The status of sustainable energy for climate

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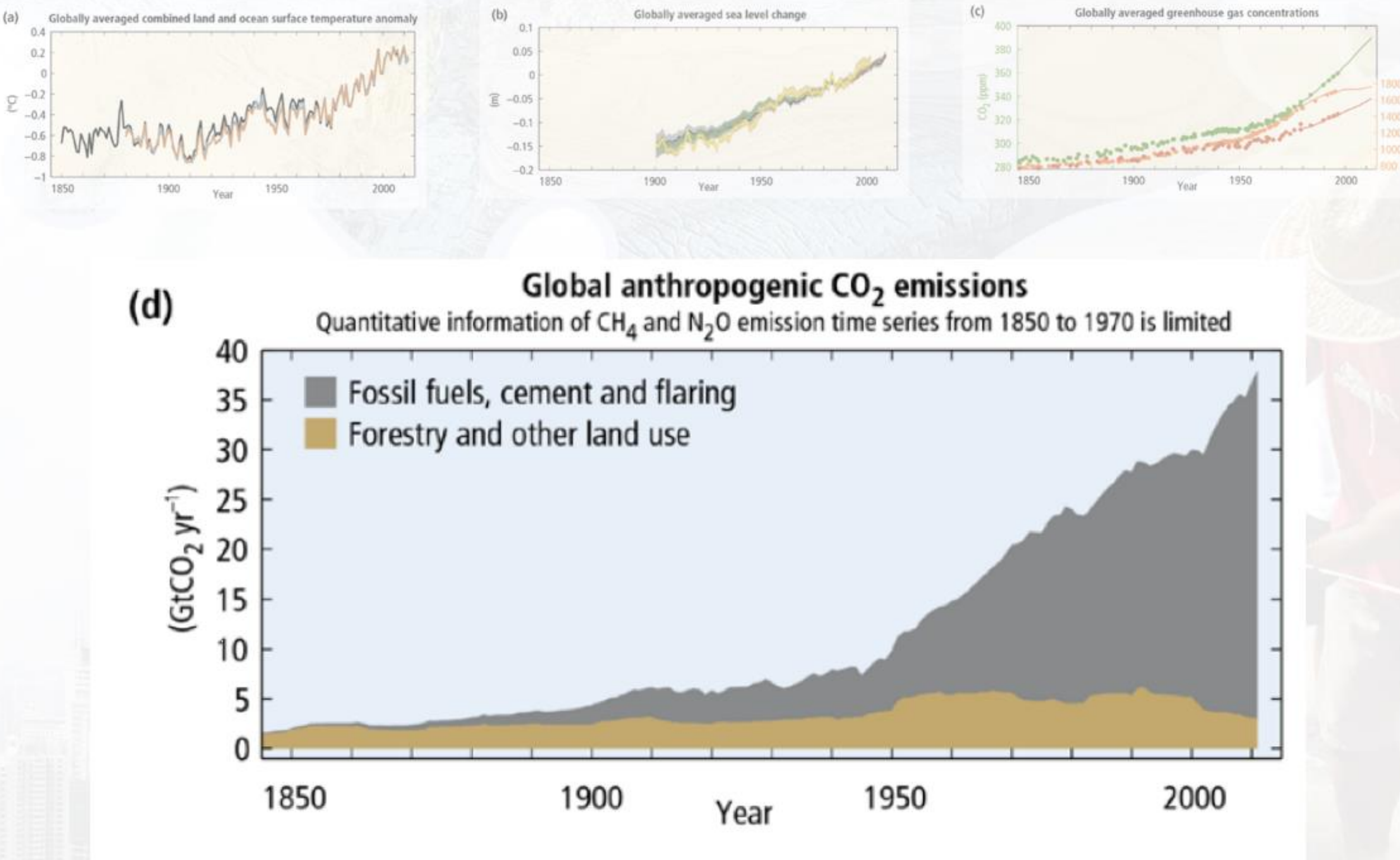
IPCC Vice-Chair

