Supplementary Information

Supplementary Tables

Supplementary Table 1. Aggregated regional classifications and AIM-Hub native regions

Native Region Code	Native Region Name	R5 classification	Developed/ developing
USA	USA	R5OECD90+EU	Developed
XE25	EU	R5OECD90+EU	Developed
XER	Rest of Europe	R5OECD90+EU	Developed
TUR	Turkey	R5OECD90+EU	Developed
XOC	New Zealand and Australia	R5OECD90+EU	Developed
CHN	China	R5ASIA	Developing
IND	India	R5ASIA	Developing
JPN	Japan	R5OECD90+EU	Developed
XSE	Rest of East and South East Asia	R5ASIA	Developing
XSA	Rest of Asia	R5ASIA	Developing
CAN	Canada	R5OECD90+EU	Developed
BRA	Brazil	R5LAM	Developing
XLM	Rest of Latin America	R5LAM	Developing
CIS	Former USSR	R5REF	Developing
XME	Middle East	R5MAF	Developing
XNF	North Africa	R5MAF	Developing
XAF	Other Africa	R5MAF	Developing

Supplementary Table 2. AIM-Hub native region definition

Native Region Name	AIM region code	ISO Code	Country
Rest of Latin America	XLM	ABW	Aruba
Rest of Asia	XSA	AFG	Afghanistan
Other Africa	XAF	AGO	Angola
Rest of Latin America	XLM	AIA	Anguilla
Rest of Europe	XER	ALB	Albania
Rest of Europe	XER	AND	Andorra
Rest of Latin America	XLM	ANT	Netherlands Antilles

Middle East	XME	ARE	United Arab Emirates
Rest of Latin America	XLM	ARG	Argentina
Former USSR	CIS	ARM	Armenia
Rest of Asia	XSA	ASM	American Samoa
Rest of Asia	XSA	ATF	French Southern Territories
Rest of Latin America	XLM	ATG	Antigua and Barbuda
New Zealand and Australia	XOC	AUS	Australia
EU	XE25	AUT	Austria
Former USSR	CIS	AZE	Azerbaijan
Other Africa	XAF	BDI	Burundi
EU	XE25	BEL	Belgium
Other Africa	XAF	BEN	Benin
Other Africa	XAF	BFA	Burkina Faso
Rest of Asia	XSA	BGD	Bangladesh
Rest of Europe	XER	BGR	Bulgaria
Middle East	XME	BHR	Bahrain
Rest of Latin America	XLM	BHS	Bahamas
Rest of Europe	XER	BIH	Bosnia and Herzegovina
Former USSR	CIS	BLR	Belarus
Rest of Latin America	XLM	BLZ	Belize
Rest of Latin America	XLM	BMU	Bermuda
Rest of Latin America	XLM	BOL	Bolivia, Plurinational State of
Brazil	BRA	BRA	Brazil
Rest of Latin America	XLM	BRB	Barbados
Rest of Asia	XSA	BRN	Brunei Darussalam
Rest of Asia	XSA	BTN	Bhutan
Rest of Latin America	XLM	BVT	Bouvet Island
Other Africa	XAF	BWA	Botswana
Other Africa	XAF	CAF	Central African Republic
Canada	CAN	CAN	Canada
Rest of Asia	XSA	CCK	Cocos (Keeling) Islands
Rest of Europe	XER	CHE	Switzerland
Rest of Latin America	XLM	CHL	Chile
China	CHN	CHN	China
Other Africa	XAF	CIV	Côte d'Ivoire

Other Africa	XAF	CMR	Cameroon
Other Africa	XAF	COD	Congo, the Democratic Republic of the
Other Africa	XAF	COG	Congo
Rest of Asia	XSA	COK	Cook Islands
Rest of Latin America	XLM	COL	Colombia
Other Africa	XAF	COM	Comoros
Other Africa	XAF	CPV	Cape Verde
Rest of Latin America	XLM	CRI	Costa Rica
Rest of Latin America	XLM	CUB	Cuba
Rest of Asia	XSA	CXR	Christmas Island
Rest of Latin America	XLM	CYM	Cayman Islands
EU	XE25	CYP	Cyprus
EU	XE25	CZE	Czech Republic
EU	XE25	DEU	Germany
Other Africa	XAF	DJI	Djibouti
Rest of Latin America	XLM	DMA	Dominica
EU	XE25	DNK	Denmark
Rest of Latin America	XLM	DOM	Dominican Republic
North Africa	XNF	DZA	Algeria
Rest of Latin America	XLM	ECU	Ecuador
North Africa	XNF	EGY	Egypt
Other Africa	XAF	ERI	Eritrea
Other Africa	XAF	ESH	Western Sahara
EU	XE25	ESP	Spain
EU	XE25	EST	Estonia
Other Africa	XAF	ETH	Ethiopia
EU	XE25	FIN	Finland
Rest of Asia	XSA	FJI	Fiji
Rest of Latin America	XLM	FLK	Falkland Islands (Malvinas)
EU	XE25	FRA	France
Rest of Europe	XER	FRO	Faroe Islands
Rest of Asia	XSA	FSM	Micronesia, Federated States of
Other Africa	XAF	GAB	Gabon
EU	XE25	GBR	United Kingdom
Former USSR	CIS	GEO	Georgia

Other Africa	XAF	GHA	Ghana
Rest of Europe	XER	GIB	Gibraltar
Other Africa	XAF	GIN	Guinea
Rest of Latin America	XLM	GLP	Guadeloupe
Other Africa	XAF	GMB	Gambia
Other Africa	XAF	GNB	Guinea-Bissau
Other Africa	XAF	GNQ	Equatorial Guinea
EU	XE25	GRC	Greece
Rest of Latin America	XLM	GRD	Grenada
Rest of Latin America	XLM	GRL	Greenland
Rest of Latin America	XLM	GTM	Guatemala
Rest of Latin America	XLM	GUF	French Guiana
Rest of Asia	XSA	GUM	Guam
Rest of Latin America	XLM	GUY	Guyana
China	CHN	HKG	Hong Kong
Rest of Asia	XSA	HMD	Heard Island and McDonald Islands
Rest of Latin America	XLM	HND	Honduras
Rest of Europe	XER	HRV	Croatia
Rest of Latin America	XLM	HTI	Haiti
EU	XE25	HUN	Hungary
Rest of East and South East Asia	XSE	IDN	Indonesia
India	IND	IND	India
Rest of Asia	XSA	IOT	British Indian Ocean Territory
EU	XE25	IRL	Ireland
Middle East	XME	IRN	Iran, Islamic Republic of
Middle East	XME	IRQ	Iraq
Rest of Europe	XER	ISL	Iceland
Middle East	XME	ISR	Israel
EU	XE25	ITA	Italy
Rest of Latin America	XLM	JAM	Jamaica
Middle East	XME	JOR	Jordan
Japan	JPN	JPN	Japan
Former USSR	CIS	KAZ	Kazakhstan
Other Africa	XAF	KEN	Kenya
Former USSR	CIS	KGZ	Kyrgyzstan

