Tol})$$

where $y_{i,t}^0$ is GDP per capita along the reference SSP2 pathway.

315 **Hope¹⁸**

The Hope's linear damage function applies a linear damage fraction to local warming relative to baseline temperature:

$$\Delta T_{i,t} = T_{i,t} - T_i^{base}$$

where T_i^{base} is the historical baseline temperature for country i. The Hope temperature effect is linear:

$$\omega_{i,t}^{Hope} = -0.0071\Delta T_{i,t}$$

The climate-affected GDP per capita path is calculated as:

$$y_{i,t}^{cc} = y_{i,t}^0(1 + \omega_{i,t}^{Hope})$$

where $y_{i,t}^0$ is GDP per capita along the reference SSP2 pathway.

325 **S2.3 Aggregation across climate models and damage functions**

Avoided damage $AD_{i,c,f,m,\rho}$, defined in Section S2.1, is calculated only for climate models that are available across all three climate scenarios, SSP2-RCP6.0, SSP2-RCP4.5, and SSP2-RCP2.6, so that mitigation effects are compared within matched climate-model realizations. For the BHM damage functions, the 1000 bootstrap parameter draws are first summarized by their median for each country i, climate model c, scenario s, and discount rate ρ . The resulting estimates are then aggregated together with the other damage functions.

We refer to the main aggregation method as the function median. Under this method, climate-model uncertainty is first summarized within each damage function:

$$\widetilde{AD}_{i,f,m,\rho} = \text{median}_c(AD_{i,c,f,m,\rho})$$

The main estimate, referred to as the function median, is then obtained as the median across damage functions:

$$AD_{i,m,\rho}^{\text{main}} = \text{median}_f(\widetilde{AD}_{i,f,m,\rho})$$

The function median is used as the main estimate because damage functions represent alternative empirical specifications of climate damages with different structural assumptions regarding the climate–economy relationship. This approach gives equal weight to each damage function. As a sensitivity analysis, we additionally report a pooled median across all climate-model and damage-function estimates.

S2.4 Sensitivity analysis

We further evaluate how the estimates at the end of the century and under stringent mitigation vary across aggregation choices and subsets of damage functions. The main estimate uses a two-step function-median aggregation, first summarizing climate-model estimates within each damage-function specification and then taking the median across damage functions. To assess sensitivity to the aggregation method and the choice of damage function, we report the following alternative estimates. Except for the pooled-median case, all estimates use the same two-step aggregation procedure within the selected damage-function subset:

- Main two-step function median
- Pooled median across all estimates (across the combinations of climate models and damage functions)
- Growth-based only (BHM 0-lag, BHM 5-lag, DJO)
- Level-based only (Hope, Tol, Kalkuhl-Wenz)
- Excluding BHM
- Excluding Kalkuhl-Wenz

Specification	P25	Median	P75	Negative share
Main: two-step function median	0.65	1.31	1.88	0%
Pooled median across all estimates	0.53	0.94	1.38	0%
Growth-based only	0.35	2.86	4.28	0%
Level-based only	0.62	0.81	1.09	0%
Excluding BHM	0.50	0.63	0.86	0%
Excluding Kalkuhl-Wenz	0.48	0.73	1.03	0%

Note: Values of P25, Median, and P75 are percentages of cumulative discounted GDP.

The sensitivity analysis shows that end-century avoided damages under stringent mitigation are positive across all countries and specifications. Growth-based functions produce larger

median and upper-quartile estimates than level functions, while excluding BHM or Kalkuhl-Wenz lowers the median and upper quartile. The lower quartile is smaller for the growth-based subset, indicating greater cross-country dispersion.

The main function-median estimate lies below the growth-only estimate but above the pooled-median and level-only estimates, indicating that the main result is not driven by any single damage-function family and remains broadly representative of the full set of damage-function specifications considered in this study.

S2.5. Potential overlap with other indicators

The climate-damage indicator uses reduced-form empirical damage functions to capture the aggregate macroeconomic consequences of temperature exposure. These functions do not identify specific causal channels, but their estimated effects may reflect climate impacts on agricultural production, labor productivity, health, energy demand, and other activities that influence GDP. The indicator should therefore be interpreted as a broad estimate of avoided macroeconomic damages rather than as a sector-specific physical damage measure.

The climate-damage indicator may conceptually overlap with other indicators where climate-sensitive factors that affect economic activity also influence estimated mitigation opportunities. However, overlap with the land carbon-sequestration indicator is limited. This indicator is derived from MAgPIE-LPJmL scenarios in which long-term climate-change effects on yields and other bioenergy constraints were held constant to isolate mitigation effects¹⁹. It therefore values mitigation-driven changes in land carbon stocks rather than avoided climate damages to land productivity.

Potential overlap with the renewable-energy mitigation indicator is model- and scenario-specific. This indicator is derived from outputs of REMIND-MAgPIE, GCAM-Demeter, and IMAGE, which differ in how they represent interactions among climate, land use, and energy systems. For example, in the GCAM-Demeter dataset, climate model projections are used to estimate water supply, changes in hydropower capacity, and building energy demand, while Demeter spatially downscales the resulting GCAM land-use projections²⁰. Climate-sensitive factors that affect economic activity may therefore also affect estimated renewable-energy mitigation potential in some scenarios. Nevertheless, the renewable-energy indicator values mitigation opportunities, whereas the climate-damage indicator estimates broad temperature-related macroeconomic damages.

