SAFE Europe
Safe And Free Exchange of EU Radiography Professionals across Europe

A review of current research on circular economy and applicability to healthcare

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SAFE Europe
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Co-funded by the Erasmus+ Programme of the European Union

Ulster University (Project Coordinator)
EFRS European Federation of Radiographer Societies
Società Tar-Radiografi Medici
IPO Porto
L-Università ta' Malta
art Associação Portuguesa de Radioterapeutas
PTE Polskie Towarzystwo Elektroradiologii

DISCLAIMER

This work was co-funded by the SAFE EUROPE project under the Erasmus+ Sector Skill Alliances programme. The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

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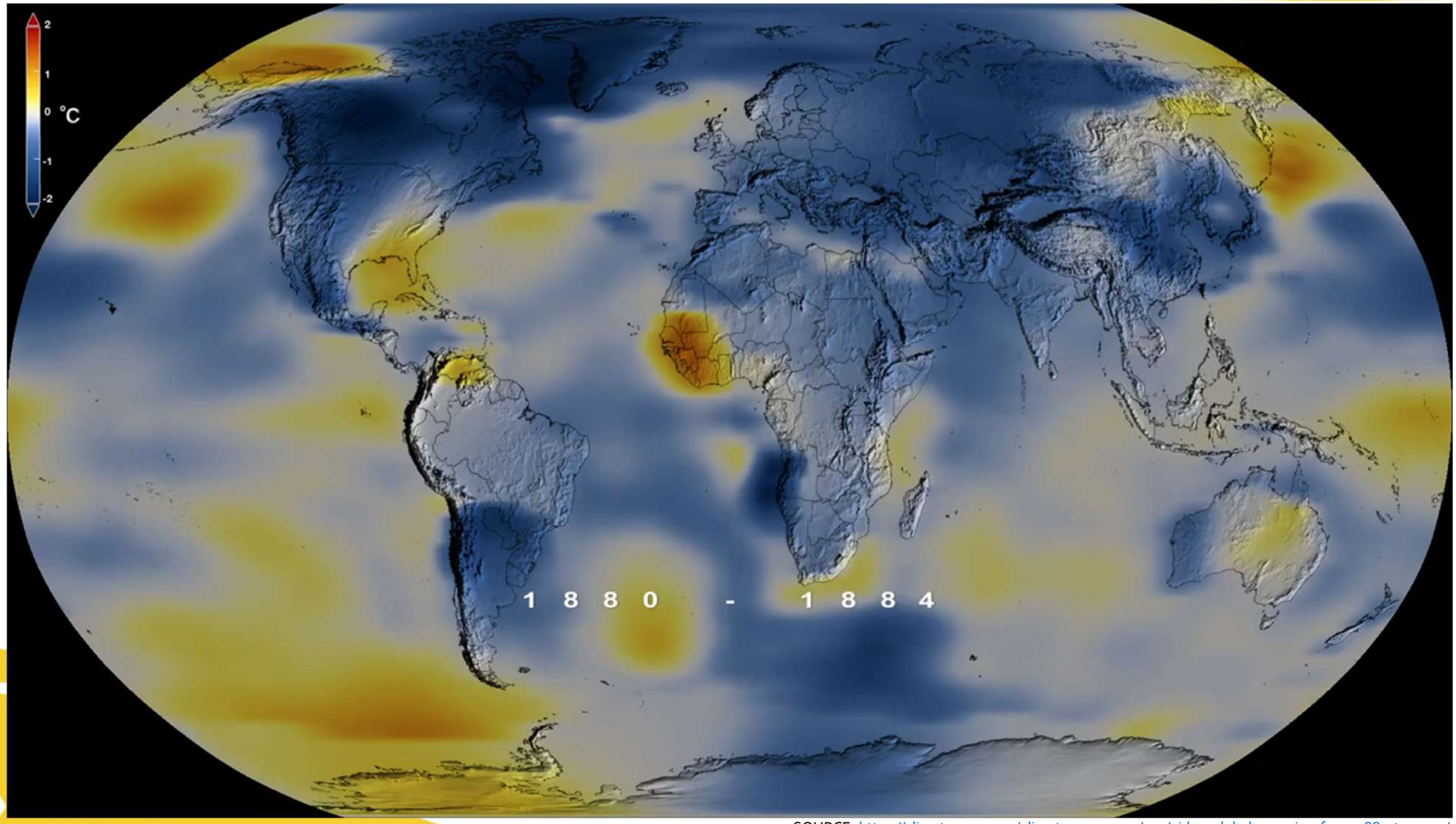
Global Warming: 1880-2020



SOURCE: https://climate.nasa.gov/climate_resources/139/video-global-warming-from-1880-to-2020/

Humans have been ignoring the signs…

SOURCE: https://trendywenergetyce.pl/en/change-starts-with-us-everyone-can-prevent-global-warming

SOURCE: : https://theconversation.com/humanity-is-in-the-existential-danger-zone-study-confirms-36307

Could we rewind?
Are we already in this pathway?

SOURCE: https://trendywenergetyce.pl/en/change-starts-with-us-everyone-can-prevent-global-warming