Rest of East and South East Asia	XSE	KHM	Cambodia
Rest of Asia	XSA	KIR	Kiribati
Rest of Latin America	XLM	KNA	Saint Kitts and Nevis
Rest of East and South East Asia	XSE	KOR	Korea, Republic of
Middle East	XME	KWT	Kuwait
Rest of East and South East Asia	XSE	LAO	Lao People's Democratic Republic
Middle East	XME	LBN	Lebanon
Other Africa	XAF	LBR	Liberia
North Africa	XNF	LBY	Libyan Arab Jamahiriya
Rest of Latin America	XLM	LCA	Saint Lucia
Rest of Europe	XER	LIE	Liechtenstein
Rest of Asia	XSA	LKA	Sri Lanka
Other Africa	XAF	LSO	Lesotho
EU	XE25	LTU	Lithuania
EU	XE25	LUX	Luxembourg
EU	XE25	LVA	Latvia
North Africa	XNF	MAR	Morocco
Rest of Europe	XER	MCO	Monaco
Former USSR	CIS	MDA	Moldova, Republic of
Other Africa	XAF	MDG	Madagascar
Rest of Asia	XSA	MDV	Maldives
Rest of Latin America	XLM	MEX	Mexico
Rest of Asia	XSA	MHL	Marshall Islands
Rest of Europe	XER	MKD	Macedonia, the former Yugoslav Republic of
Other Africa	XAF	MLI	Mali
EU	XE25	MLT	Malta
Rest of East and South East Asia	XSE	MMR	Myanmar
Rest of Europe	XER	MNE	Montenegro
Rest of East and South East Asia	XSE	MNG	Mongolia
Rest of Asia	XSA	MNP	Northern Mariana Islands
Other Africa	XAF	MOZ	Mozambique
Other Africa	XAF	MRT	Mauritania
Rest of Latin America	XLM	MSR	Montserrat
Rest of Latin America	XLM	MTQ	Martinique

Other Africa	XAF	MUS	Mauritius
Other Africa	XAF	MWI	Malawi
Rest of East and South East Asia	XSE	MYS	Malaysia
Other Africa	XAF	MYT	Mayotte
Other Africa	XAF	NAM	Namibia
Rest of Asia	XSA	NCL	New Caledonia
Other Africa	XAF	NER	Niger
Rest of Asia	XSA	NFK	Norfolk Island
Other Africa	XAF	NGA	Nigeria
Rest of Latin America	XLM	NIC	Nicaragua
Rest of Asia	XSA	NIU	Niue
EU	XE25	NLD	Netherlands
Rest of Europe	XER	NOR	Norway
Rest of Asia	XSA	NPL	Nepal
Rest of Asia	XSA	NRU	Nauru
New Zealand and Australia	XOC	NZL	New Zealand
Middle East	XME	OMN	Oman
Rest of Asia	XSA	PAK	Pakistan
Rest of Latin America	XLM	PAN	Panama
Rest of Asia	XSA	PCN	Pitcairn
Rest of Latin America	XLM	PER	Peru
Rest of East and South East Asia	XSE	PHL	Philippines
Rest of Asia	XSA	PLW	Palau
Rest of Asia	XSA	PNG	Papua New Guinea
EU	XE25	POL	Poland
Rest of Latin America	XLM	PRI	Puerto Rico
Rest of East and South East Asia	XSE	PRK	Korea, Democratic People's Republic of
EU	XE25	PRT	Portugal
Rest of Latin America	XLM	PRY	Paraguay
Rest of Asia	XSA	PYF	French Polynesia
Middle East	XME	QAT	Qatar
Other Africa	XAF	REU	Réunion
Rest of Europe	XER	ROU	Romania
Former USSR	CIS	RUS	Russian Federation
Other Africa	XAF	RWA	Rwanda

Middle East	XME	SAU	Saudi Arabia
Other Africa	XAF	SDN	Sudan
Other Africa	XAF	SEN	Senegal
Rest of East and South East Asia	XSE	SGP	Singapore
Rest of Latin America	XLM	SGS	South Georgia and the South Sandwich Islands
Other Africa	XAF	SHN	Saint Helena, Ascension and Tristan da Cunha
Rest of Europe	XER	SJM	Svalbard and Jan Mayen
Rest of Asia	XSA	SLB	Solomon Islands
Other Africa	XAF	SLE	Sierra Leone
Rest of Latin America	XLM	SLV	El Salvador
Rest of Europe	XER	SMR	San Marino
Other Africa	XAF	SOM	Somalia
Rest of Latin America	XLM	SPM	Saint Pierre and Miquelon
Rest of Europe	XER	SRB	Serbia
Other Africa	XAF	STP	Sao Tome and Principe
Rest of Latin America	XLM	SUR	Suriname
EU	XE25	SVK	Slovakia
EU	XE25	SVN	Slovenia
EU	XE25	SWE	Sweden
Other Africa	XAF	SWZ	Swaziland
Other Africa	XAF	SYC	Seychelles
Middle East	XME	SYR	Syrian Arab Republic
Rest of Latin America	XLM	TCA	Turks and Caicos Islands
Other Africa	XAF	TCD	Chad
Other Africa	XAF	TGO	Togo
Rest of East and South East Asia	XSE	THA	Thailand
Former USSR	CIS	TJK	Tajikistan
Rest of Asia	XSA	TKL	Tokelau
Former USSR	CIS	TKM	Turkmenistan
Rest of East and South East Asia	XSE	TLS	Timor-Leste
Rest of Asia	XSA	TON	Tonga
Rest of Latin America	XLM	TTO	Trinidad and Tobago
North Africa	XNF	TUN	Tunisia
Turkey	TUR	TUR	Turkey

Rest of Asia	XSA	TUV	Tuvalu
Rest of East and South East Asia	XSE	TWN	Taiwan
Other Africa	XAF	TZA	Tanzania, United Republic of
Other Africa	XAF	UGA	Uganda
Former USSR	CIS	UKR	Ukraine
Rest of Asia	XSA	UMI	United States Minor Outlying Islands
Rest of Latin America	XLM	URY	Uruguay
USA	USA	USA	United States
Former USSR	CIS	UZB	Uzbekistan
Rest of Europe	XER	VAT	Holy See (Vatican City State)
Rest of Latin America	XLM	VCT	Saint Vincent and the Grenadines
Rest of Latin America	XLM	VEN	Venezuela, Bolivarian Republic of
Rest of Latin America	XLM	VGB	Virgin Islands, British
Rest of Latin America	XLM	VIR	Virgin Islands, U.S.
Rest of East and South East Asia	XSE	VNM	Viet Nam
Rest of Asia	XSA	VUT	Vanuatu
Rest of Asia	XSA	WLF	Wallis and Futuna
Rest of Asia	XSA	WSM	Samoa
Middle East	XME	YEM	Yemen
Other Africa	XAF	ZAF	South Africa
Other Africa	XAF	ZMB	Zambia
Other Africa	XAF	ZWE	Zimbabwe