Potential overlap with fossil-fuel rent loss is more limited because that indicator captures transition-related producer revenue losses rather than temperature-related economic damages. We report all indicators separately and do not sum them into a single aggregate benefit measure, thereby avoiding arithmetic double-counting.

S3. Panel efficiency and capacity factor calculations

S3.1. Panel efficiency calculation

The photovoltaic (PV) panel efficiency at a given grid cell i and year t is calculated as:

$$\eta_{PV,i,t} = 17\% \times (1 + \gamma[T_{i,t} - T_{STC}])$$

Where $T_{i,t}$ is the PV cell temperature, $T_{STC} = 25^{\circ}\text{C}$ represents the standard condition, and γ is the temperature coefficient of efficiency, reflecting the rate at which efficiency decreases with increasing temperature, which is $-0.005^{\circ}\text{C}^{-1}$ ²¹.

Then, The PV cell temperature $T_{i,t}$ is estimated as a function of ambient environmental conditions using the following empirical equation:

$$T_{i,t} = c_1 + c_2 \cdot tas_{i,t} + c_3 \cdot rsds_{i,t} + c_4 \cdot vws_{i,t}$$

Where $tas_{i,t}$, $rsds_{i,t}$, $vws_{i,t}$ are ambient temperature, solar irradiation, wind speed (10m height), respectively, which can be derived from climate model datasets. The coefficients used in the temperature model are: $c_1=4.3^\circ\text{C}$, $c_2=0.943$, $c_3=0.028^\circ\text{C m}^2 \text{W}^{-1}$ and $c_4=-1.528^\circ\text{C sm}^{-1,22}$.

S3.2. CF calculation method

To calculate the capacity factor (CF), a Weibull distribution function is employed to estimate the wind speed distribution over the course of a year. The probability of wind turbine operation within a specific wind speed range is determined using the cumulative Weibull distribution function:

$$P(v_c < v < v_f) = \exp[-(v_c/c)^k] - \exp[-(v_f/c)^k]$$

$$c = v \times (0.568 + 0.433/k)^{-\frac{1}{k}}$$

where $P(v_c < v < v_f)$ denotes the operation probability of a turbine; v_c is the cut in speed; v_f is the cut out speed; c and k are the Weibull scale parameter and shape parameter, respectively; In this study, the hub height is set as 100m and the wind speed at 100m height can be estimated according to the surface wind speed data from CMIP 6:

$$v = v_{ref} \times (H/H_{ref})^\alpha$$

Subsequently, CF is derived from the probability distribution functions of wind turbine operation²³,

$$CF = \frac{\exp\left(-\left(\frac{v_c}{c}\right)^k\right) - \exp\left(-\left(\frac{v_r}{c}\right)^k\right)}{\left(\frac{v_r}{c}\right)^k - \left(\frac{v_c}{c}\right)^k} - \exp\left(-\left(\frac{v_f}{c}\right)^k\right)$$

where v_c , v_r , and v_f denote the cut-in wind speed (4 m/s), rated wind speed (13 m/s), and cut-out wind speed (25 m/s), respectively. The parameter k is the shape factor of the Weibull distribution, set to $k=2^1$, while c is the scale factor, calculated from the mean wind speed v and the shape parameter k . Together, these parameters characterize the wind speed distribution, which forms the basis for estimating the capacity factor. This formulation integrates the probabilistic characteristics of wind speed distributions with turbine operating parameters, enabling the estimation of capacity factor (CF) as a measure of expected energy generation under varying wind conditions.

S4. Sensitivity analysis of country clustering

S4.1. Sensitivity to cluster numbers

Sensitivity analyses of the number of clusters are shown in Supplementary Table 10 and Supplementary Fig. 9. The $k = 5$ solution does not correspond to a sharp elbow in terms of within-cluster sum of squares (WSS), but rather to a smoother point of diminishing returns. The selection of $k = 5$ is therefore primarily guided by interpretability and the ability to identify meaningful mitigation-asset archetypes.

