ABN·AMRO

Welcome to the summary of IPCC's Climate Mitigation Report

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It's easy to feel overwhelmed by the latest report of the Intergovernmental Panel on Climate Change (IPCC).
The IPCC released their 3000 page AR6 WGIII assessment report on climate mitigation as a means to inspire policymakers to promote climate action to change our economies.
While the content gives scientific backgrounds to the required system change, the sheer size and complexity of the IPCC publication can lead to despair.
We have compiled the highlights of the report into 8 fact snacks with brief backgrounds to the graphs. This publication will take around 15 minutes to read. Our goal is to make the information in this IPCC report more accessible to you, so you can start contributing to climate action. If anything the eight fact snacks show that system change is multi-faceted.

What does TLDR stand for?

(reading time: 30 seconds)

#TLDR is a commonly used hashtag that stands for "Too Long; Didn't Read." #TLDR is used to express that a piece of digital text is too long to actually invest the time to read it. Another TLDR related internet slang is "Wall of Text", which refers to an intimidating piece of text. The intimidating piece of text that we have read for you is called the IPCC AR6 WGIII. It is the latest compilation of scientific progress in human understanding of the causes and solutions to human induced/accelerated climate change.

Our TLDR service saves you time, but how much?

(reading time: 30 seconds)

Assuming that you are an average reader, you would need at least 2 (maybe 3) minutes for every page in the IPCC report. Give or take 50 hours, it would take an average reader 100 hours of concentrated reading to devour the report from cover to cover. We have put those 100 hours in for you and hopefully you enjoy the 8 key insights that we distilled as a summary. We have selected 8 nuggets of information for you to be able to digest the contents of the IPCC report in a comfortable way that does not require spending 100 hours, but 1 to 2 minutes per nugget.

Why is the word Anthropogenic crucial in this TLDR IPCC and what does it mean?

(reading time: 30 seconds)

The 2913 pages long IPCC report contains 279 mentions of the word "anthropogenic". A word built from the Greek word 'Anthropos' (human) and suffixed by the Greek word 'Genes' (born, produced, having origin in). In other word, the IPCC report gives us the scientific low-down on human produced climate change. So yes, the report is also talking to you, since as an individual you belong to the larger group called "the human race".