Supplementary Figures
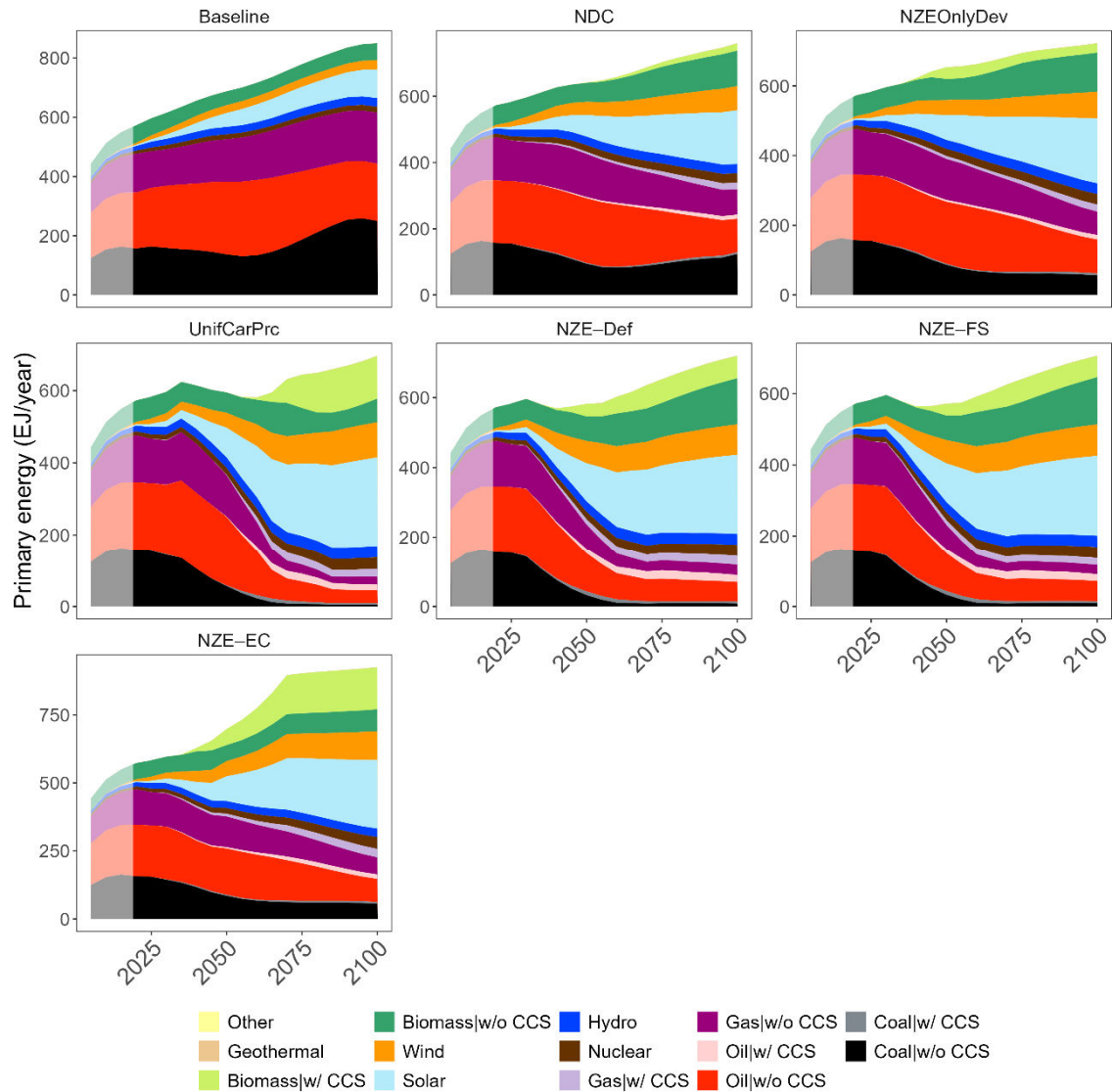
Supplementary Fig. 1 | Global primary energy supply under the reference and core scenarios. The shaded area for 2005–2019 represents historical records from energy balances by the International Energy Agency (IEA).
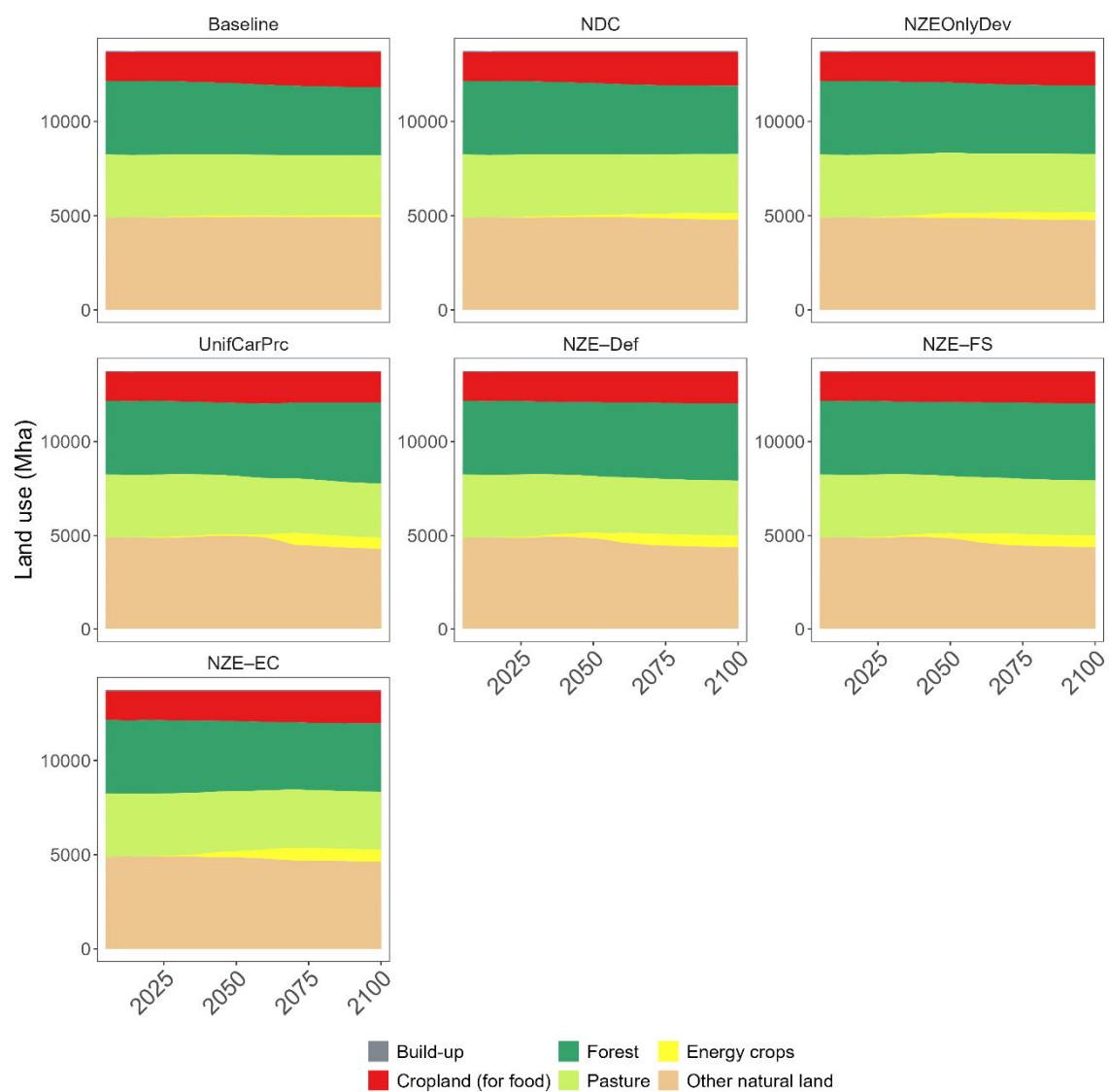
Supplementary Fig. 2 | Global land use under the reference and core scenarios.
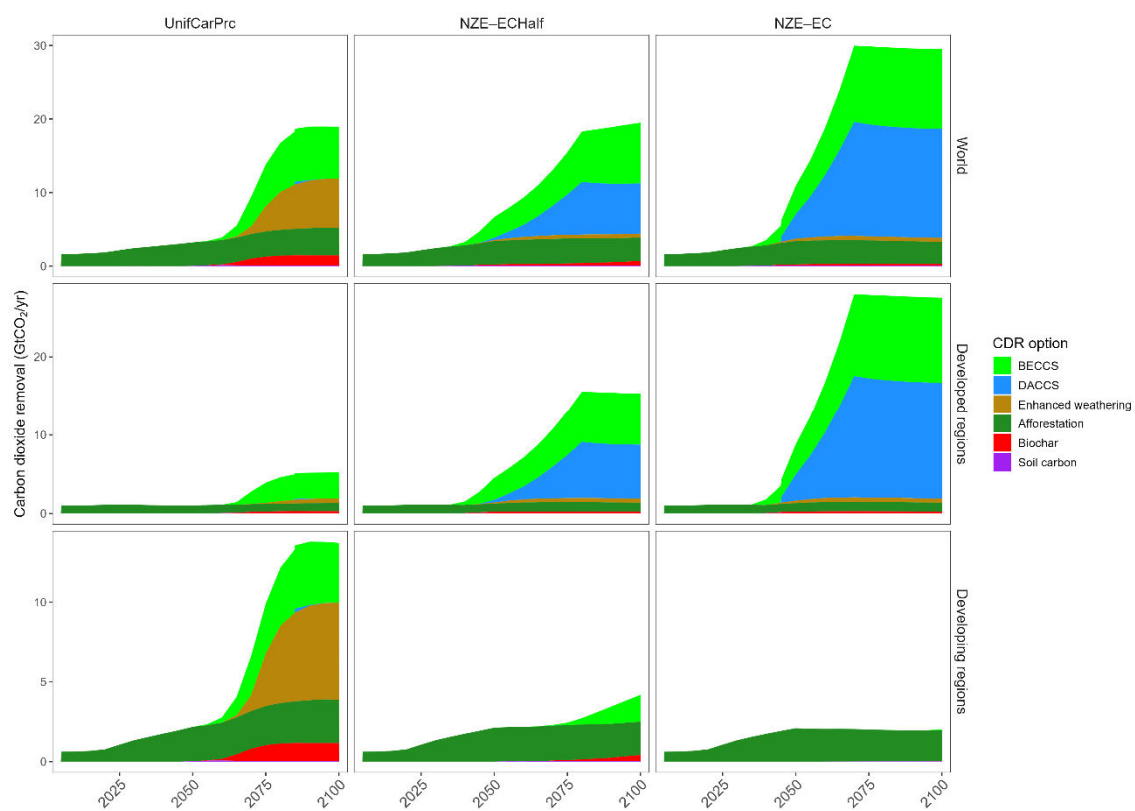
Supplementary Fig. 3 | CDR composition by region for the UnifCarPrc, NZE–EChalf, and NZE–EC scenarios.
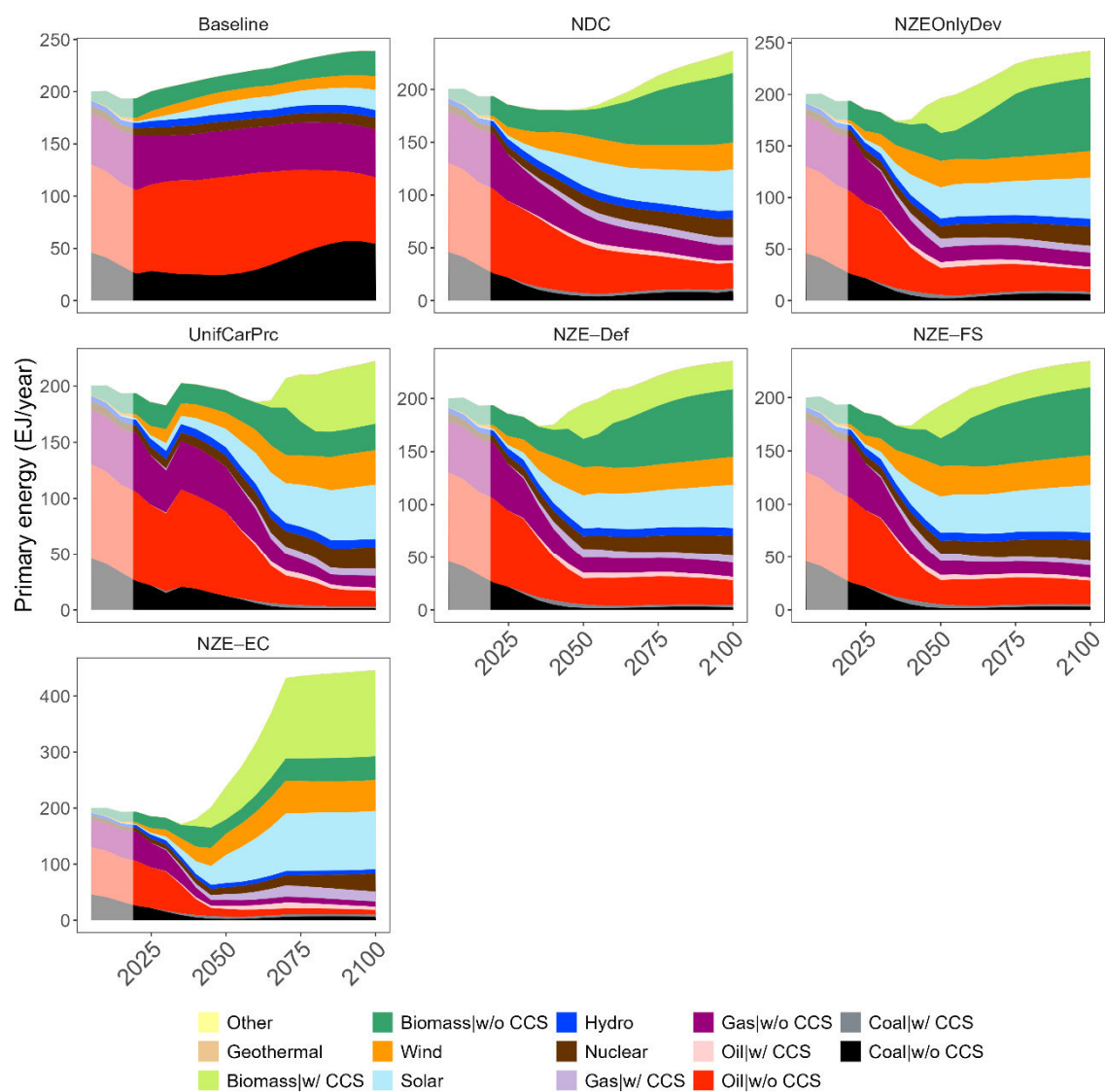
Supplementary Fig. 4 | Primary energy supply in developed regions under the reference and core scenarios. The shaded area for 2005–2019 represents historical records from energy balances by the IEA