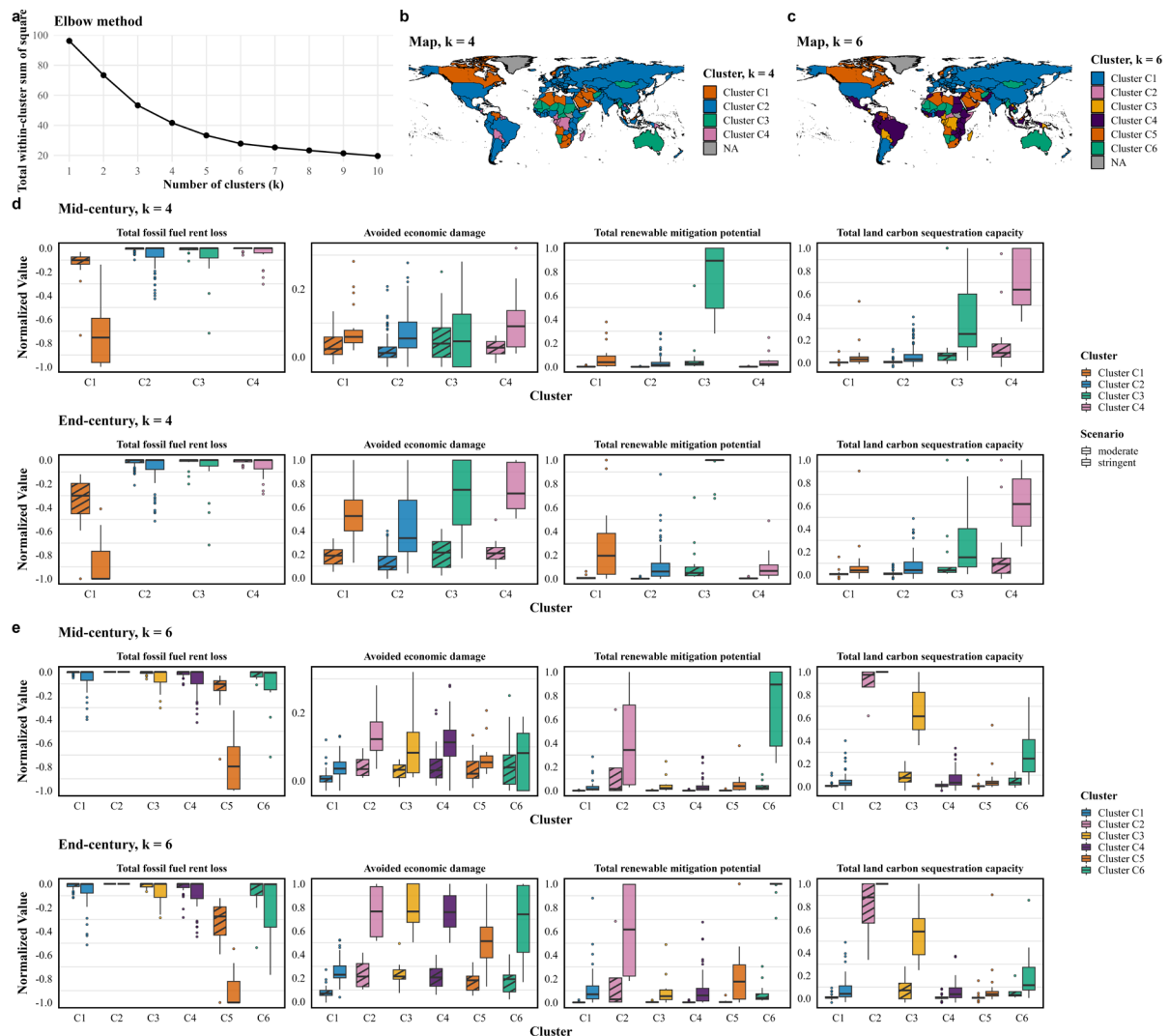
We additionally evaluated the Silhouette Coefficient, which is maximized at $k = 4$. However, the $k = 4$ solution produces a highly imbalanced clustering structure, with 116 countries grouped into a single cluster, effectively separating only a few extreme cases from a large central group. In addition, $k = 4$ explains only approximately 56.7% of the total variance. The $k = 5$ solution substantially increases the explained variance and separates the large central group into more distinct and policy-relevant categories. Increasing the number of clusters further does not reveal additional broadly representative mitigation-asset groups; instead, the $k = 6$ and $k = 7$ solutions produce several very small clusters, indicating increasing fragmentation.

Comparison between the $k = 4$ and $k = 5$ solutions further shows that ADE countries merge into the moderate-impact economy (MIE) group when $k = 4$. This pattern likely reflects the underlying structure of the data: climate damages are relatively more evenly distributed across countries, whereas fossil fuel dependence, renewable potential, and carbon sequestration capacity are substantially more uneven. As a result, distance-based clustering criteria tend to emphasize strongly differentiated resource dimensions, while distinctions driven primarily by avoided damages are less pronounced in geometric terms.

Because the objective of this study is to identify economically meaningful and policy-relevant country groups, rather than maximize geometric separation alone, we retain the $k = 5$ solution as a more balanced and informative representation of mitigation-asset heterogeneity across countries.

Supplementary Table 10: Sensitivity of clustering diagnostics to the number of clusters (k). The table reports within-cluster sum of squares (WSS), the ratio of between-cluster to total sum of squares (B/T ratio), average Silhouette Coefficient values, and cluster sizes for k-means solutions with $k = 4$ –7. Increasing k improves the proportion of explained variance (B/T ratio) but also leads to increasingly fragmented cluster structures. While the silhouette score is highest for $k = 4$, this solution groups 116 countries into a single cluster. The $k = 5$ solution provides a more balanced and interpretable partition of mitigation-asset profiles across countries.

k	WSS	B/T ratio	Silhouette score	Cluster sizes
4	41.7	0.567	0.456	15, 18, 116, 20
5	33.3	0.653	0.376	17, 13, 51, 69, 19
6	27.9	0.710	0.389	13, 69, 4, 18, 49, 16
7	25.3	0.737	0.394	6, 4, 50, 17, 8, 16, 68