Overview of Carbon emission mitigation options

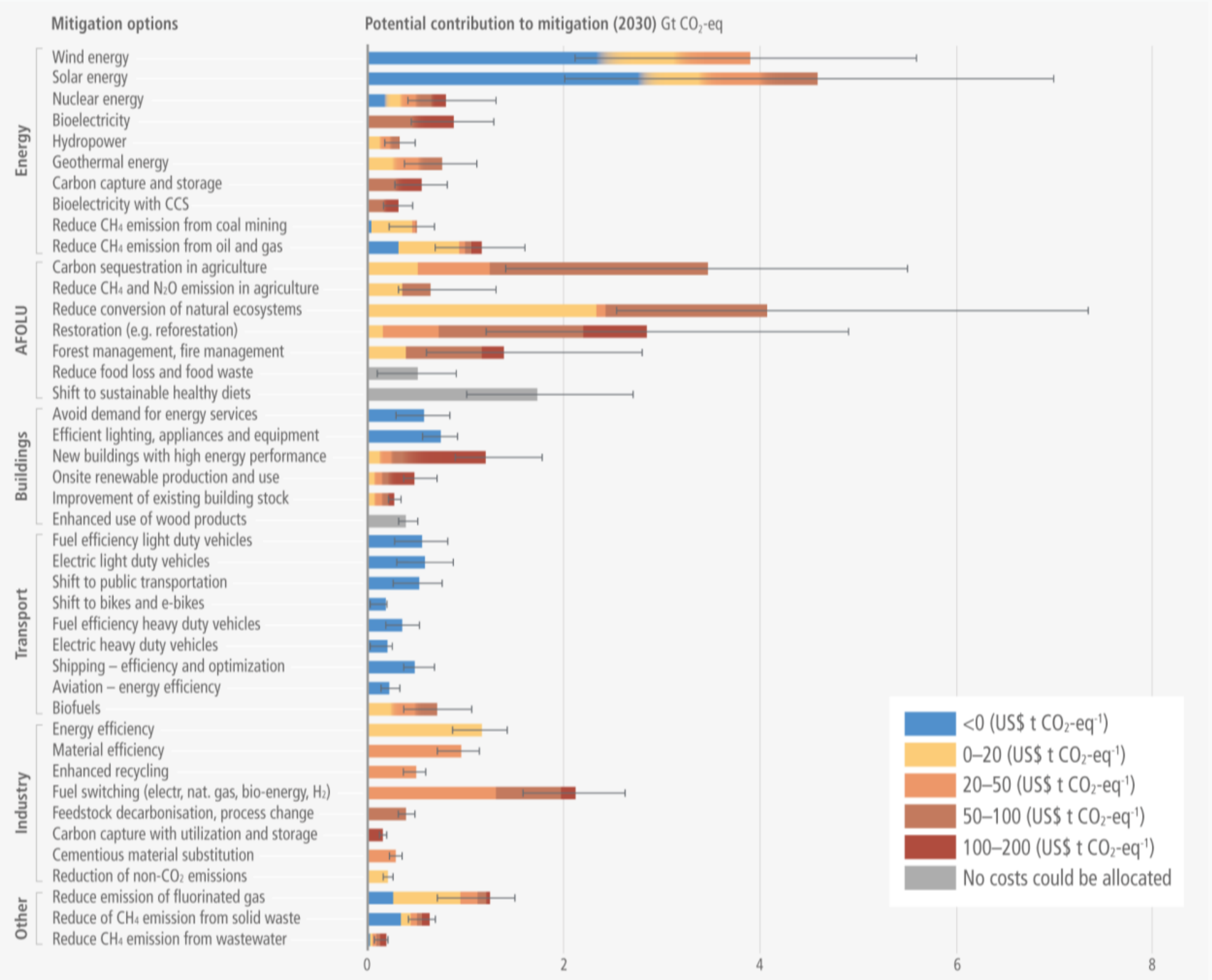

Figure TS.23: Overview of emission mitigation options and their cost and potential for 2030

Most covered piece of IPCC AR6 WG3 information: aka "the pricelist" with cost and mitigation potential of low-carbon technologies

Main message is that all mitigation options should be weighed by their potential contribution to climate change mitigation and the unit cost per ton of CO2 Eq. that can be avoided or mitigated by use of the technology.

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The most covered piece of information from the IPCC report in podcasts, videos and summaries of the IPCC AR6 WG3 report is what we call "the pricelist". It is a list of low-carbon or decarbonisation technologies that forms an overview of emission mitigation/reduction/decarbonisation options and their cost and potential for 2030.

Although we acknowledge that this is an attractive piece of information for policymakers, because it is actionable and contains budget related data, there is a major shortcoming as we simply cannot consume our way out of climate change. To broaden your perspective on the solution pathways, we will present you with 8 other nuggets of knowledge from the IPCC report that are somewhat less covered, but important enough to explain where we are today and where we are going with the climate agenda in the years ahead.

What is obvious from this IPCC "Pricelist" graph, is that with a 2030 time horizon the wind and solar-based technologies and land use, forestry and agriculture changes remain the technologies of choice to mitigate carbon emissions. Also note that at the bottom of the 2030 list carbon capture and storage shows a limited short to medium term potential. In order to contribute to the long run, climate mitigation options after 2030, venture capital and private capital, will need to find their way to the carbon capture and storage technologies. This is a race against the clock of carbon concentrations. Soon-to-be climate unicorns, semi-jokingly called "soonicorns" will need to come up with surprising technological improvements to dramatically lower the unit cost and improve mass availability of experimental techniques such as carbon capture and storage and hopefully many other alternatives.