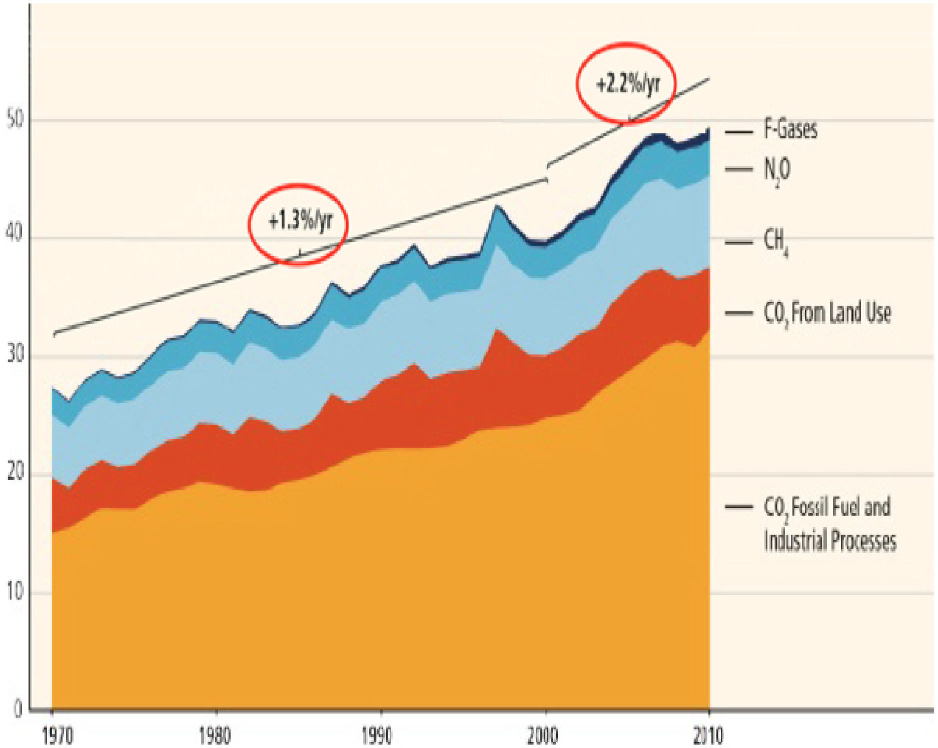
CGEE and ECLAC, COP 25, Madrid, December 11th, 2019


(a)
Globally averaged combined land and ocean surface temperature anomaly
(°C)
Year
(b)
Globally averaged sea level change
(m)
Year
(c)
Globally averaged greenhouse gas concentrations
CO_2 (ppm)
Year
(d)
Global anthropogenic CO_2 emissions
Quantitative information of CH_4 and N_2O emission time series from 1850 to 1970 is limited
Fossil fuels, cement and flaring
Forestry and other land use
($GtCO_2$ yr^{-1})
Year

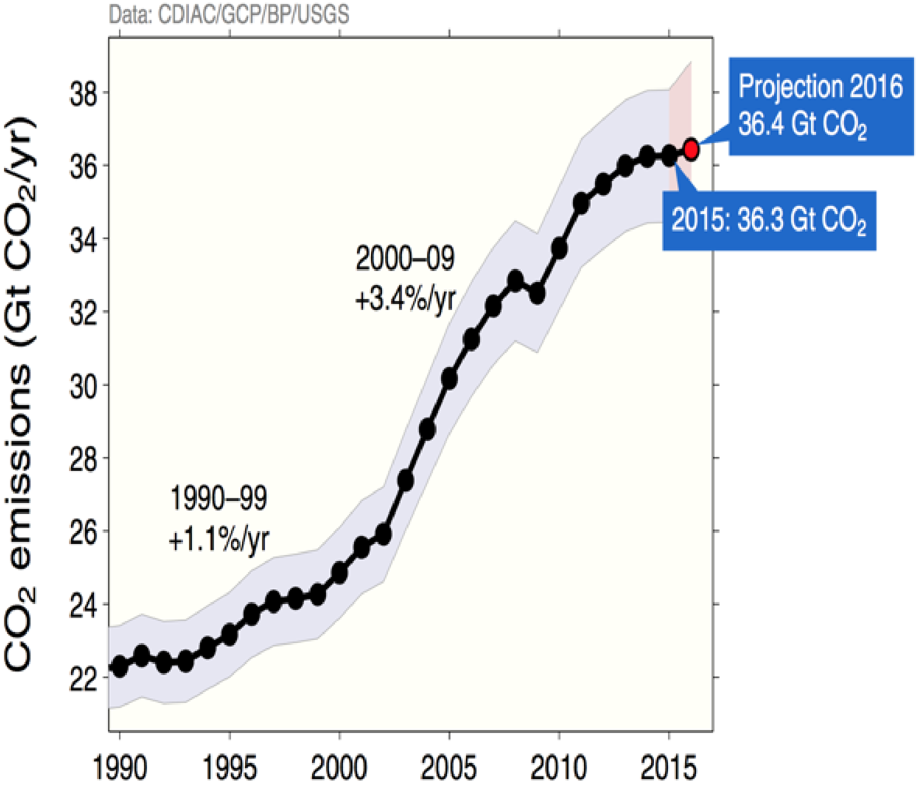
AR5 SYR S

Trend of Anthropogenic Emissions

Annual Anthropogenic Emissions by Groups of Gases (1970 – 2010) (IPCC, WG III, 2014)