Supplementary Figure 9: Comparison of clustering structures under different numbers of clusters. **a**, Elbow plot showing the total within-cluster sum of squares for k-means solutions from k = 1 to k = 10. **b**, **c**, Spatial distribution of country clusters for k = 4 and k = 6, respectively. **d**, **e**, Distributions of normalized indicators across clusters for mid-century and end-century outcomes under moderate and stringent scenarios for k = 4 and k = 6, respectively. Alternative solutions are labeled using neutral cluster identifiers (C1, C2, etc.). Colors are used consistently within each alternative solution and are aligned, where possible, with the closest corresponding k = 5 cluster based on country overlap. Based on country overlap and boxplot profiles relative to the main k = 5 solution, the k = 4 clusters approximately correspond to REE-like (C1), CSE-like (C2), MIE-like (C3), and FFE-like (C4) groups, while the k = 6 clusters approximately correspond to REE-like (C1), MIE-like (C2), CSE-like (C3), FFE-like (C4), ADE-like (C5), and ADE/CSE-like (C6) groups. In box plots, centre lines denote medians, box bounds denote the 25th and 75th percentiles, whiskers extend to the most extreme values within 1.5 times the interquartile range, and points outside this range are shown individually. Each data point represents one independent country-level observation. In **d**, sample sizes are fixed across period–scenario combinations within each cluster: C1, n = 20; C2, n = 116; C3, n = 18; and C4, n = 15 countries. In **e**, sample sizes are fixed across period–scenario combinations within each cluster: C1, n = 69; C2, n = 16; C3, n = 4; C4, n = 49; C5, n = 18; and C6, n = 13 countries. These approximate correspondences do not imply one-to-one equivalence with the k = 5 clusters. These results are used as sensitivity checks rather than as the primary classification. Country boundaries are from GADM version 3.6 (<https://gadm.org>).

S4.2. Boundary countries

To further characterize relationships among mitigation-asset groups, we identified each country's second-nearest cluster based on distances to the cluster centroids in the k-means solution. We then calculated the centroid-distance margin as the distance to the second-nearest centroid minus the distance to the country's assigned centroid. Smaller margins indicate that a country lies closer to the boundary between clusters and therefore exhibits a more mixed mitigation-asset profile. Each country's second-nearest cluster and centroid-distance margin are reported in Supplementary Data 3.

As an illustrative diagnostic, Supplementary Table 11 reports the 20% of countries with the smallest centroid-distance margins. This threshold is not intended as a strict classification criterion, but rather to characterize transitional cases within the continuous multidimensional structure of the data.

Most countries with relatively small centroid-distance margins occur between the avoided-damage economy (ADE) and moderate-impact economy (MIE) clusters. This suggests that countries mainly differentiated by avoided damages tend to be more similar to each other, while dimensions such as fossil fuel dependence or renewable resource potential create clearer separations between mitigation-asset groups.

Supplementary Table 11: Boundary countries and alternative cluster proximity in the k-means clustering solution. The table reports countries with the smallest centroid-distance margins (lowest 20%) in the k-means clustering solution. For each country, the assigned cluster, second-nearest cluster, assigned centroid distance, second-nearest centroid distance, and the resulting distance margin are shown. Smaller distance margins indicate countries located near transitions between broader mitigation-asset archetypes and therefore exhibiting mixed mitigation-asset characteristics. The threshold is illustrative rather than definitive and is intended to characterize transitional cases within the continuous multidimensional mitigation-asset space.

ISO3	Assigned cluster	Second-nearest cluster	Assigned distance	Second-nearest distance	Distance margin
DOM	ADE	MIE	0,33	0,34	0,01
ISR	ADE	MIE	0,33	0,35	0,02
JAM	MIE	ADE	0,31	0,33	0,02
BHS	MIE	ADE	0,34	0,37	0,03
LBN	MIE	ADE	0,34	0,37	0,03
MEX	ADE	MIE	0,31	0,36	0,05
PAK	ADE	MIE	0,42	0,46	0,05
PER	ADE	MIE	0,45	0,49	0,05
VNM	MIE	ADE	0,56	0,61	0,05
CUB	ADE	MIE	0,28	0,36	0,08
GNB	ADE	MIE	0,56	0,64	0,08

ISO3	Assigned cluster	Second-nearest cluster	Assigned distance	Second-nearest distance	Distance margin
IDN	ADE	MIE	0,48	0,57	0,08
BDI	ADE	CSE	0,52	0,61	0,09
ECU	ADE	MIE	0,52	0,61	0,09
RUS	MIE	FFE	0,75	0,84	0,09
LBR	CSE	ADE	0,55	0,65	0,1
KHM	ADE	REE	0,67	0,79	0,12
THA	ADE	MIE	0,31	0,43	0,12
PAN	ADE	MIE	0,26	0,39	0,13
SEN	MIE	ADE	0,26	0,39	0,13
WSM	MIE	ADE	0,48	0,6	0,13
NIC	CSE	ADE	0,51	0,65	0,14
BWA	FFE	REE	0,98	1,12	0,15
DZA	FFE	ADE	0,56	0,72	0,15
NCL	MIE	ADE	0,31	0,46	0,15
BRA	ADE	MIE	0,42	0,58	0,17
KAZ	MIE	FFE	0,71	0,88	0,17
USA	MIE	ADE	0,38	0,56	0,18
CAF	REE	CSE	1,28	1,47	0,19
LAO	CSE	ADE	0,64	0,83	0,19
AUS	REE	FFE	0,84	1,04	0,2
CRI	ADE	MIE	0,25	0,45	0,2
ZWE	ADE	FFE	0,76	0,95	0,2
PSE	ADE	MIE	0,25	0,46	0,21

Note: Countries are identified using ISO 3166-1 alpha-3 codes. Corresponding names are provided in Supplementary Table 5.