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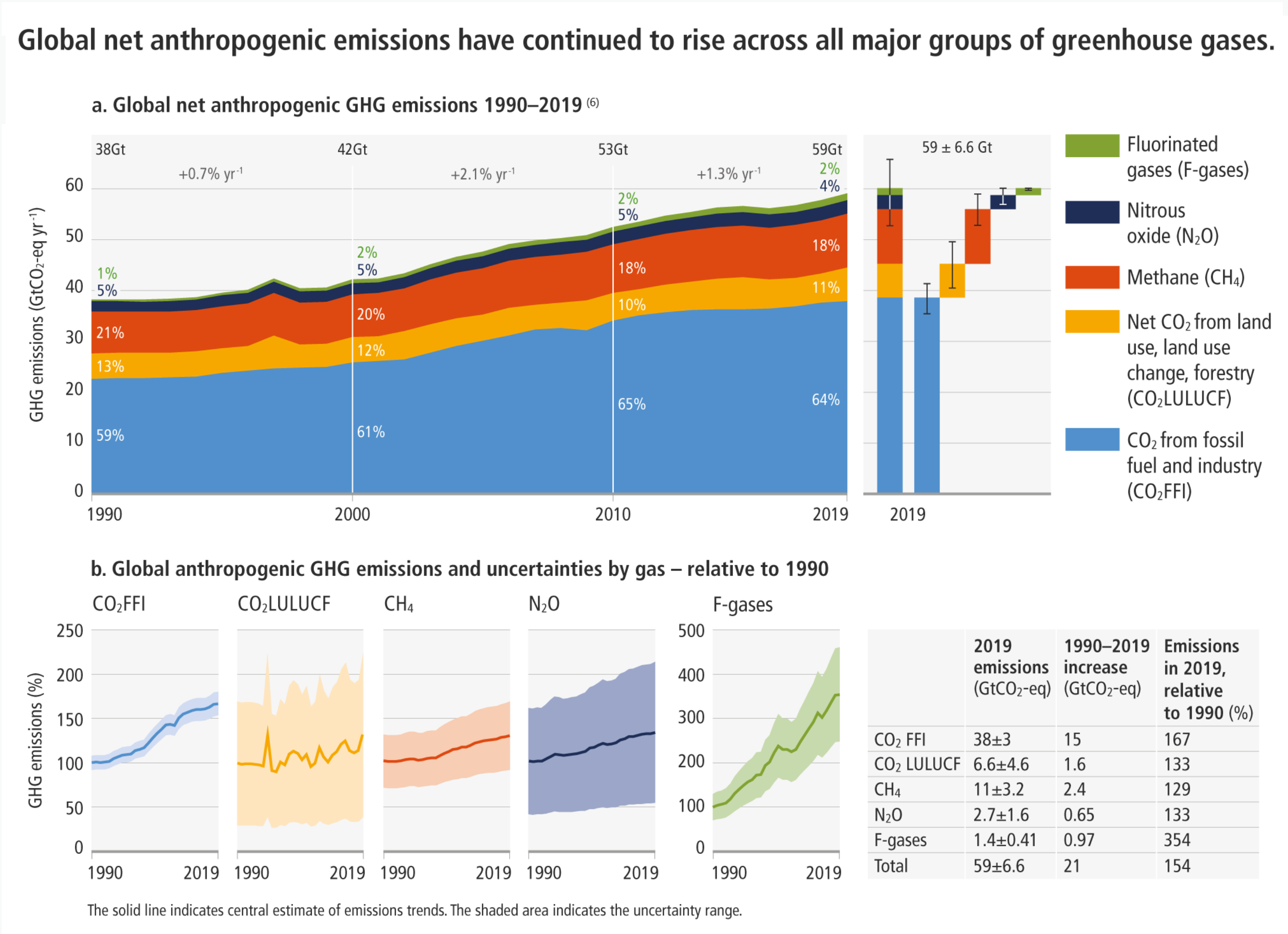
Knowledge Nugget #1: We are not on track

(reading time: 30 seconds)

Main message by IPCC that was picked up by international media worldwide from the IPCC WGIII AR6: We are not on track for a 1.5 degree warming world by the end of the century (2100).

Global net anthropogenic GHG emissions have continued to rise for the last 30 years (and in fact for the last 150 years as shown in other graphs in the report). And yes, science confirms that two thirds of the greenhouse gases produced by humans come from fossil fuels and industrial activity. In five words: "We are not on track".

Furthermore the distribution of greenhouse gases growth created by humans is uneven across continents and countries, built up over long periods of economic activity between 1850 and 2019 and continuing to grow in this uneven way.