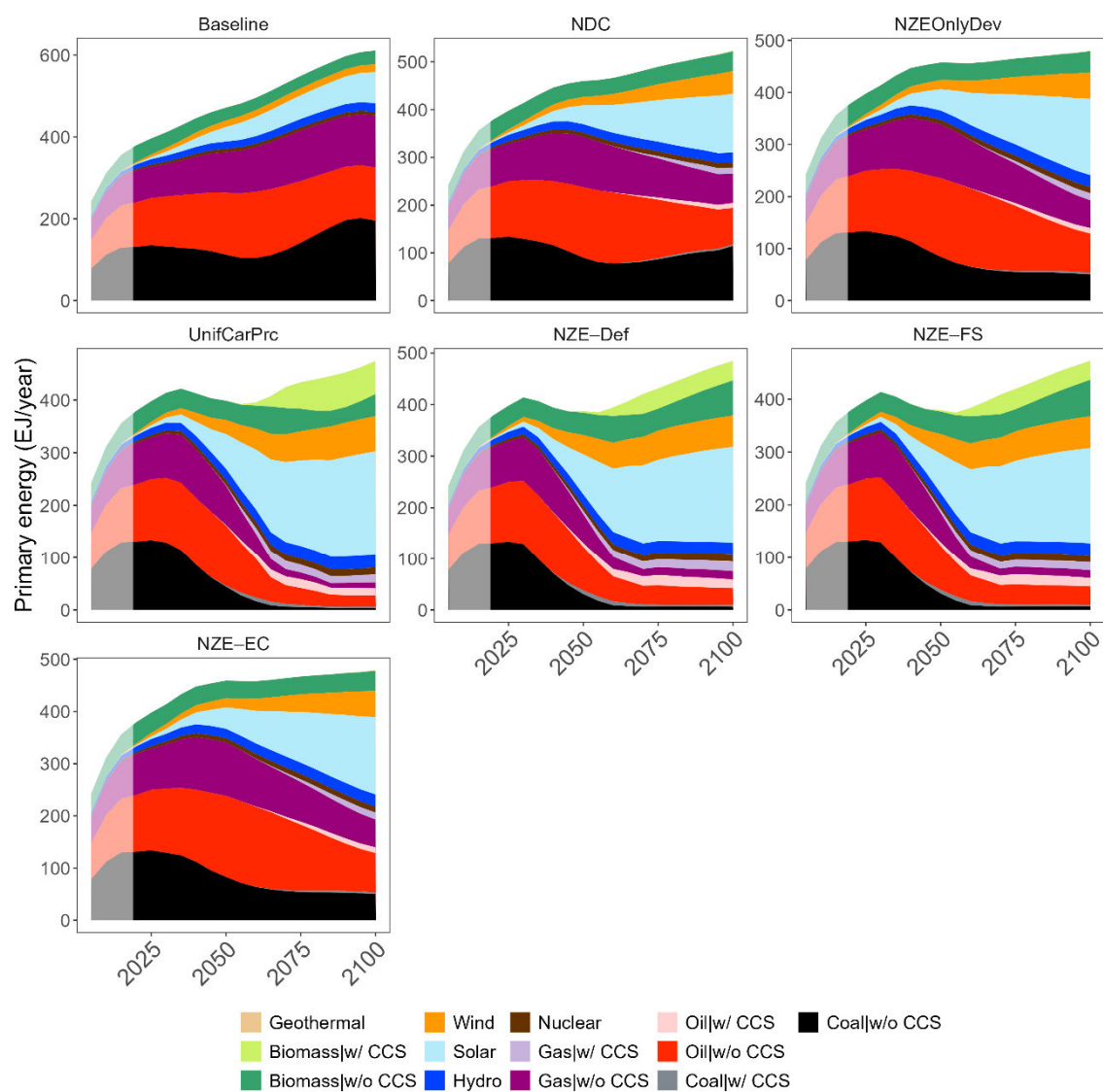
Supplementary Fig. 5 | Primary energy supply in developing regions under the reference and core scenarios. The shaded area for 2005–2019 represents historical records from energy balances by the IEA
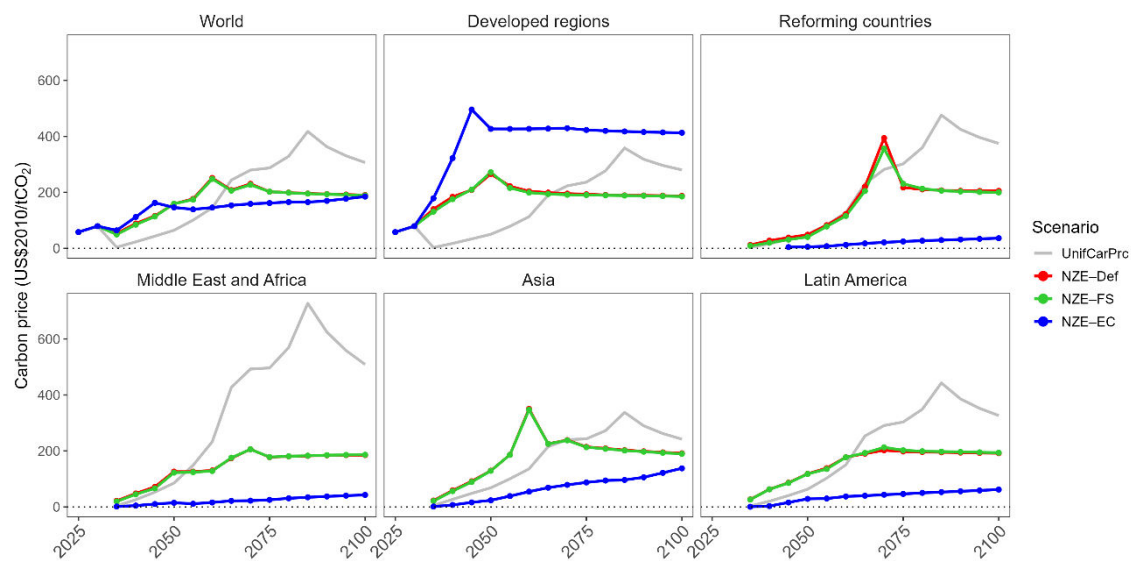
**Supplementary Fig. 6 | Regional carbon prices for the core and UnifCarPrc scenarios**
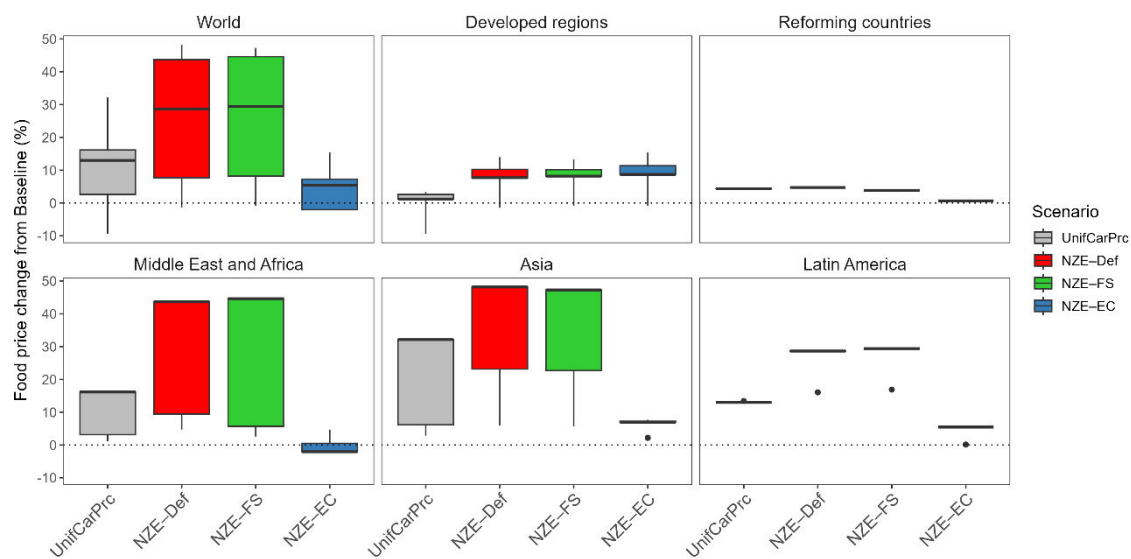
Supplementary Fig. 7 | Regional food price changes from the baseline scenario in 2050. The box plot indicates all countries classified for each R5 regions are plotted as ranges (25-75% is within box and whiskers extend to the largest/smallest values within 1.5 times the IQR from the hinges).