S4.3. Alternative clustering approach - Hierarchical clustering

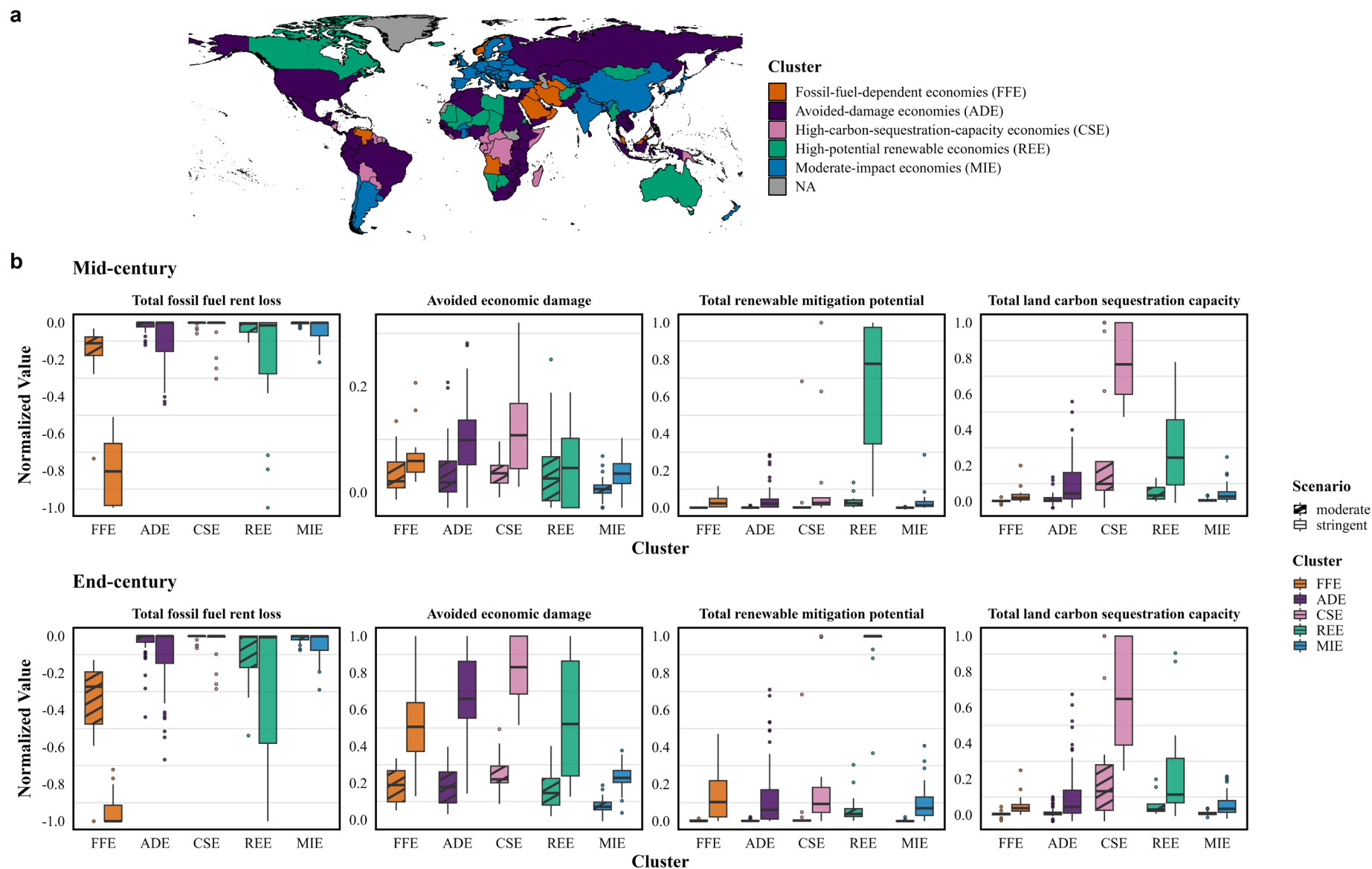
As an alternative clustering approach, we applied hierarchical clustering using Ward's method (Supplementary Fig. 10). The resulting spatial patterns and cluster profiles are broadly consistent with the k-means classification, with 146 out of 169 countries (86.4%) assigned to

the same cluster across the two methods. Supplementary Table 12 reports the 23 countries assigned to different clusters under the two approaches.

To interpret these differences, we examined each country's second-nearest cluster in the k-means solution, based on distances to the k-means centroids. Among the 23 countries assigned to different clusters by hierarchical clustering, 19 correspond to their second-nearest k-means cluster. This indicates that most discrepancies reflect alternative placements of boundary countries among nearby mitigation-asset groups, rather than fundamentally different clustering structures.

The two methods also reflect different clustering philosophies. Hierarchical clustering constructs nested groupings based on pairwise similarities, whereas k-means partitions countries around global centroids in the multidimensional mitigation-asset space. For comparability, cluster names in the hierarchical solution were assigned according to the closest corresponding k-means groups. However, the hierarchical solution produces less clearly separated group characteristics in some cases, particularly by assigning many countries classified as moderate-impact economies (MIE) under k-means to the avoided-damage economy (ADE) group. This broadens the ADE group and weakens the distinction between countries primarily characterized by avoided damages and those with more mixed mitigation-asset profiles.