Historical GHG emissions sliced by geography and by source of GHG emissions

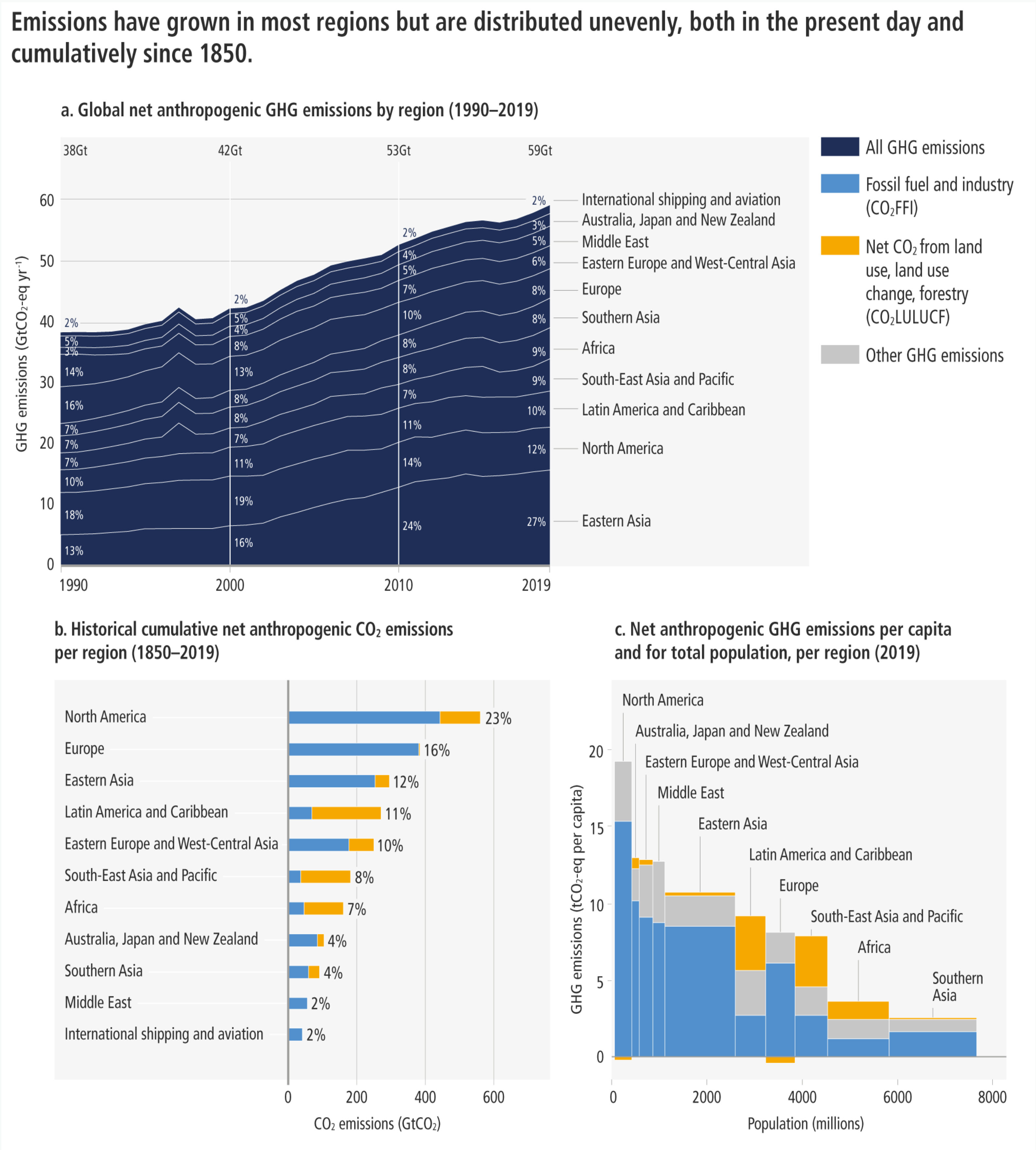


Figure SPM.2: Regional GHG emissions, and the regional proportion of total cumulative production-based CO2 emissions from 1850–2019

Source: Figure SPM.1: Global net anthropogenic GHG emissions (GtCO2-eq yr-1) 1990–2019, page 7

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Knowledge Nugget #2
Human development and "How one carbon trajectory does NOT fit all"

(reading time: 3 minutes)

Main message: The carbon trajectory of low and middle-income countries that need to further develop services as health care, education