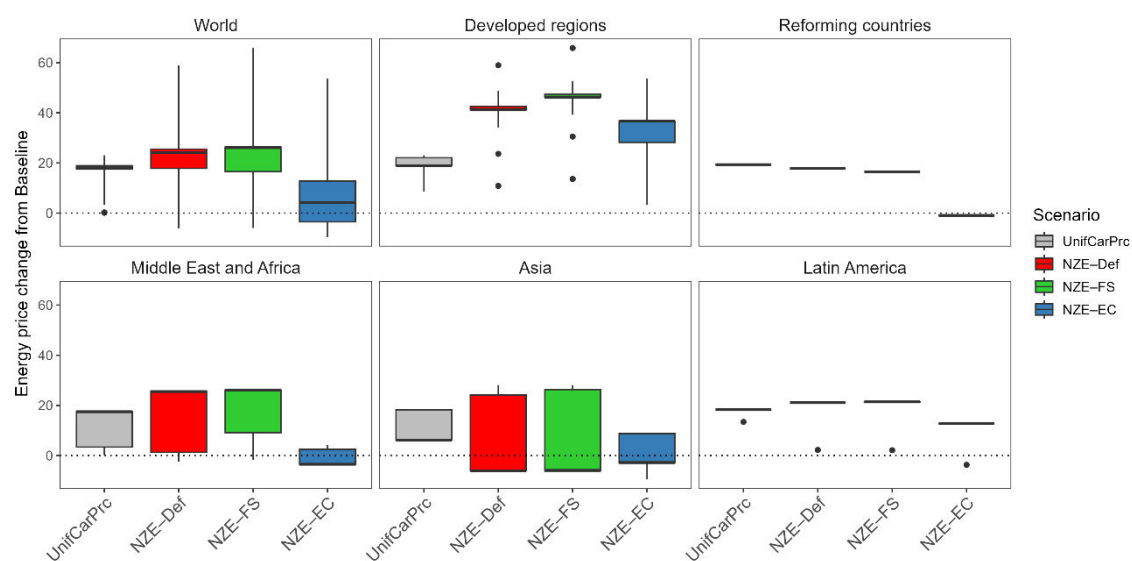
Supplementary Fig. 8 | Regional energy price changes from the baseline scenario in 2050. The box plot indicates all countries classified for each R5 regions are plotted as ranges (25-75% is within box and whiskers extend to the largest/smallest values within 1.5 times the IQR from the hinges).
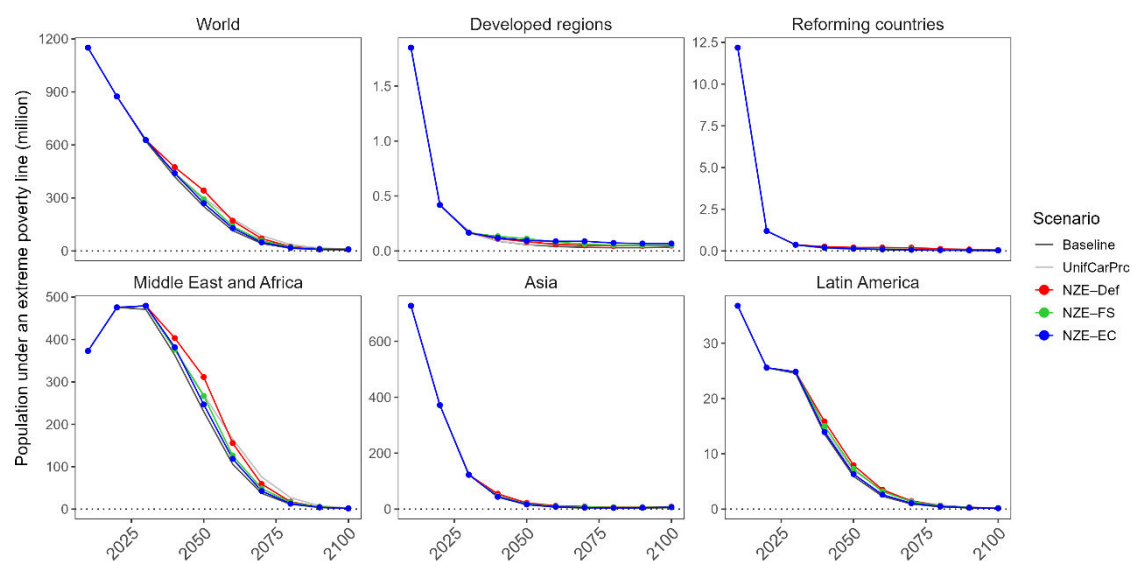
Supplementary Fig. 9 | Time-series data for the population under an extreme poverty line
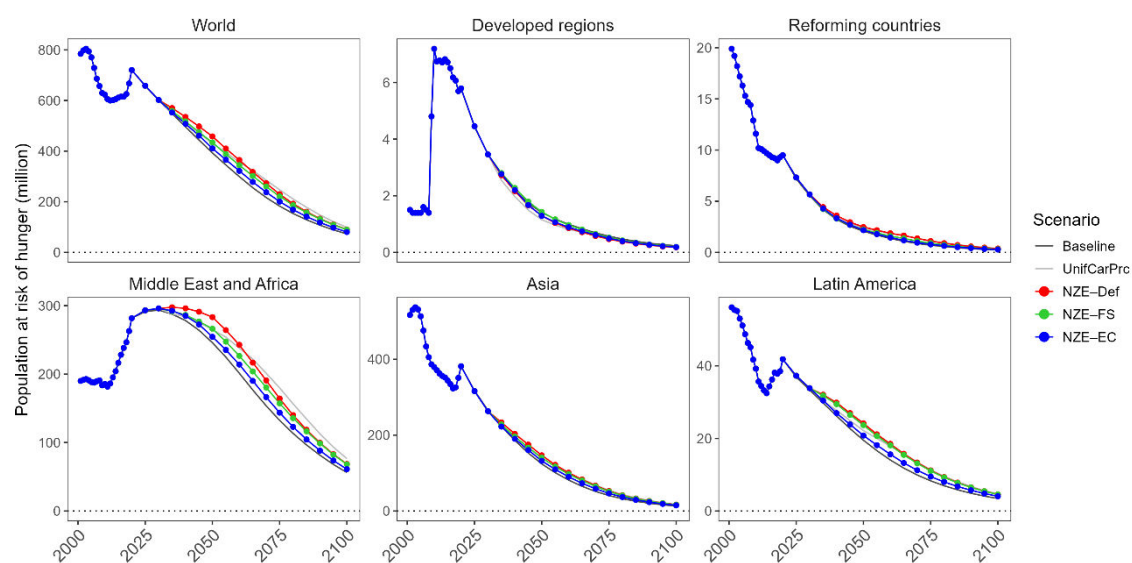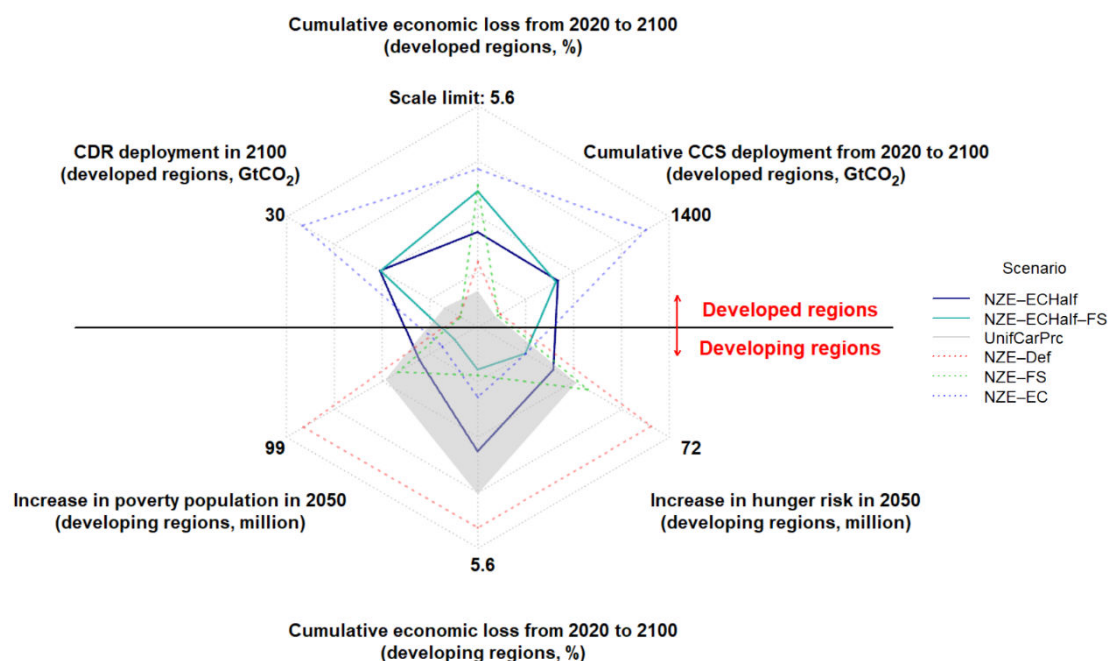
Supplementary Fig. 10 | Time-series data for the hunger-risk population