Given the objective of this study to identify broad, economically meaningful, and policy-relevant mitigation-asset groups at the global scale, we use the k-means solution with $k = 5$ as the primary classification framework, while using the hierarchical clustering results as a robustness check.



545

546 **Supplementary Fig. 10: Comparison between k-means and hierarchical clustering.** Hierarchical clustering was implemented using Ward's
 547 method with five clusters. Cluster names in the hierarchical solution were assigned according to the closest corresponding k-means k = 5 groups to
 548 enable comparison. **a**, Spatial distribution of hierarchical clusters. Country boundaries are from GADM version 3.6 (<https://gadm.org>). **b**, Distributions
 549 of normalized indicators across hierarchical clusters for mid-century and end-century outcomes under moderate and stringent scenarios. Colors

550 correspond to the five main k-means cluster labels. In **b**, centre lines denote medians, box bounds denote the 25th and 75th percentiles, whiskers extend
551 to the most extreme values within 1.5 times the interquartile range, and points outside this range are shown individually. Each data point represents
552 one independent country-level observation. Sample sizes are fixed across period–scenario combinations within each cluster: FFE, $n = 14$; ADE, $n =$
553 66; CSE, $n = 17$; REE, $n = 15$; and MIE, $n = 57$ countries.

Supplementary Table 12: Countries assigned to different clusters by k-means and hierarchical clustering. The table reports the 23 countries whose hierarchical Ward's-method cluster assignment differs from their k-means $k = 5$ assignment. For each country, the table shows the k-means cluster, the hierarchical cluster, and whether the hierarchical assignment corresponds to the country's second-nearest k-means cluster based on distances to k-means centroids. A "yes" indicates that the discrepancy reflects reassignment to a nearby alternative cluster in the k-means solution.

ISO3	K-means cluster	Hierarchical cluster	Matches the second-nearest k-means cluster
BDI	ADE	CSE	yes
FJI	CSE	ADE	yes
LAO	CSE	ADE	yes
SLB	CSE	ADE	yes
DZA	FFE	ADE	yes
ZAF	FFE	ADE	yes
BWA	FFE	REE	yes
CAN	FFE	REE	no
LBY	FFE	REE	yes
BHS	MIE	ADE	yes
JAM	MIE	ADE	yes
KAZ	MIE	ADE	no
KGZ	MIE	ADE	yes
LBN	MIE	ADE	yes
NCL	MIE	ADE	yes
RUS	MIE	ADE	no
SEN	MIE	ADE	yes
USA	MIE	ADE	yes
VNM	MIE	ADE	yes
WSM	MIE	ADE	yes
ISL	MIE	REE	no
CAF	REE	CSE	yes

ISO3	K-means cluster	Hierarchical cluster	Matches the second-nearest k-means cluster
SOM	REE	CSE	yes

Note: Countries are identified using ISO 3166-1 alpha-3 codes. Corresponding names are provided in Supplementary Table 5.

S5. Cross-cluster nearest-asset-counterpart relationships

To further assess the relationship between the cluster typology and the similarity analysis, we examined countries whose closest counterpart belongs to a different k-means cluster. Across all 169 countries, 146 (86.4%) have their closest counterpart within the same cluster. The remaining 23 countries exhibit cross-cluster nearest- asset-counterpart relationships.

For each of these 23 countries, Supplementary Table 13 reports the assigned k-means cluster, the closest counterpart and its cluster, the country's second-nearest k-means cluster, and the hierarchical clustering assignment. For 18 of the 23 countries (78.3%), the closest counterpart belongs to the country's second-nearest k-means cluster. This indicates that most cross-cluster nearest-asset-counterpart relationships occur between neighboring asset-profile types rather than between fundamentally different groups.

The countries identified through the nearest-asset-counterpart analysis only partially overlap with those reassigned under hierarchical clustering, suggesting that the two approaches capture complementary aspects of cluster uncertainty. Nevertheless, both analyses consistently indicate that uncertainty is concentrated in a limited subset of countries located near transitions between broad asset-profile types.

579 **Supplementary Table 13:** Countries whose closest climate-asset counterpart belongs to a different cluster.

Country	K-means cluster	Closest asset-profile counterpart	Similarity coefficient	Counterpart cluster	Second-nearest k-means cluster	Counterpart in second-nearest cluster?	Hierarchical cluster
BDI	ADE	VUT	0,7	CSE	CSE	yes	CSE
DOM	ADE	JAM	0,9	MIE	MIE	yes	ADE
IDN	ADE	CHN	0,6	MIE	MIE	yes	ADE
MOZ	ADE	ZAF	0,48	FFE	MIE	no	ADE
PAK	ADE	BGD	0,68	MIE	MIE	yes	ADE
PAN	ADE	JAM	0,9	MIE	MIE	yes	ADE
ZWE	ADE	BWA	0,47	FFE	FFE	yes	ADE
BOL	CSE	PER	0,52	ADE	ADE	yes	CSE
LAO	CSE	KAZ	0,45	MIE	ADE	no	ADE
MDG	CSE	ETH	0,65	ADE	ADE	yes	CSE
SLB	CSE	NCL	0,45	MIE	ADE	no	ADE
BWA	FFE	AUS	0,51	REE	REE	yes	REE
ZAF	FFE	SRB	0,53	MIE	ADE	no	ADE
BHS	MIE	KEN	0,69	ADE	ADE	yes	ADE
JAM	MIE	DOM	0,9	ADE	ADE	yes	ADE