and safety for their population is inherently different from the carbon trajectory for high developed economies. This insight belongs to the just transition principles underpinning the transition towards a low carbon economy.

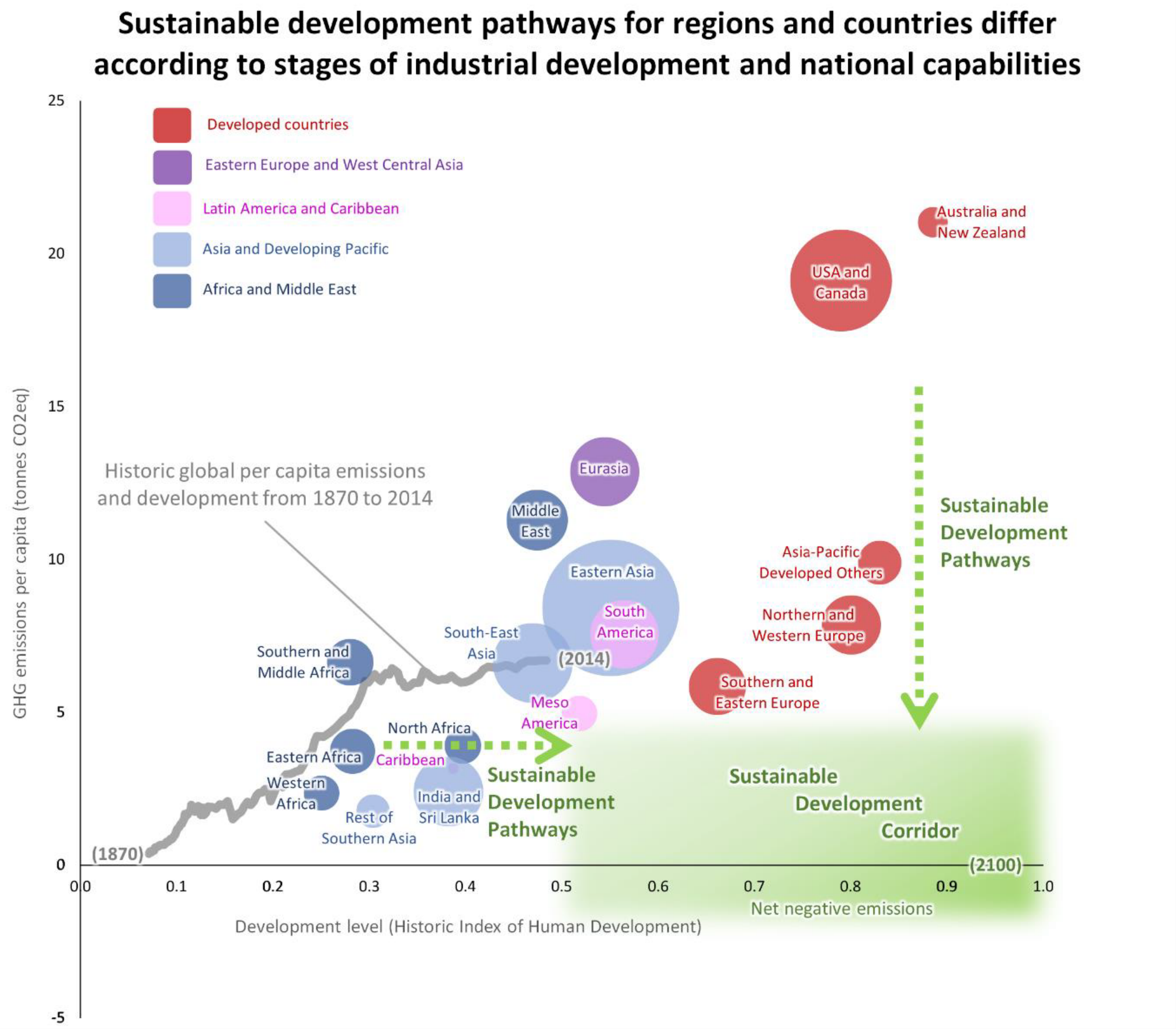
Historically, since industrialisation, high levels of human development and high levels of GHG emissions per capita go hand in hand. This can be seen in the graph by inspecting the position of Australia, New Zealand, USA and Canada. Although developed countries in Asia Pacific and Europe prove that carbon emissions per capita can be lower with a high standard of human development.