Annual Anthropogenic CO_2 *Emissions (CDIAC; Le Queré et al.,2016; Global Carbon Budget, 2016)*



INTERGOVERNMENTAL PANEL ON climate change

Global Warming of 1.5^{o}C

- Not impossible to limit global warming to 1.5^{o}C
  - Unprecedented transformation across all areas of society
    - Global net zero CO_2 emissions around 2050
    - Concurrent emission reduction of other non-CO_2 emissions
- Requires transformative systemic change
  - Upscalling and acceleration of far-reaching, multi-level and cross sectoral climate mitigation
  - Greater scale and pace of change to transform energy, land and ecosystems, urban and infrastructure, and industrial system transitions globally

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WMO UNEP

Energy System Transition

- Meet energy service demand with lower energy use
  - enhanced energy efficiency
  - faster electrification of energy end use compared to 2ºC

- Higher share of low emission energy sources compared to 2ºC pathways, particularly before 2050

- Renewables are projected to supply 70 – 85% of electricity in 2050

Renewable energy continues to grow

- **Total global capacity rose 8%** in 2018
  - 2,378 GW capacity including hydropower
- **Non-hydro capacity grew 15%**
  - 1,246 GW by the end of 2018
- **181 GW** of renewable power additions led by
  - Solar PV with 100 GW (55% of new additions)
  - Wind power: 51 GW (28%)
  - Hydropower: 20 GW (11%)
- **Global reach of renewable power:**
  - over 90 countries have more than 1 GW
  - over 30 countries have more than 10 GW

RENEWABLE ENERGY INDICATORS 2018

		2017	2018
INVESTMENT			
New investment (annual) in renewable power and fuels[1]	billion USD	326	**289**
POWER			
Renewable power capacity (including hydropower)	GW	2,197	**2,378**
Renewable power capacity (not including hydropower)	GW	1,081	**1,246**
Hydropower capacity[2]	GW	1,112	**1,132**
Wind power capacity	GW	540	**591**
Solar PV capacity[3]	GW	405	**505**
Bio-power capacity	GW	121	**130**
Geothermal power capacity	GW	12.8	**13.3**
Concentrating solar thermal power (CSP) capacity	GW	4.9	**5.5**
Ocean power capacity	GW	0.5	**0.5**
Bioelectricity generation (annual)	TWh	532	**581**
HEAT			
Solar hot water capacity[4]	GW_{th}	472	**480**
TRANSPORT			
Ethanol production (annual)	billion litres	104	**112**
FAME biodiesel production (annual)	billion litres	33	**34**
HVO biodiesel production (annual)	billion litres	6.2	**7.0**