Country	K-means cluster	Closest asset-profile counterpart	Similarity coefficient	Counterpart cluster	Second-nearest k-means cluster	Counterpart in second-nearest cluster?	Hierarchical cluster
NCL	MIE	SLB	0,45	CSE	ADE	no	ADE
NPL	MIE	PAK	0,65	ADE	ADE	yes	MIE
RUS	MIE	AZE	0,5	FFE	FFE	yes	ADE
USA	MIE	MEX	0,73	ADE	ADE	yes	ADE
VNM	MIE	THA	0,65	ADE	ADE	yes	ADE
AUS	REE	BWA	0,51	FFE	FFE	yes	REE
BTN	REE	NPL	0,55	MIE	MIE	yes	REE
MMR	REE	ARG	0,48	MIE	MIE	yes	REE

Note: Countries are identified using ISO 3166-1 alpha-3 codes. Corresponding names are provided in Supplementary Table 5.

S6. Alternative climate-asset counterparts under additional comparability constraints

The main analysis identifies counterparts solely based on climate-asset profiles. Supplementary Table 14 reports alternative counterparts for the representative countries shown in Fig. 3 after additionally constraining comparisons by GDP, population, or geographic region. These counterparts complement the main similarity analysis by identifying countries that share similar climate-asset profiles and exhibit comparable economic size, population, or geographic proximity.

Supplementary Table 14: Alternative climate-asset counterparts under GDP-, population-, and region-constrained comparisons. GDP- and population-constrained counterparts are identified among countries whose GDP or population lies between one-third and three times that of the focal country. Region-constrained counterparts are identified among countries belonging to the same AR6 R5 world region: OECD and EU countries, Reforming Economies of Eastern Europe and the Former Soviet Union, Asia excluding Japan, Latin America and the Caribbean, and Middle East and Africa.

Representative country	Main climate-asset counterpart	GDP ^a -constrained counterpart	Population-constrained counterpart	Region-constrained counterpart
AUS	BWA (0.51)	IDN (0.39)	KAZ (0.42)	SRB (0.43)
BRA	PER (0.73)	MEX (0.65)	MEX (0.65)	PER (0.73)
CHN	BIH (0.75)	USA (0.51)	IND (0.73)	IND (0.73)
DEU	SVN (0.92)	TUR (0.89)	TUR (0.89)	SVN (0.92)
IND	BGR (0.76)	TUR (0.63)	CHN (0.73)	CHN (0.73)
MEX	DOM (0.77)	EGY (0.73)	USA (0.73)	DOM (0.77)
NGA	MEX (0.72)	MEX (0.72)	MEX (0.72)	EGY (0.71)
RUS	AZE (0.5)	ARG (0.46)	USA (0.49)	AZE (0.5)
SAU	IRQ (0.79)	MYS (0.61)	IRQ (0.79)	IRQ (0.79)
USA	MEX (0.73)	CHN (0.51)	MEX (0.73)	ALB (0.68)

Note: Countries are identified using ISO 3166-1 alpha-3 codes. Corresponding names are provided in Supplementary Table 5.

S7. Climate policy ambition scores

We gather data of 6 country-level climate policy rating scores. The 6 policy scores are:

NDC ambition score: we replicate the ambition score of Nationally Determined Contribution (NDC) from ²⁴. The score was originally developed by ²⁵. The score assesses the implied warming if all countries had the ambition of the respective country in the NDCs, but inverted so that a higher score means a higher ambition. Underlying the assessment of ambition are some normative principles, reducing the objectivity of the measure.

CCPI score: we use the Climate Policy indicator by the Climate Change Performance Indicator (CCPI; page 15 of ²⁶). The indicator rates national and international climate policy by country, based on expert interviews.

CAPMF – 3 sub indicators: we use the policy stringency scores for ETS - Electricity, Carbon Tax – Electricity and Nationally Determined Contributions for the year 2022 from the CAPMF

database^{27,28}. The scores rate by policy type stringency on a scale from 0 to 10, where 0 means the policy is not implemented and 10 means the policy is among the top 10 most ambitious policies. We choose the two carbon pricing policies because their stringency is readily comparable between countries and the policy is widely adopted. We also choose the stringency of the Nationally Determined contributions because these better reflect a country's geopolitical position on climate change.

Climate Action Tracker: we convert the ordered assessment of climate policy from the Climate Action Tracker²⁹ of “Critically Insufficient, Highly Insufficient, Insufficient, Almost Sufficient, 1.5°C Compatible” to a numerical scale from 1 to 5 (5 =1.5°C Compatible). The Climate Action Tracker score includes ratings of country's climate policies, targets, fair share of their target and climate finance contributions.

First, we perform a cross-country OLS regression of the 6 climate policy ambition or stringency scores and the four broad asset categories of the main analysis.