Human development looks at whether the population can lead a healthy life under the offered circumstances, has access to knowledge and a decent standard of living, mostly measured by life expectancy. There are large differences here.

Just compare the blue bubble of Western Africa in the bottom left corner to the red bubbles of the USA, Canada, Australia and New Zealand in the upper right corner.

Let's start with understanding the horizontal axis: Historical Index of Human Development (HIHD) levels. This is mostly measured by access to education, healthcare and safety resulting in a higher or lower life expectancy. The vertical axis shows per capita GHG emissions for the country or region. Low- and middle-income countries are at the lower end of the spectrum when it comes to greenhouse gases per capita and highly developed economies are at the high end of the spectrum for per capita GHG emissions.

Difference in trajectory for high income and low and middle income countries



Source: IPCC, Chapter 1 IPCC AR6 WGIII, Figure 1.5, page 249 (Chapter 1 – 43) Vertical axis: per capita GHG emissions, Horizontal axis: Historical Index of Human Development (HIHD) levels. Figure 1.5: Sustainable development pathways towards fulfilling the SDGs.

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The position of Western Africa and USA in Figure 1.5 is explained in further detail by the graphs underneath.

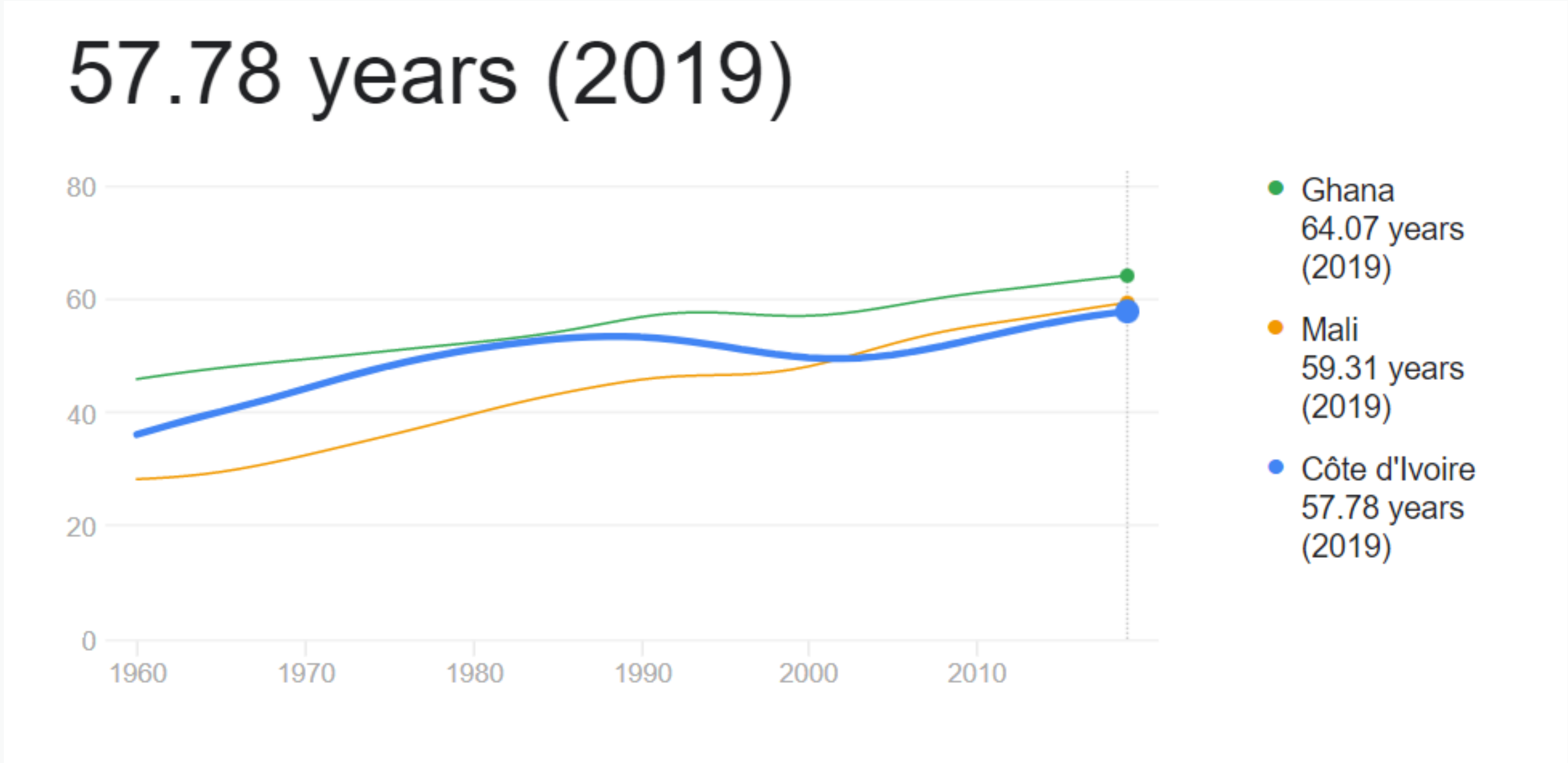
The green box called the Sustainable Development Corridor edges on the average of Human development on the horizontal axis (.5) and the global average of GHG emissions per capita (lower than 5 tonnes CO2 eq per capita).