REN21 RENEWABLES 2019 GLOBAL STATUS REPORT

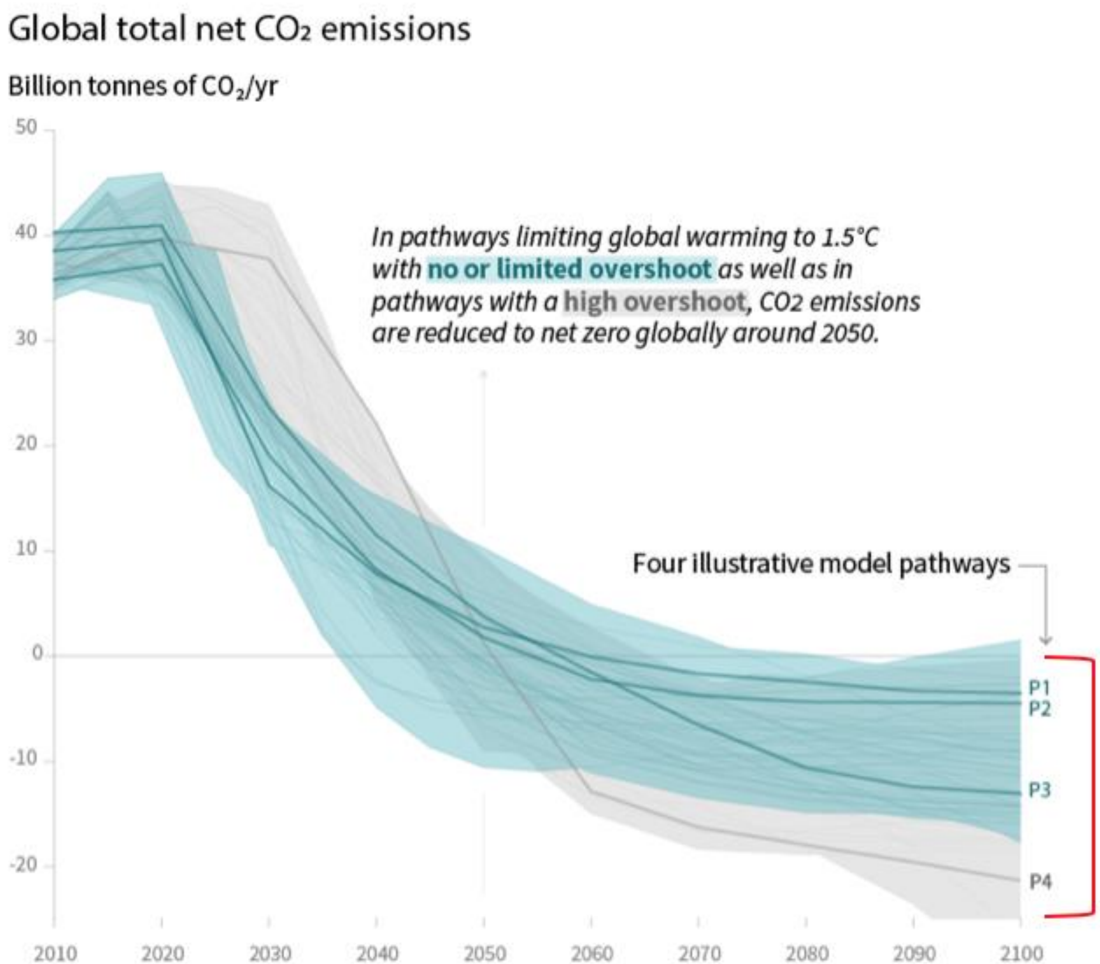
Which countries led the way in 2018?

TOP FIVE COUNTRIES

Annual Investment / Net Capacity Additions / Production in 2018

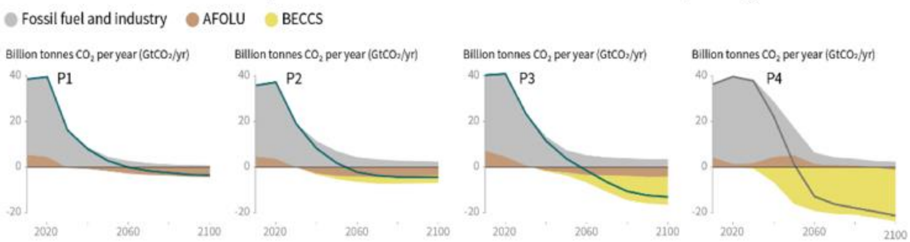
	1	2	3	4	5
Investment in renewable power and fuels (not including hydropower over 50 MW)	**China**	United States	Japan	India	Australia
Investment in renewable power and fuels per unit GDP[1]	**Palau**	Djibouti	Morocco	Iceland/Serbia	
Geothermal power capacity	**Turkey**	Indonesia	United States	Iceland	New Zealand
Hydropower capacity	**China**	Brazil	Pakistan	Turkey	Angola
Solar PV capacity	**China**	India[2]/United States		Japan	Australia
Concentrating solar thermal power (CSP) capacity	**China/Morocco**		South Africa	Saudi Arabia	–
Wind power capacity	**China**	United States	Germany	India	Brazil
Solar water heating capacity	**China**	Turkey	India	Brazil	United States
Biodiesel production	**United States**	Brazil	Indonesia	Germany	Argentina
Ethanol production	**United States**	Brazil	China	Canada	Thailand

Global Warming of 1.5^oC



Illustrative pathways for 1.5°C

Breakdown of contributions to global net CO_2 emissions in four illustrative model pathways



P1: A scenario in which social, business and technological innovations result in lower energy demand up to 2050 while living standards rise, especially in the global South. A downsized energy system enables rapid decarbonization of energy supply. Afforestation is the only CDR option considered; neither fossil fuels with CCS nor BECCS are used.

P2: A scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with limited societal acceptability for BECCS.

P3: A middle-of-the-road scenario in which societal as well as technological development follows historical patterns. Emissions reductions are mainly achieved by changing the way in which energy and products are produced, and to a lesser degree by reductions in demand.