The NDC ambition score has the widest overlap with our dataset (157 countries) such that testing a statistical relationship between our four asset indicators and climate policy ambition is more appropriate. In addition, understanding climate policy ambition as what countries pledge in their NDCs fits the purpose of our study as we analyze the geopolitical consequences of the low-carbon transition, making international policy positions important. Thus, we test both moderate and stringent climate change mitigation scenarios and mid- and end-century values of the four asset categories. We find the expected statistical relationship whenever there is statistical significance (Supplementary Table 15). Relationships are most robust for fossil fuel losses and less so for avoided damages, while support is less strong for carbon sequestration potential. For renewable energy's mitigation potential, we do not find support for the expected direction, but we also do not find evidence for a relationship of the opposite sign.

For the other three databases, coverage is much lower and biased toward high-income countries such that testing statistical relationships is less robust. Statistical significance is mostly lacking. One notable observation is that countries with higher avoided damages are negatively correlated with policy stringency within Emission Trading Schemes (ETS). This could be due to this indicator rating the stringency of only one of the possible climate policies that countries implement. A country with a low stringency within its ETS, or a non-existing ETS, might show large stringency in another policy (e.g. renewable energy support scheme).

639 **Supplementary Table 15: Cross-country regression analysis.** Explanatory variables are the four broad asset categories, with the indicator at end of
640 the century and under the stringent mitigation scenario (ES); unless indicated as mid century - moderate mitigation (MM), mid century - stringent
641 mitigation (MS) or end century - moderate mitigation (EM). Dependent variables are the four policy databases, with the CAPMF data being the
642 Emissions Trading Scheme (ETS), Carbon Tax (CT) or NDC policy stringency scores.

	NDC score				CCPI score	CAPMF policy stringency			Climate Action Tracker rating
	ES	MS	EM	MM	(1)	ETS	CT	NDC	(1)
Ren. energy mit. pot.	0.143 (0.376)	0.772 (0.545)	1.378 (2.169)	0.135 (2.545)	-0.379 (4.018)	-0.696 (2.608)	-2.077 (2.174)	0.243 (0.820)	1.023 (0.809)
FF rent loss	2.334*** (0.355)	2.645*** (0.461)	4.754*** (0.861)	7.312*** (1.738)	3.970 (2.449)	1.772 (2.206)	-0.931 (1.840)	2.584*** (0.694)	1.571* (0.605)
Carbon seq. pot.	-0.080 (0.415)	1.251** (0.461)	-0.481 (1.011)	1.063 (0.979)	-0.970 (4.472)	-0.722 (3.482)	2.219 (2.904)	2.557* (1.095)	0.075 (1.053)
Avoided damage	2.426*** (0.365)	1.996 (1.727)	4.856*** (1.132)	8.813** (2.718)	3.705 (3.065)	-16.674*** (3.237)	3.143 (2.699)	-0.853 (1.018)	0.996 (0.723)
Intercept	1.231*** (0.226)	2.065*** (0.194)	1.680*** (0.210)	2.043*** (0.147)	8.981*** (1.277)	11.332*** (1.086)	0.196 (0.905)	7.754*** (0.341)	2.443*** (0.449)
Num.Obs.	157	157	157	157	61	48	48	48	38
R2	0.397	0.249	0.246	0.163	0.080	0.452	0.088	0.319	0.228
R2 Adj.	0.381	0.229	0.226	0.141	0.014	0.401	0.003	0.255	0.135

Note: Fossil fuel rent losses are expressed as negative values; therefore, a positive coefficient indicates that larger fossil fuel rent losses are associated with lower climate policy ambition. * p < 0.05, ** p < 0.01, *** p < 0.001

643

Second, Supplementary Table 16 shows the average rating of the 6 policy stringency/ambition scores by the 5 cluster. Except for the NDC ambition score, differences in the averages between clusters need to sometimes be interpreted with caution as the number of countries that are in a cluster and have a climate policy ambition/stringency score are relatively low.

Comparing the averages when at least 4 observations are present, we mostly find expected results. For the NDC, CCPI, CAPMF-NDC and CAT data, the FFE cluster rates lowest, followed by the MIE cluster. The ADE cluster rates highest, while the CSE and REE clusters also show high climate policy ambition/stringency. However, the average policy ambition score of the CAPMF database for the specific climate policies of a carbon tax and Emissions Trading scheme are higher for the FFE cluster - albeit with only 4 observations - and the ADE cluster rates low (with 6 observations). Since these are specific climate policies and countries may be ambitious using other policies, we refrain from over-interpreting this finding.

Supplementary Table 16: Average policy score by cluster. Policy scores are from the four policy databases, with the CAPMF data being the Emissions Trading Scheme (ETS), Carbon Tax (CT) or NDC policy stringency scores. The number N indicates the number of countries for which we and the respective policy databases provide data.

NDC			CCPI		CAPMF				CAT	
Cluster	Avg	N	Avg	N	ETS	Carbon Tax	NDC	N	Avg	N
ADE	3.18	48	11.69	11	0.50	1.67	7.61	6	3.07	15
CSE	2.97	17		0				0		0
FFE	0.39	17	7.03	7	4.62	3.25	5.75	4	2.20	5
MIE	1.51	64	9.16	42	7.45	0.86	7.51	37	2.31	16
REE	2.88	11	7.84	1	0.00	0.00	8.33	1	3.50	2

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