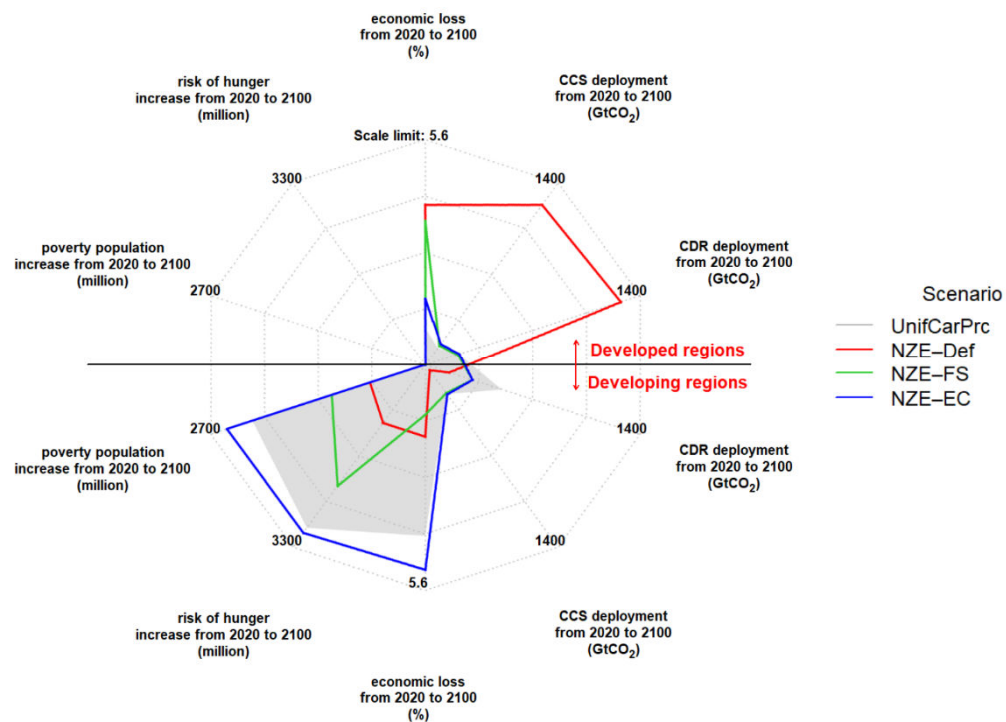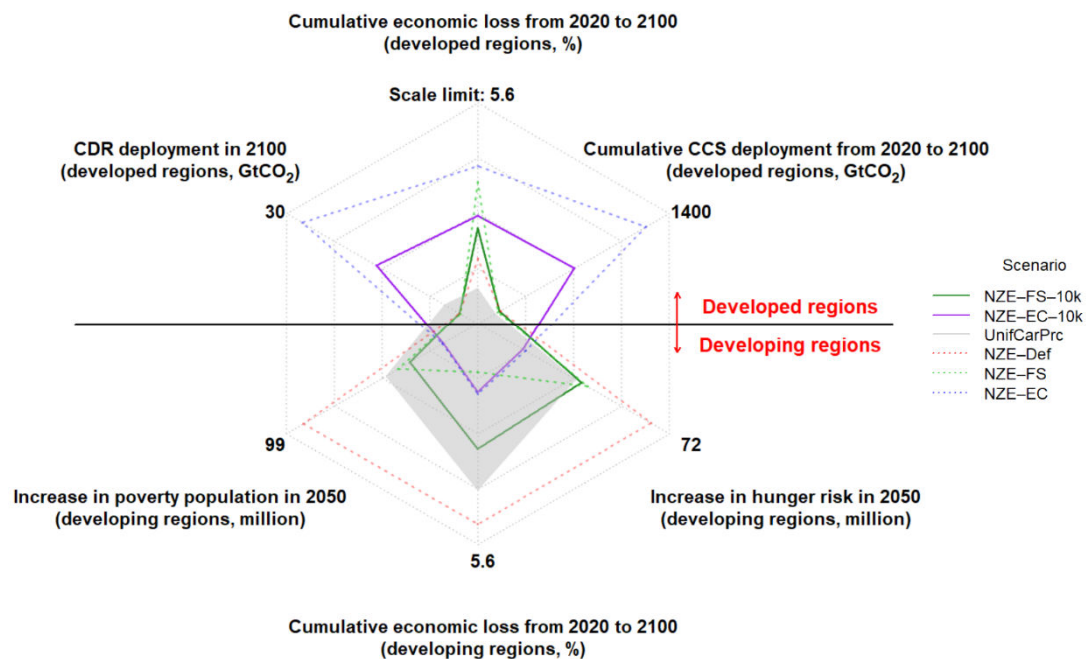
Supplementary Fig. 11 | Indicators used to examine differences between global emissions reduction options. Indicators include consumption loss rates in developing countries and developed countries, CDR, CCS, and populations at risk of hunger and poverty. All indicators are cumulative values from 2020 to 2100, shown for developing and developed regions, respectively. For population at risk of hunger and poverty headcount, the data have been linearly interpolated to provide estimates for each year.
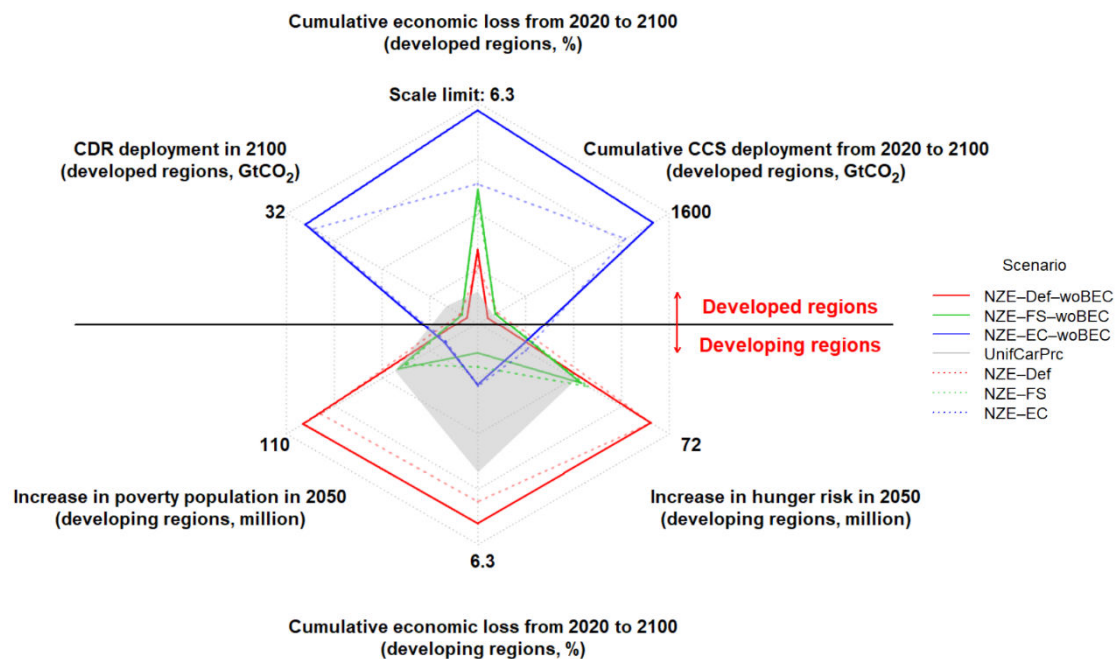