Global Warming and Greenhouse Gas (GHG) emissions

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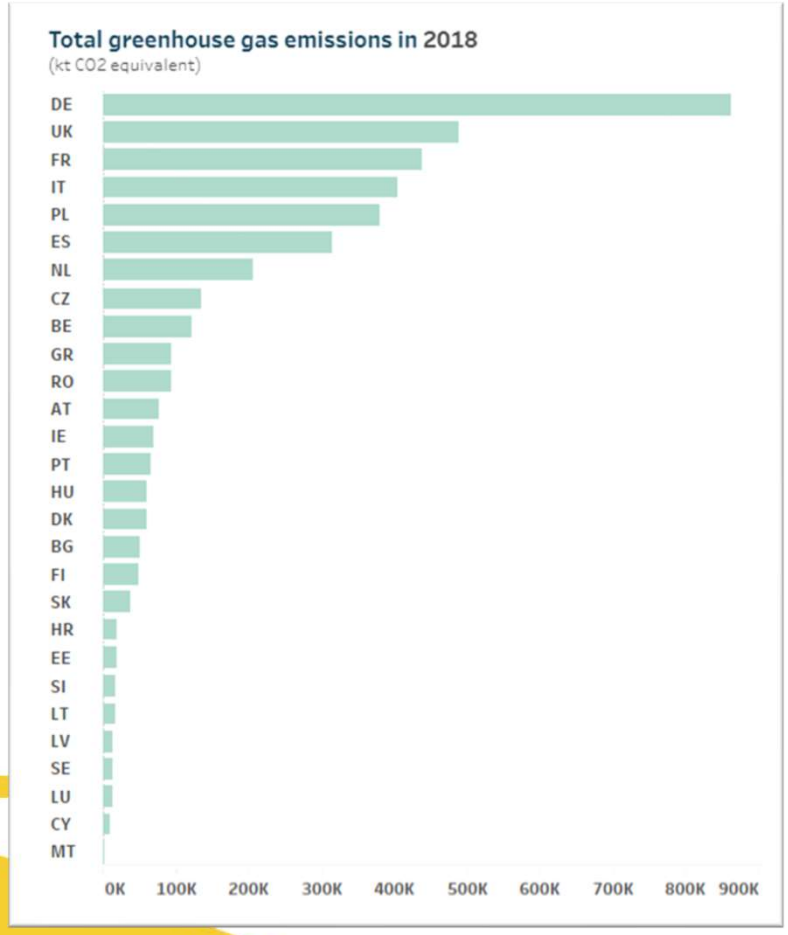
Global Warming (GW) – How it happens?

SOURCE: https://climate.nasa.gov/causes/

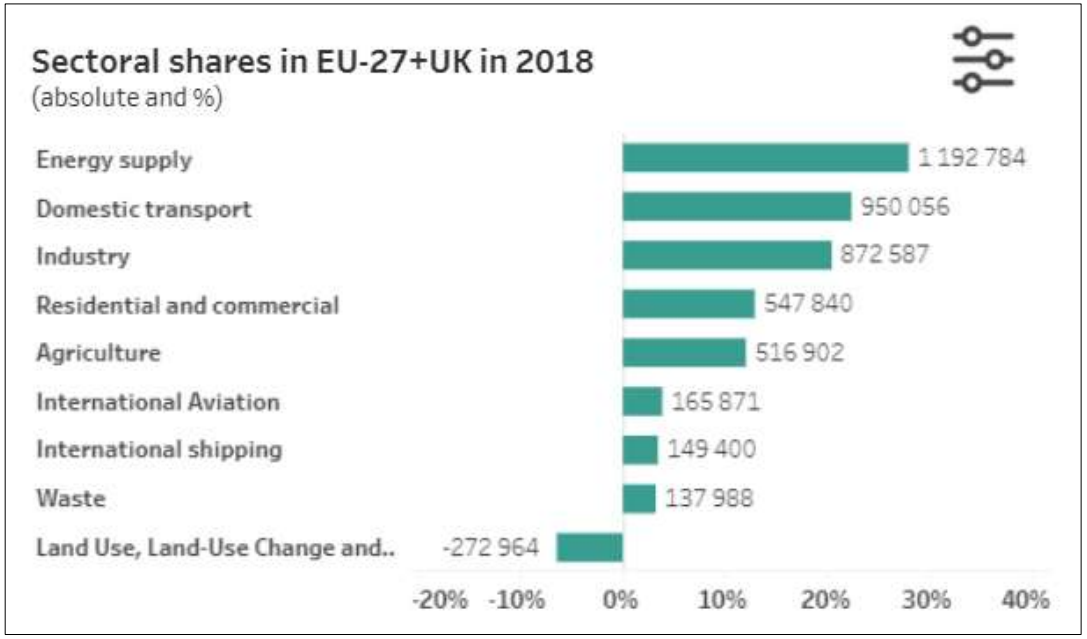
GHG emissions by country in EU-27+UK



SOURCE: https://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer

- 1st: Germany
- 2nd: UK
- 3rd: France
- 4th: Italy
- 5th: Poland
- …
- 13th: Ireland
- 14th: Portugal
- Last: Malta

GHG emissions by sector/source in EU-27+UK



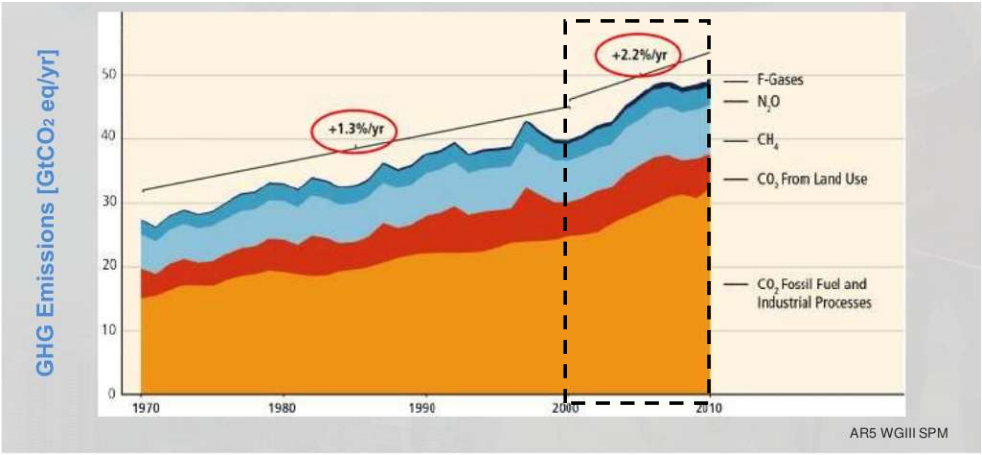
SOURCE: https://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer

GHG and relative contribution to GW

Compound	Pre-industrial concentration (ppmv*)	Concentration in 2018 (ppmv)	Atmospheric lifetime (years)	Main human activity source	GWP**
Carbon dioxide (CO_2)	280	408	variable	Fossil fuels, cement production, land use change	1
Methane (CH_4)	0.715	1.869	12	Fossil fuels, rice paddies, waste dumps, livestock	28
Nitrous oxide (N_2O)	0.27	0.331	121	Fertilizers, combustion industrial processes	265
HFC 23 (CHF_3)	0	0.000024***	222	Electronics, refrigerants	12,400
HFC 134a (CF_3CH_2F)	0	0.000062***	13	Refrigerants	1,300
HFC 152a (CH_3CHF_2)	0	0.0000064***	1.5	Industrial processes	138
Perfluoromethane (CF_4)	0.00004	0.000079***	50,000	Aluminum production	6,630
Perfluoroethane (C_2F_6)	0	0.0000041***	10,000	Aluminum production	11,100
Sulphur hexafluoride (SF_6)	0	0.0000073***	3,200	Electrical insulation	23,500

*ppmv = parts per million by volume, **GWP = 100-year global warming potential, ***Concentration in 2011
Water vapor not included in table, see bullet.