As you can see from the green arrows, the path of Western Africa and USA towards the Sustainable Development Corridor are inherently different in direction. For Western Africa a slightly diagonal, but primarily horizontal trajectory. For USA the trajectory is primarily vertical by lowering GHG emissions and maintaining or improving human development levels.

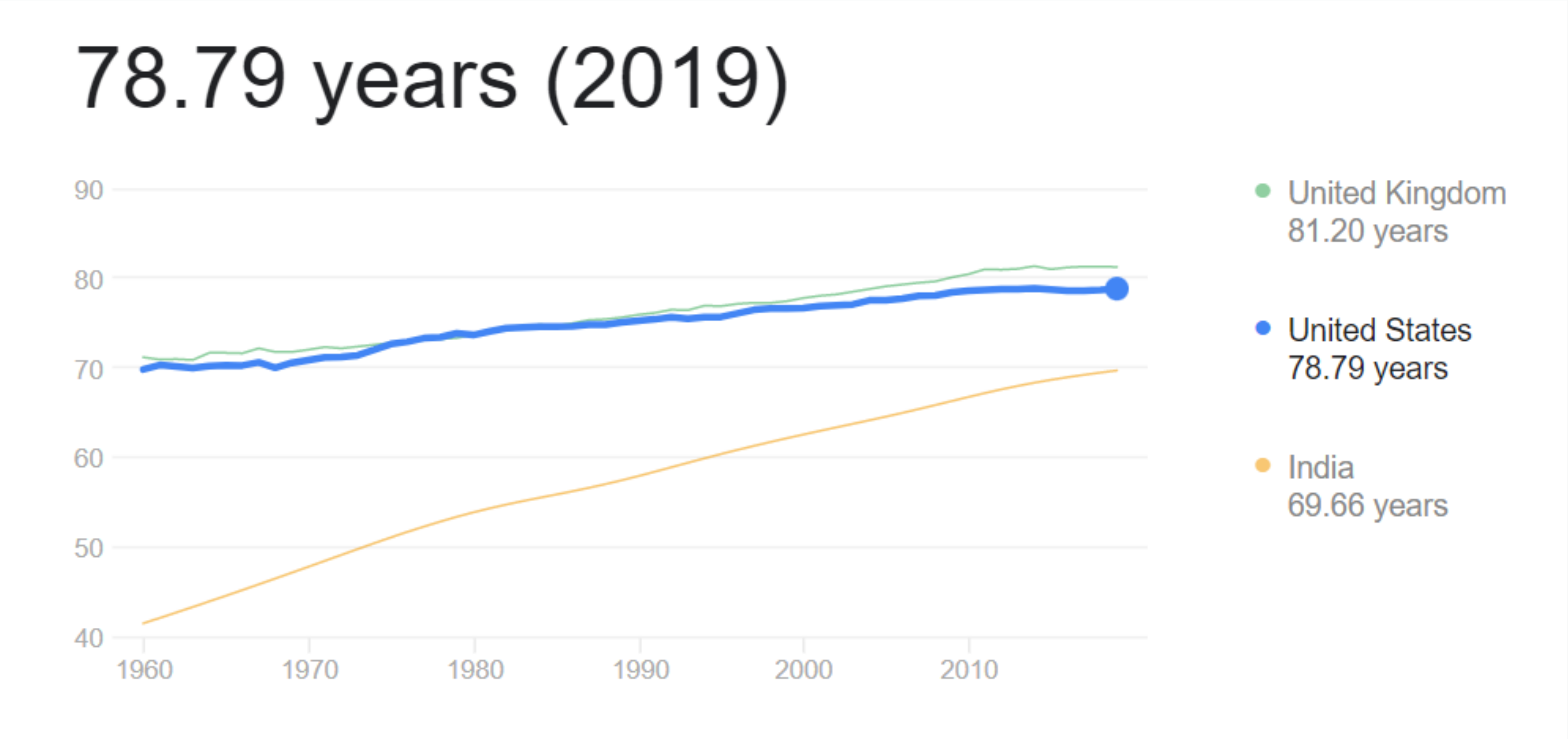
The sustainable development pathways situated at both sides of the spectrum (bottom left corner and top right-hand corner) are inherently different: one size does not fill all. The starting position matters. The respective starting points illustrate the lack of equality between the economic faith of humans on this planet and the sustainable development tasks at hand. Some countries, for the sake of developing more human services in the fight against poverty, will need to slightly increase their carbon footprints. While those at the apex of current human development (education, healthcare, safety, good common infrastructure), will need to put most efforts into decarbonisation.