P4: A resource- and energy-intensive scenario in which economic growth and globalization lead to widespread adoption of greenhouse-gas-intensive lifestyles, including high demand for transportation fuels and livestock products. Emissions reductions are mainly achieved through technological means, making strong use of CDR through the deployment of BECCS.

Pathways to limit warming to 1.5°C

- **Illustrative pathway P1** : scenario of low energy demand up to 2050, energy system that allow for rapid decarbonization of energy supply
  - Use of CDR is limited : only afforestation/reforestation
- **Illustrative pathway P4** : resource and energy intensive scenario with high demand for transportation fuels and livestock products
  - Substantial reliance on CDR measures
    - Bionergy with Carbon Capture and Storage
    - Afforestation and Reforestation

INTERGOVERNMENTAL PANEL ON climate change

SPM3b | Characteristics of four illustrative model pathways

Global indicators	P1	P2	P3	P4	Interquartile range
Pathway classification	No or low overshoot	No or low overshoot	No or low overshoot	High overshoot	No or low overshoot
CO_2 emission change in 2030 (% rel to 2010)	-58	-47	-41	4	(-59,-40)
↳ in 2050 (% rel to 2010)	-93	-95	-91	-97	(-104,-91)
Kyoto-GHG emissions in 2030 (% rel to 2010)*	-50	-49	-35	-2	(-55,-38)
↳ in 2050 (% rel to 2010)	-82	-89	-78	-80	(-93,-81)
*Final energy demand** in 2030 (% rel to 2010)*	-15	-5	17	39	(-12, 7)
↳ in 2050 (% rel to 2010)	-32	2	21	44	(-11, 22)
Renewable share in electricity in 2030 (%)	60	58	48	25	(47, 65)
↳ in 2050 (%)	77	81	63	70	(69, 87)
Primary energy from coal in 2030 (% rel to 2010)	-78	-61	-75	-59	(-78, -59)
↳ in 2050 (% rel to 2010)	-97	-77	-73	-97	(-95, -74)
from oil in 2030 (% rel to 2010)	-37	-13	-3	86	(-34,3)
↳ in 2050 (% rel to 2010)	-87	-50	-81	-32	(-78,-31)
from gas in 2030 (% rel to 2010)	-25	-20	33	37	(-26,21)
↳ in 2050 (% rel to 2010)	-74	-53	21	-48	(-56,6)
from nuclear in 2030 (% rel to 2010)	59	83	98	106	(44,102)
↳ in 2050 (% rel to 2010)	150	98	501	468	(91,190)
from biomass in 2030 (% rel to 2010)	-11	0	36	-1	(29,80)
↳ in 2050 (% rel to 2010)	-16	49	121	418	(123,261)
from non-biomass renewables in 2030 (% rel to 2010)	430	470	315	110	(243,438)
↳ in 2050 (% rel to 2010)	832	1327	878	1137	(575,1300)
Cumulative CCS until 2100 ($GtCO_2$)	0	348	687	1218	(550, 1017)
↳ of which BECCS ($GtCO_2$)	0	151	414	1191	(364, 662)
Land area of bioenergy crops in 2050 (million hectare)	22	93	283	724	(151, 320)
Agricultural CH_4 emissions in 2030 (% rel to 2010)	-24	-48	1	14	(-30,-11)
in 2050 (% rel to 2010)	-33	-69	-23	2	(-46,-23)
Agricultural N_2O emissions in 2030 (% rel to 2010)	5	-26	15	3	(-21,4)
in 2050 (% rel to 2010)	6	-26	0	39	(-26,1)

Temperature and emissions

Energy systems

Carbon dioxide removal

Agriculture

NOTE: Indicators have been selected to show global trends identified by the Chapter 2 assessment. National and sectoral characteristics can differ substantially from the global trends shown above.

** Kyoto-gas emissions are based on SAR GWP-100*

*** Changes in energy demand are associated with improvements in energy efficiency and behaviour change*

Bioenergy in para. B.3.3 and B.3.7 in the SPM

- The production and use of biomass for bioenergy can have co-benefits, adverse side-effects, and risks for land degradation, food insecurity, GHG emissions and other environmental and sustainable development goals
- These impacts are **context specific** and depend on the **scale of deployment**, **initial land use**, **land type**, **bioenergy feedstock**, **initial carbon stocks**, **climatic region** and **management regime**, and other land-demanding response options can have a similar range of consequences
- Whether CDR (and bioenergy in general) has large adverse impacts on environmental and societal goals depends in large part on the **governance of land use**
  - accountable multilevel governance that includes non-state actors, such as industry, civil society and scientific institutions