SOURCE: http://css.umich.edu/sites/default/files/Greenhouse%20Gases_CSS05-21_e2020.pdf



IPCC AR5 Synthesis Report

ipcc INTERGOVERNMENTAL PANEL ON climate change

SOURCE: https://www.ipcc.ch/report/ar5/syr/

Climate and healthcare

May 21, 2021

Climate and health

The NEW ENGLAND JOURNAL of MEDICINE

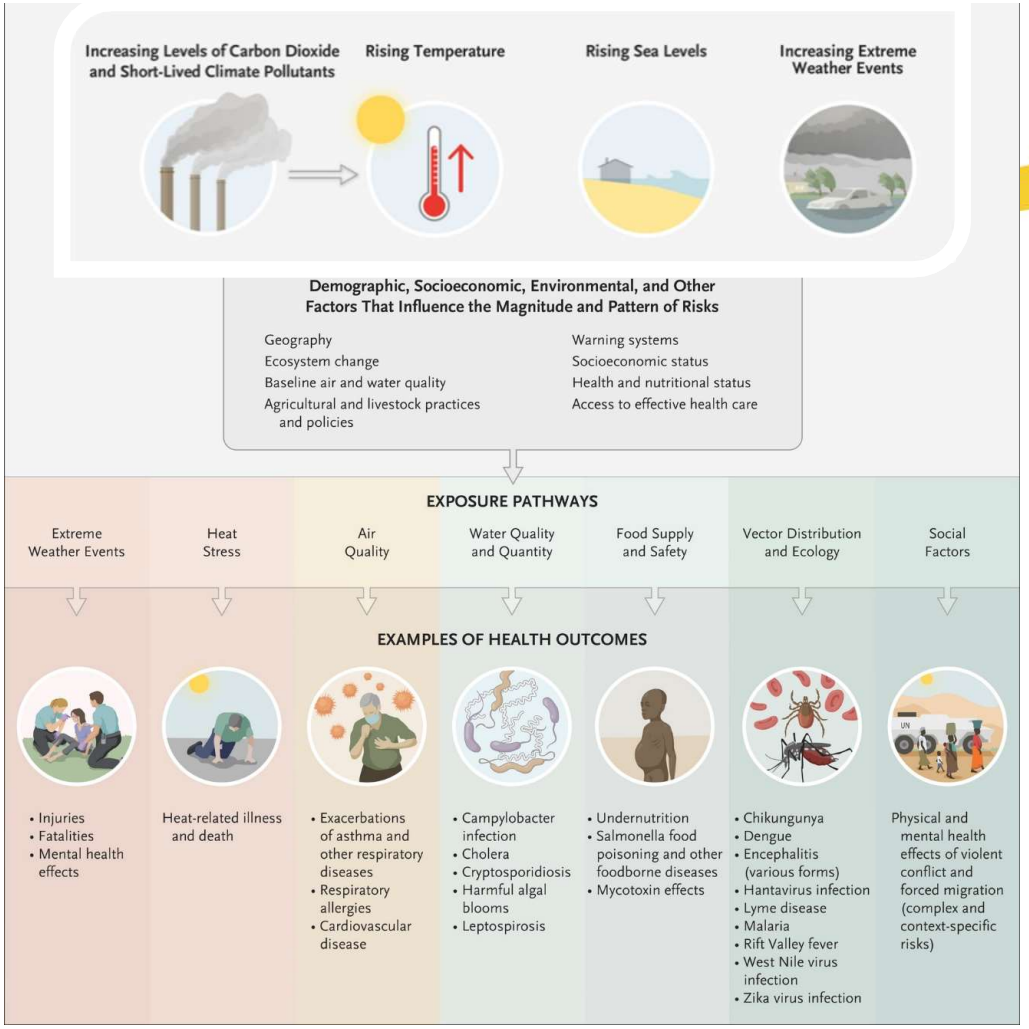
2019

REVIEW ARTICLE

Caren G. Solomon, M.D., M.P.H., *Editor*

The Imperative for Climate Action to Protect Health

Andy Haines, M.D., and Kristie Ebi, M.P.H., Ph.D.



SOURCE: https://www.nejm.org/doi/full/10.1056/NEJMra1807873
N Engl J Med 2019;380:263-73. DOI: 10.1056/NEJMra1807873

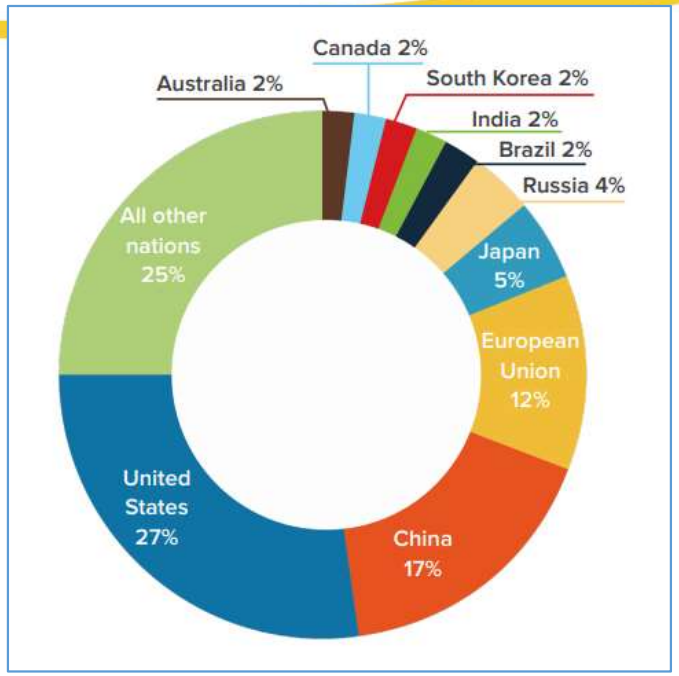
Climate and healthcare

- The healthcare sector:
  - one of the largest industries worldwide;
  - a major contributor to the climate crisis with the sector's carbon footprint equivalent to **4.4% of global net emissions**.