Supplementary Fig. 12 | Indicators used to examine differences between global emissions reduction options. Indicators include consumption loss rates in developing countries and developed countries, CDR, CCS, and populations at risk of hunger and poverty. All indicators are for 2100, shown for developing and developed regions, respectively.
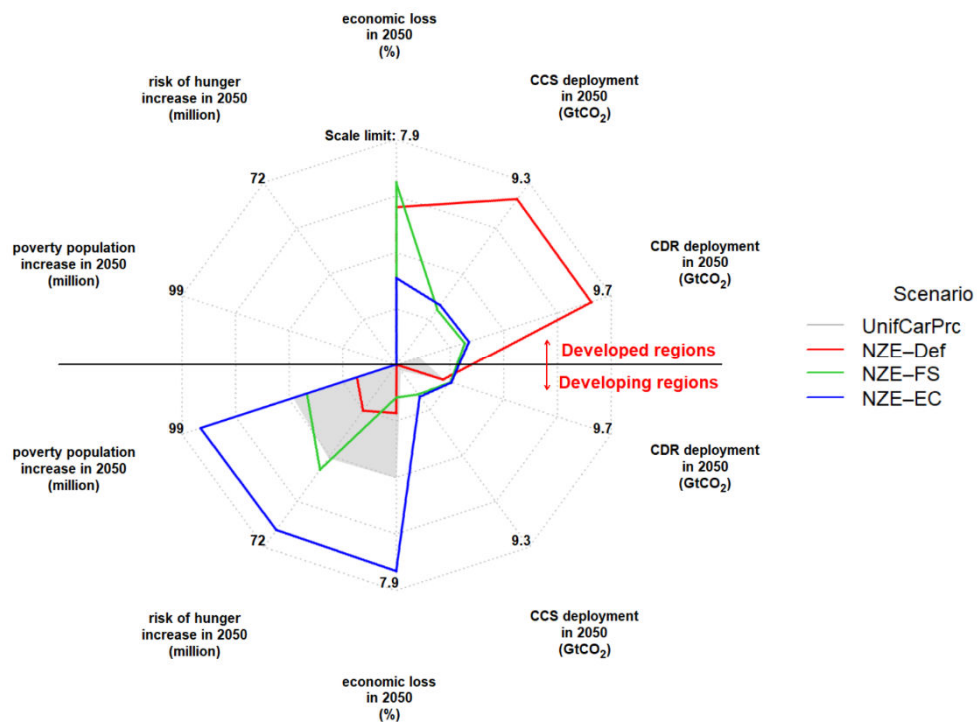
Supplementary Fig. 13 | Indicators used to examine differences between global emissions reduction options. Indicators include consumption loss rates in developing countries and developed countries, CDR, CCS, and populations at risk of hunger and poverty. All indicators are for 2050, shown for developing and developed regions, respectively.