- **Top 3** emitters: U.S., China, and EU countries (56%)

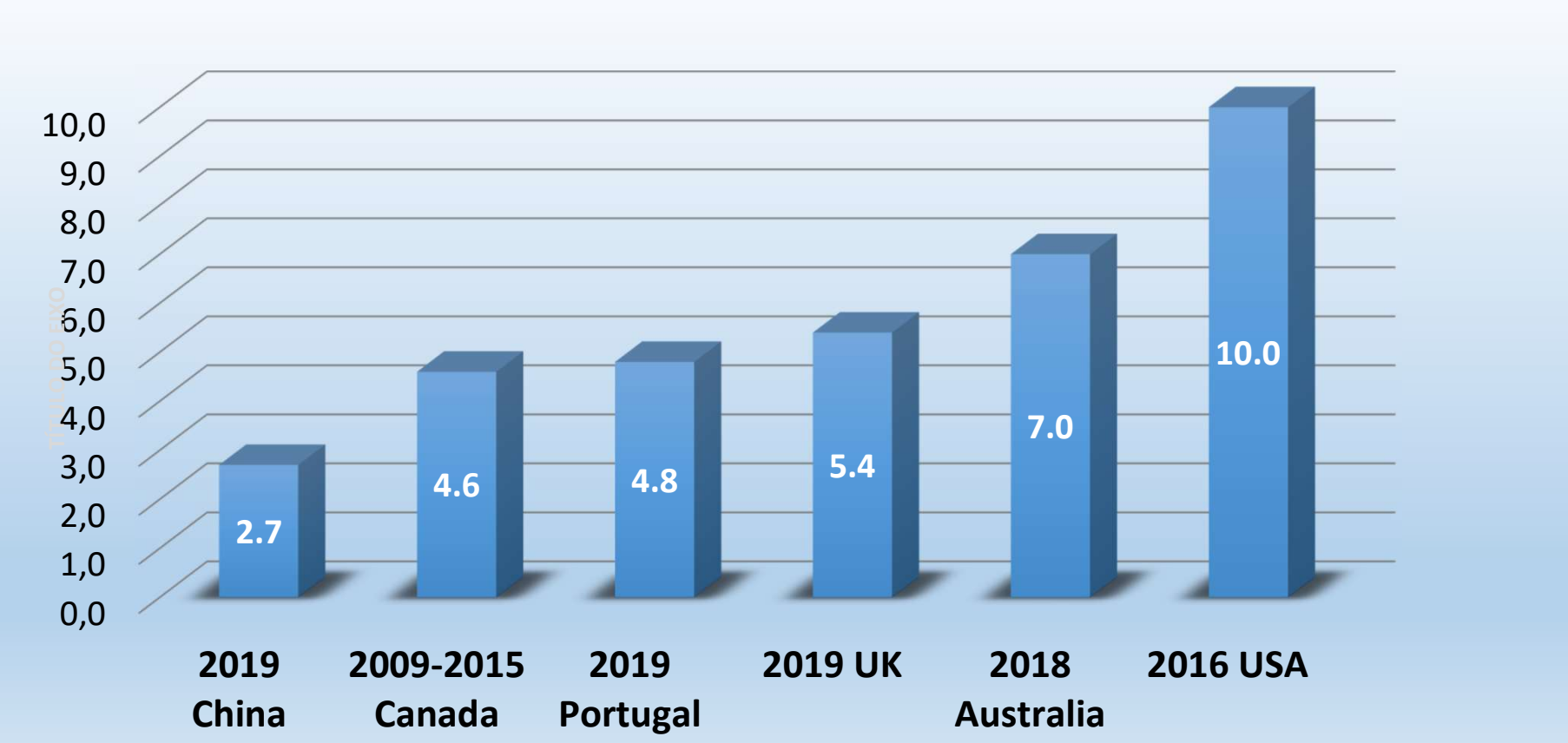
- **Top 10** healthcare emitters make up **75%** of the global health care climate footprint

Top 10 emitters as percentage of global healthcare footprint



SOURCE: Bosurgi R. Climate crisis: healthcare is a major contributor, global report finds. BMJ. 2019 Sep 13;l5560
HCWH, Arup. Health care climate footprint report [Internet]. 2019 Sep [cited 2020 Sep 8]. Available from: https://noharm-uscanada.org/ClimateFootprintReport

Carbon footprint



SOURCE: Eckelman MJ, Sherman J. Environmental Impacts of the U.S. Health Care System and Effects on Public Health. Ahmad S, editor. PLoS ONE. 2016 Jun 9;11(6):e0157014.
Malik A, Lenzen M, McAlister S, McGain F. The carbon footprint of Australian health care. The Lancet Planetary Health. 2018 Jan;2(1):e27–35.
Wu R. The carbon footprint of the Chinese health-care system: an environmentally extended input–output and structural path analysis study. The Lancet Planetary Health. 2019 Oct;3(10):e413–9.
Eckelman MJ, Sherman JD, MacNeill AJ. Life cycle environmental emissions and health damages from the Canadian healthcare system: An economic-environmental-epidemiological analysis. Patz JA, editor. PLoS Med. 2018 Jul 31;15(7):e1002623.

Current research on circular economy (CE)

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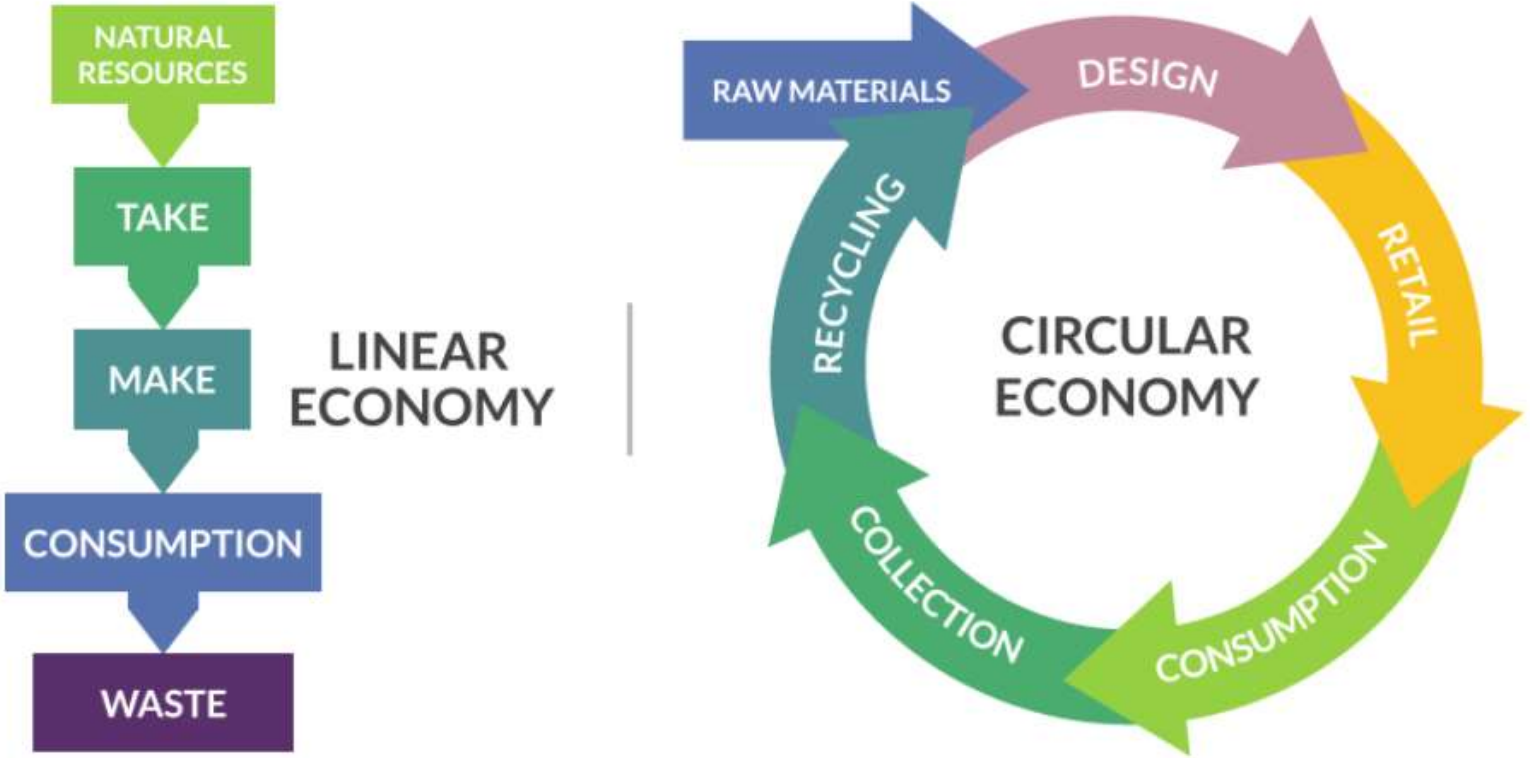
From Linear Economy (LE) to CE



SOURCE: https://endofwaste.com/individuals

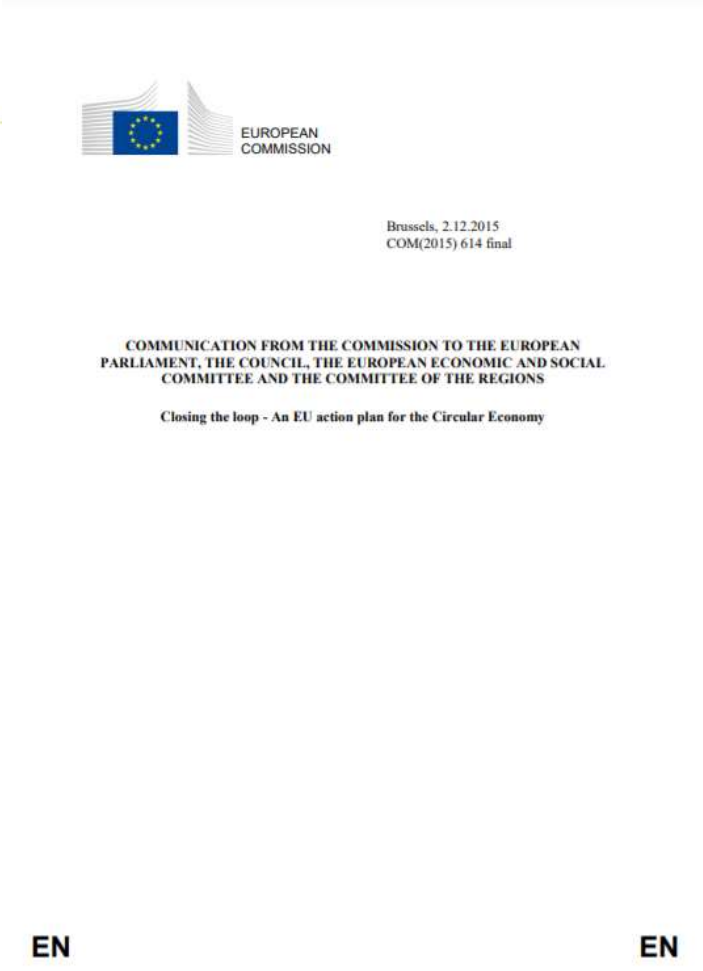
CE definitions

- CE definition from EMF (2013):
  - "A circular economy is an industrial system that is restorative or regenerative by intention and design".

SOURCE: Ellen MacArthur Foundation. Towards the Circular Economy Opportunities for the consumer goods sector. Ellen MacArthur Foundation; 2013. https://www.ellenmacarthurfoundation.org/publications

CE definitions

- EC (2015):
  - "the transition to a more circular economy where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised"



EUROPEAN COMMISSION

Brussels, 2.12.2015
COM(2015) 614 final

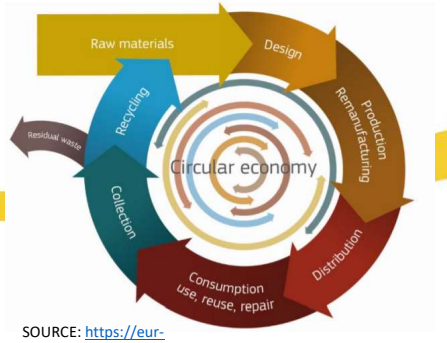
COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Closing the loop - An EU action plan for the Circular Economy

EN **EN**

SOURCE: https://eur-lex.europa.eu/resource.html?uri=cellar:50edd1fd-01ec-11e4-831f-01aa75ed71a1.0001.01/DOC_1&format=PDF