Supplementary Fig. 14 | Indicators used to examine differences between global emissions reduction options. Indicators include consumption loss rates in developing countries and developed countries, CDR, CCS, and populations at risk of hunger and poverty. Data are based on a sensitivity assessment of half emissions reduction compensation.

Supplementary Fig. 15 | Indicators used to examine differences between global emissions reduction options. Indicators include consumption loss rates in developing countries and developed countries, CDR, CCS, and populations at risk of hunger and poverty. Data are based on a sensitivity assessment of the regional classification threshold

Supplementary Fig. 16 | Indicators used to examine differences between global emissions reduction options. Indicators include consumption loss rates in developing countries and developed countries, CDR, CCS, and populations at risk of hunger and poverty. Data are based on a sensitivity assessment of the effects of excluding BECCS
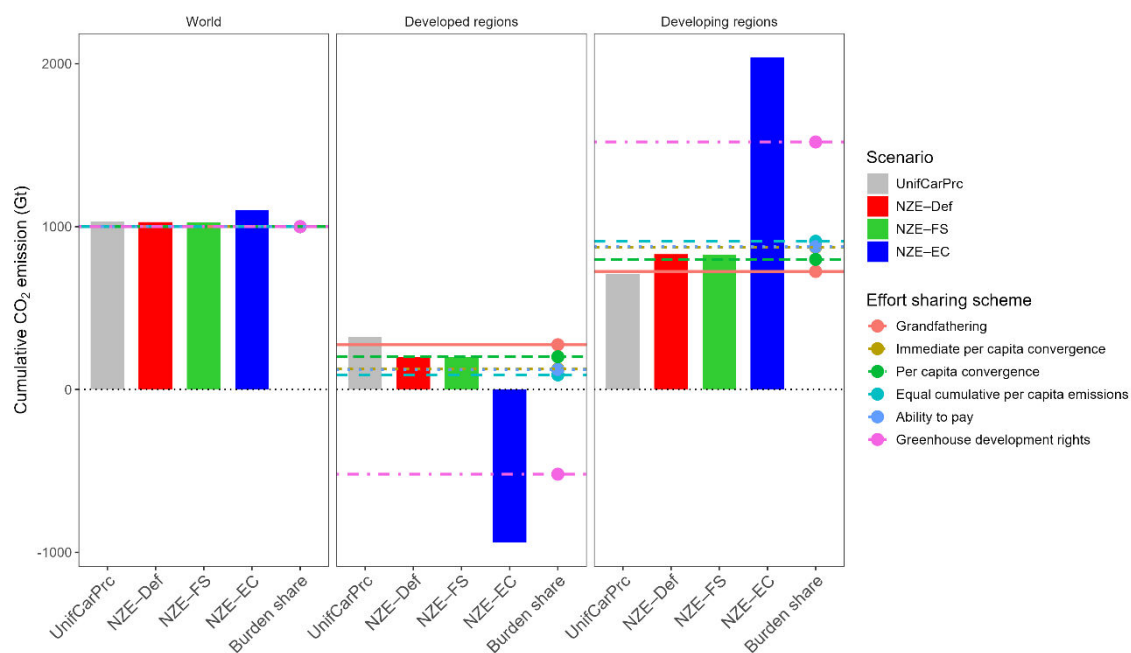
Supplementary Fig. 17 | Projected cumulative CO2 emissions and the cumulative carbon budget under different effort-sharing schemes. Results obtained including an immediate per capita convergence scheme and an ability-to-pay scheme overlap in the figure.