CE



SOURCE: https://eur-lex.europa.eu/resource.html?uri=cellar:50edd1fd-01ec-11e4-831f-01aa75ed71a1.0001.01/DOC_1&format=PDF

- Alternative to the LE model allowing a greener economy
- Integrate economic activity and environmental wellbeing in a sustainable way
- Maintain the value of resources in the economy for as long as possible

SOURCE: Ghisellini P, Cialani C, Ulgiati S. A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. Journal of Cleaner Production. 2016 Feb;114:11–32
Wautelet T. The Concept of Circular Economy: its Origins and its Evolution. 2018 [cited 2020 Jun 20]; Available from: http://rgdoi.net/10.13140/RG.2.2.17021.87523
Ellen MacArthur Foundation. Towards the Circular Economy Economic and business rationale for an accelerated transition. Ellen MacArthur Foundation; 2012.
Murray A, Skene K, Haynes K. The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context. J Bus Ethics. 2015 May;140(3):369–80.
https://eur-lex.europa.eu/resource.html?uri=cellar:50edd1fd-01ec-11e4-831f-01aa75ed71a1.0001.01/DOC_1&format=PDF

Origins of CE

1966

Boulding: *spaceman economy*

1968

Ludwig von Bertalanffy: *General Systems Theory* (GST)

1976-77

Walter Stahel and Geneviève Reday-Mulvey

1990

Pearce and Turner: first introduced the concept formally

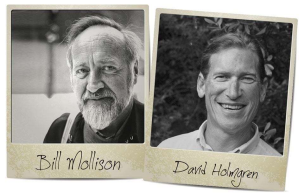
2010

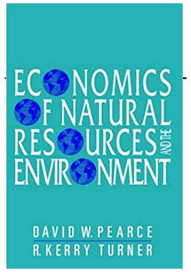
EMF Ellen McArthur Foundation

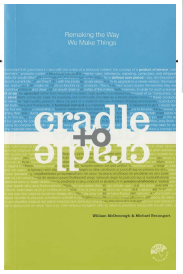
SOURCE: 1,6-8

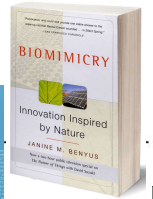
Schools of thought

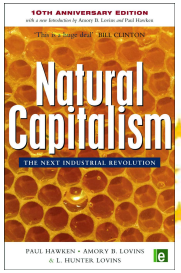
Year	1966	1968	1970s	1970s	Late 1970s	1976	1976	1990	1990	1997	1999	2009
Schools of thought	Ecological studies	General system theory	Industrial ecology	Regenerative design	Permanculture	Closed-loop economy	Performance economy	New economic model, named CE	Cradle-to-cradle	Biomimicry	Natural Capitalism	Blue economy
Author(s)	Kenneth Boulding	Von Bertalanffy	Frosch and Gallopoulos	John T. Lyle	Bill Mollison and David Holmgren	Walter Stahel and Reday-Mulvey	Walter Stahel	Pearce & Turner	Michael Braungart and Bill McDonough	Janine Benyus	Paul Hawken, Amory Lovins and L. Hunter Lovins	Gunter Pauli

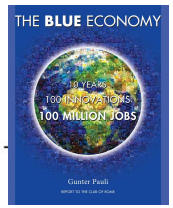












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Overview of the CE implementation

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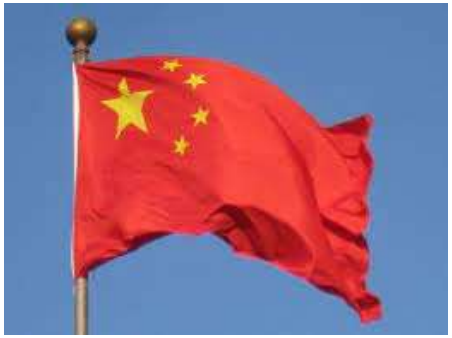
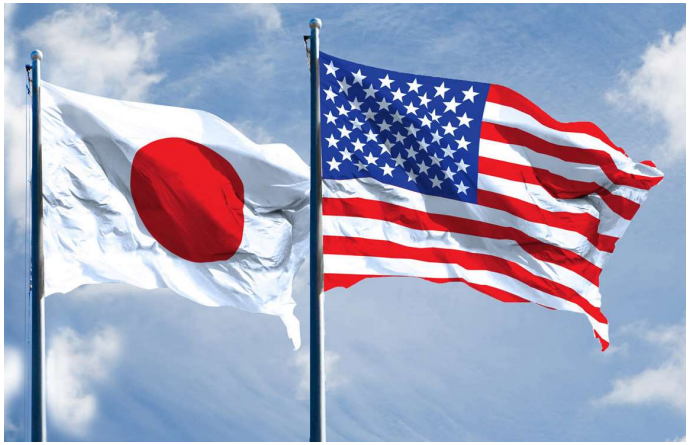
Worldwide





SOURCE: https://www.dreamstime.com/stock-photography-globe-earth-flag-ring-europe-centric-image12609082
https://commons.wikimedia.org/wiki/File:Chinese_flag_(Beijing)_-_IMG_1104.jpg
https://spfusa.org/
https://eupol.eu/

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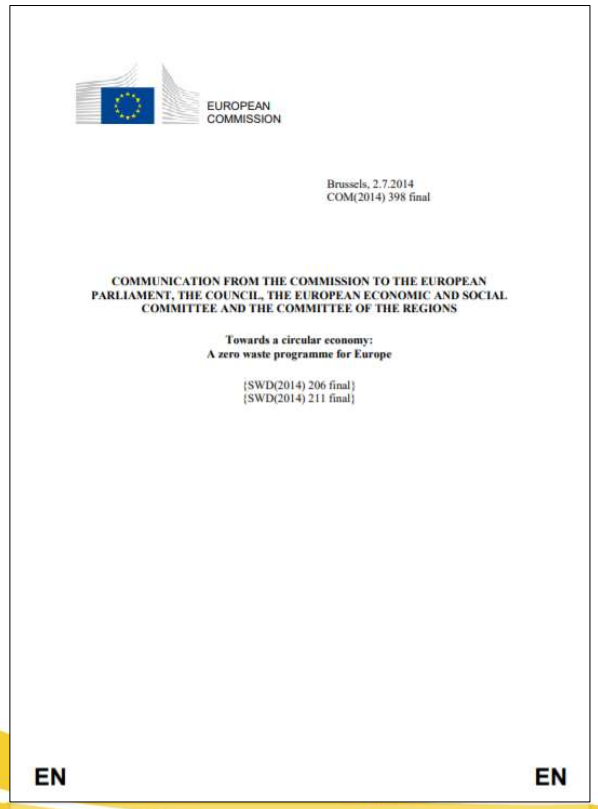
European level


EUROPEAN COMMISSION

Brussels, 2.7.2014
COM(2014) 398 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Towards a circular economy:
A zero waste programme for Europe

{SWD(2014) 206 final}
{SWD(2014) 211 final}

EN EN

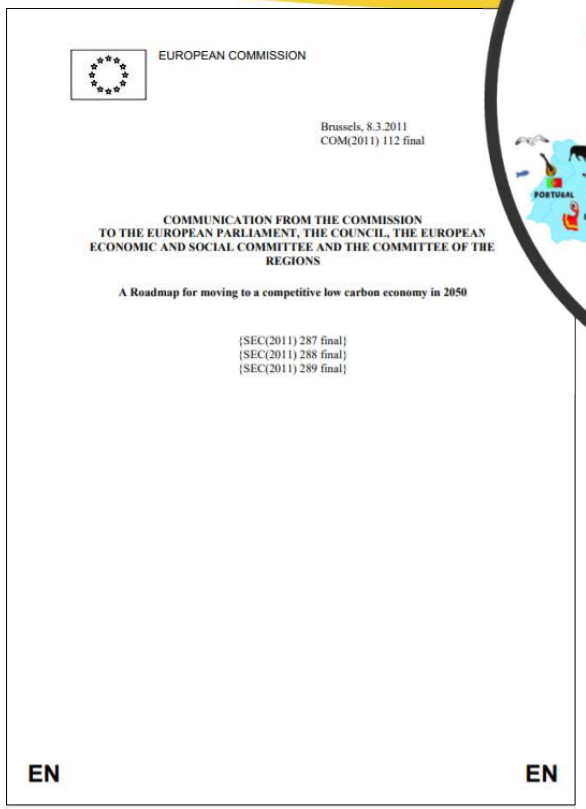

EUROPEAN COMMISSION

Brussels, 2.12.2015
COM(2015) 614 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Closing the loop - An EU action plan for the Circular Economy

EN EN


EUROPEAN COMMISSION

Brussels, 8.3.2011
COM(2011) 112 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

A Roadmap for moving to a competitive low carbon economy in 2050

{SEC(2011) 287 final}
{SEC(2011) 288 final}
{SEC(2011) 289 final}

EN EN

SOURCE: https://eur-lex.europa.eu/resource.html?uri=cellar:50edd1fd-01ec-11e4-831f-01aa75ed71a1.0001.01/DOC_1&format=PDF
https://eur-lex.europa.eu/resource.html?uri=cellar:8a8ef5e8-99a0-11e5-b3b7-01aa75ed71a1.0012.02/DOC_1&format=PDF
https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0112:FIN:EN:PDF

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Circular economy (CE) applicability to healthcare

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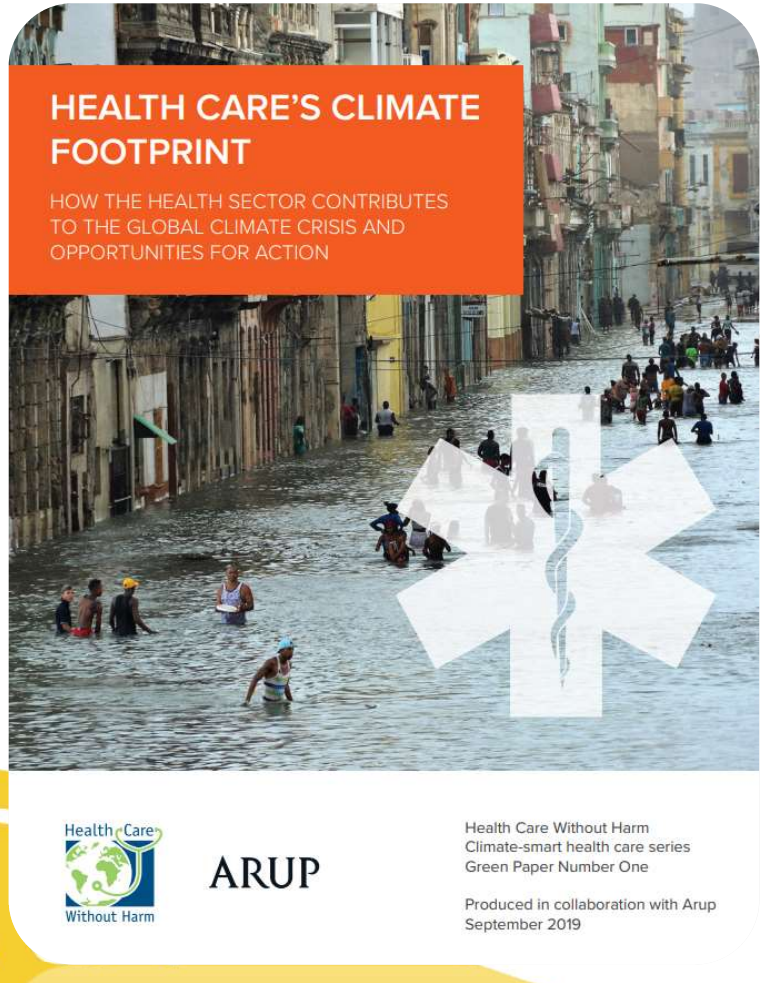
Environmental sustainability in hospitals



- 2019: HCHW/Arup
  - First report analysis of global health care's climate footprint

Environmental sustainability in hospitals

What are the key areas?

The RTTs have skills or a role in hospitals sustainability?

SOURCE: https://pt.dreamstime.com/salas-m%C3%A9dicas-do-escrit%C3%B3rio-interior-da-constru%C3%A7%C3%A3o-hospital-sala-de-espera-doutor-cl%C3%ADnica-emerg%C3%AAncia-e-desenhos-anim-image141652356
https://br.pinterest.com/pin/591378994806631387/
https://www.chandlermacleod.com.hk/blog/2018/11/the-future-of-diversity-in-renewable-energy-challenges-and-solutions
https://blog.krost.com.au/blog/2018/6/15/5-tips-to-create-sustainable-workplaces

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Environmental sustainability in hospitals

Environmental sustainability in hospitals

Authors	Year	Country of Origin	Type of study	Types of waste or Waste segregation or HWM	Energy	Behaviour or engagement and carbon footprint/environment sustainability	Environmental sustainability in hospitals, excluding HWM and energy
Muñoz	2012	USA	Opinion article	Yes	Yes	Yes	No
Mcgain and Naylor	2014	Australia	Systematic review and research agenda	Yes	Yes	Yes	Yes (hospital design, water, travel, procured goods, staff behaviour)
Tomson	2015	Newcastle	Opinion article	Yes	Yes	Yes	Yes (sustainable procurement)
Weimann and Patel	2016	South Africa	Research paper	Yes	Yes	Yes	Yes (energy, coal and water consumption)
Voudrias	2018	Greece	Editorial	Yes	No	No	Yes (green team)
Ferronato et al	2019	Italy	Research paper	Yes	No	No	No
Ali et al	2017	China and Pakistan	Mini-review	Yes	No	Yes	No
Barbosa and Mol	2018	Brazil	Research paper	Yes	No	No	No
Zamparas et al	2019	Greece	Research paper	Yes	No	Yes	No
Sherman et al	2020	USA	Narrative review	Yes	Yes	Yes	Yes (disposable vs reusable devices, education)
Esmaeili et al	2014	USA	Research paper	No	Yes	Yes	Yes (Fuel energy used to generate electricity and to manufacture the CT consumables)
Esmaeili et al	2018	USA	Research paper	No	Yes	Yes	

Most studied:

- **Waste management**
- **Energy consumption**

Environmental sustainability in hospitals

- Key application: **Waste management**
  - Minimising
  - Reducing
  - Reuse
  - Safely dispose
  - Segregating
  - Recycling

SOURCE: https://www.greenhospitals.net/sustainability-goals/

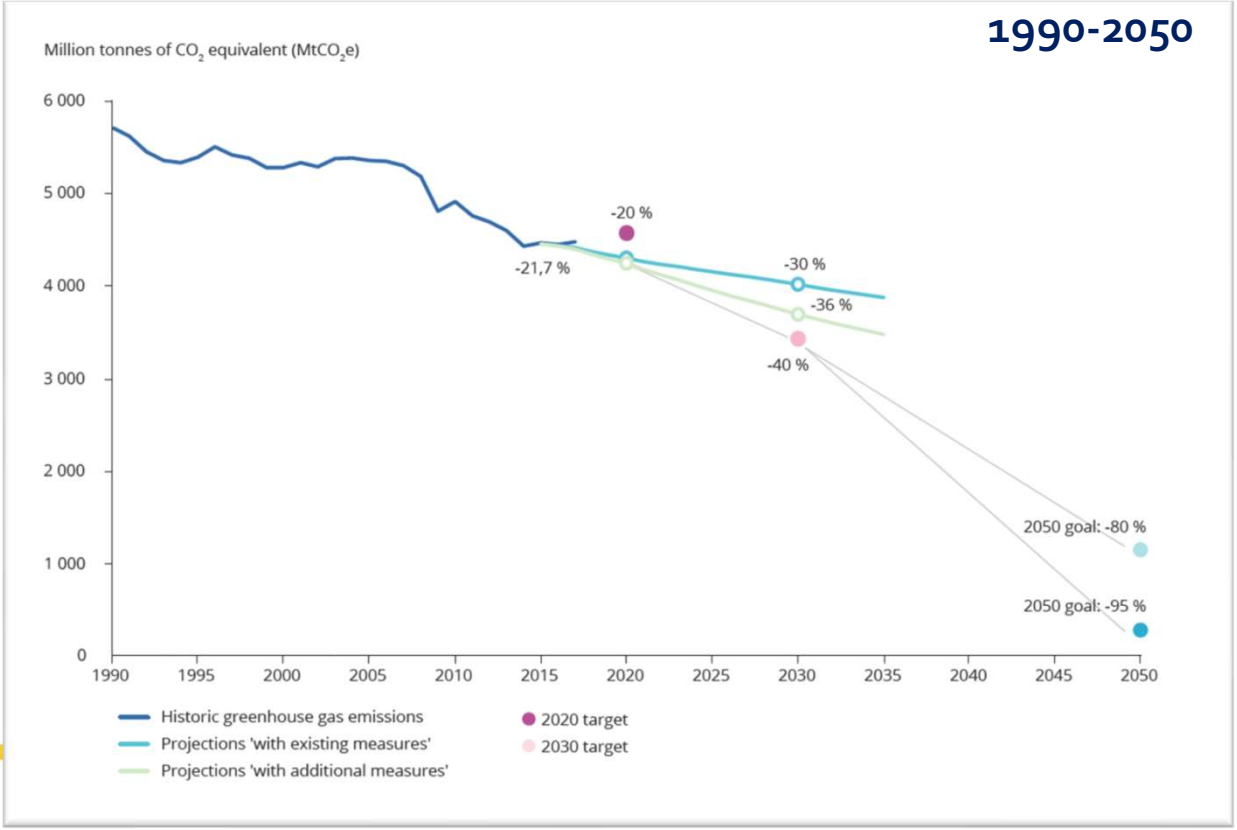
Environmental sustainability in hospitals

- Key application: **Behaviour**
  - **Related with psychological and social facts**
    - **Personal interest in the environment has been found related**
    - **Encourage the engagement in sustainable practices**

SOURCE: McGain F, Naylor C. Environmental sustainability in hospitals – a systematic review and research agenda. J Health Serv Res Policy. 2014 Oct;19(4):245–52.
https://www2.deloitte.com/us/en/insights/topics/talent/workplace-mental-health-programs-worker-productivity.html

Final remarks

Greenhouse gas emission trends and projections in the EU 27+UK



SOURCE: https://www.eea.europa.eu/data-and-maps/indicators/greenhouse-gas-emission-trends-7/assessment

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Take home message…

- Climate changes are a challenge to healthcare sector
- It is essential evalute, measure and report GHG/CO_2 emissions
- Everyone have a role in climate footprint reduction of the hospitals
  - Knowledge
  - Individual behaviour, attitudes and engagement
  - Institutional projects
  - Technology

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May 21, 2021

SOURCE: : https://www.delta-net.com/health-and-safety/environmental-awareness/faqs/what-is-global-warming