To illustrate the differences, we compare Western Africa and North America: Ivory Coast's GHG emissions per member of the population is around 10 times lower than the global average and the USA's GHG emissions per member of the population is around 3 times higher than the global average. There is science available that shows that certain levels of affluence allow GHG emissions per capita to drop, this is the driving factor behind the decarbonisation of the USA. For Cote d'Ivoire there is still room to travel higher on the curve of GHG emissions per capita, all the while stimulating Cote d'Ivoire's horizontal move towards higher human development and higher life expectancy.

Illustrative GRAPH: Development of life expectancy in three Western African Countries



Illustrative GRAPH: Development of life expectancy in USA



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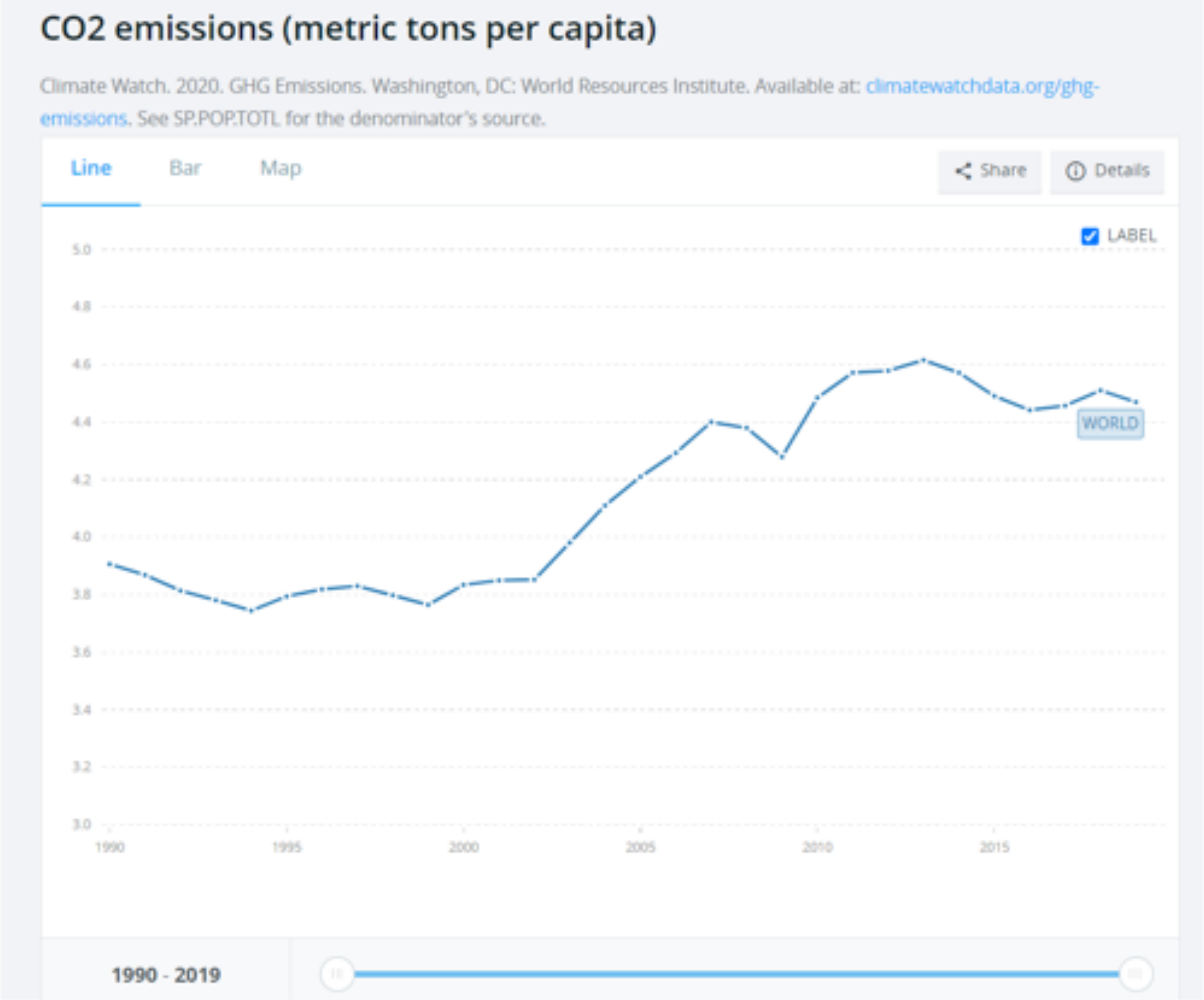
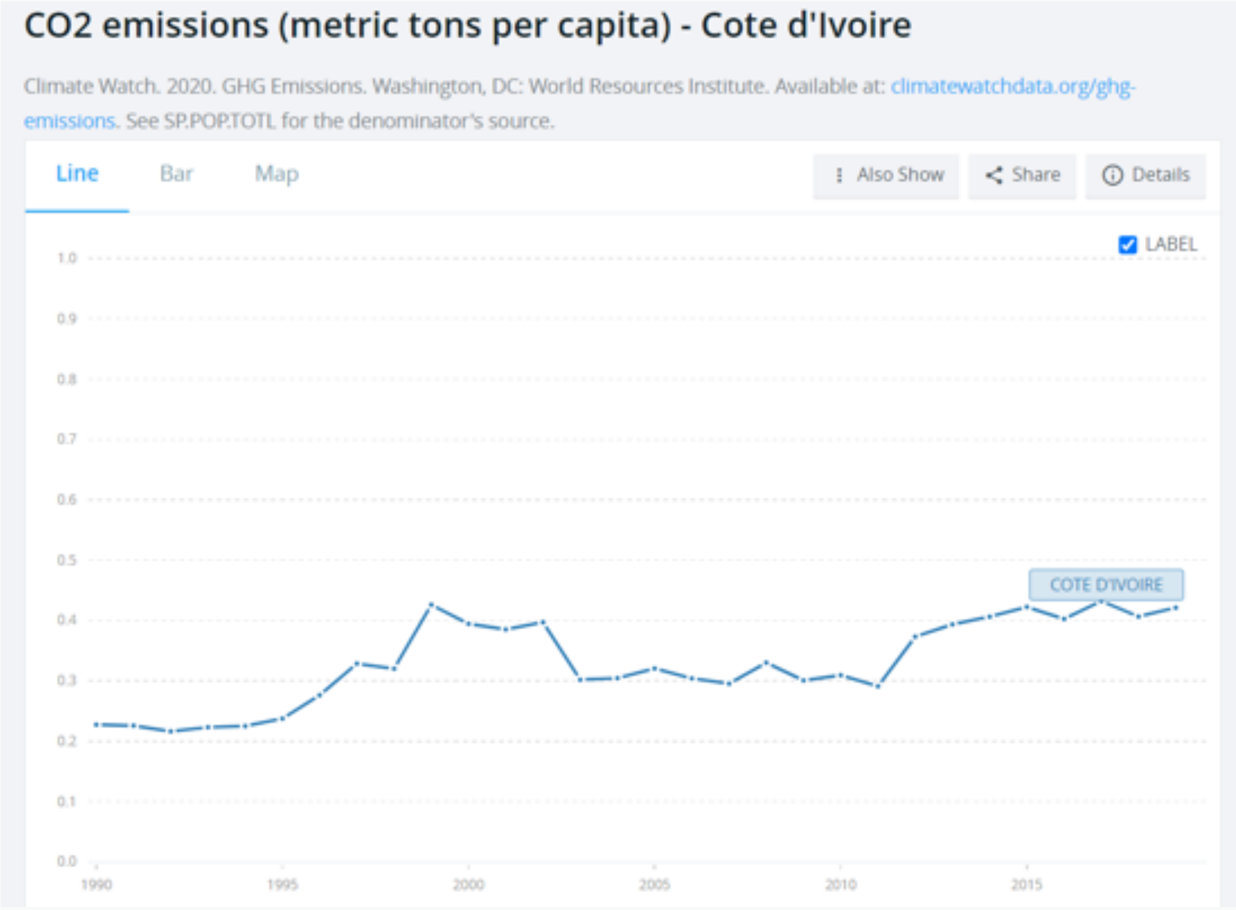
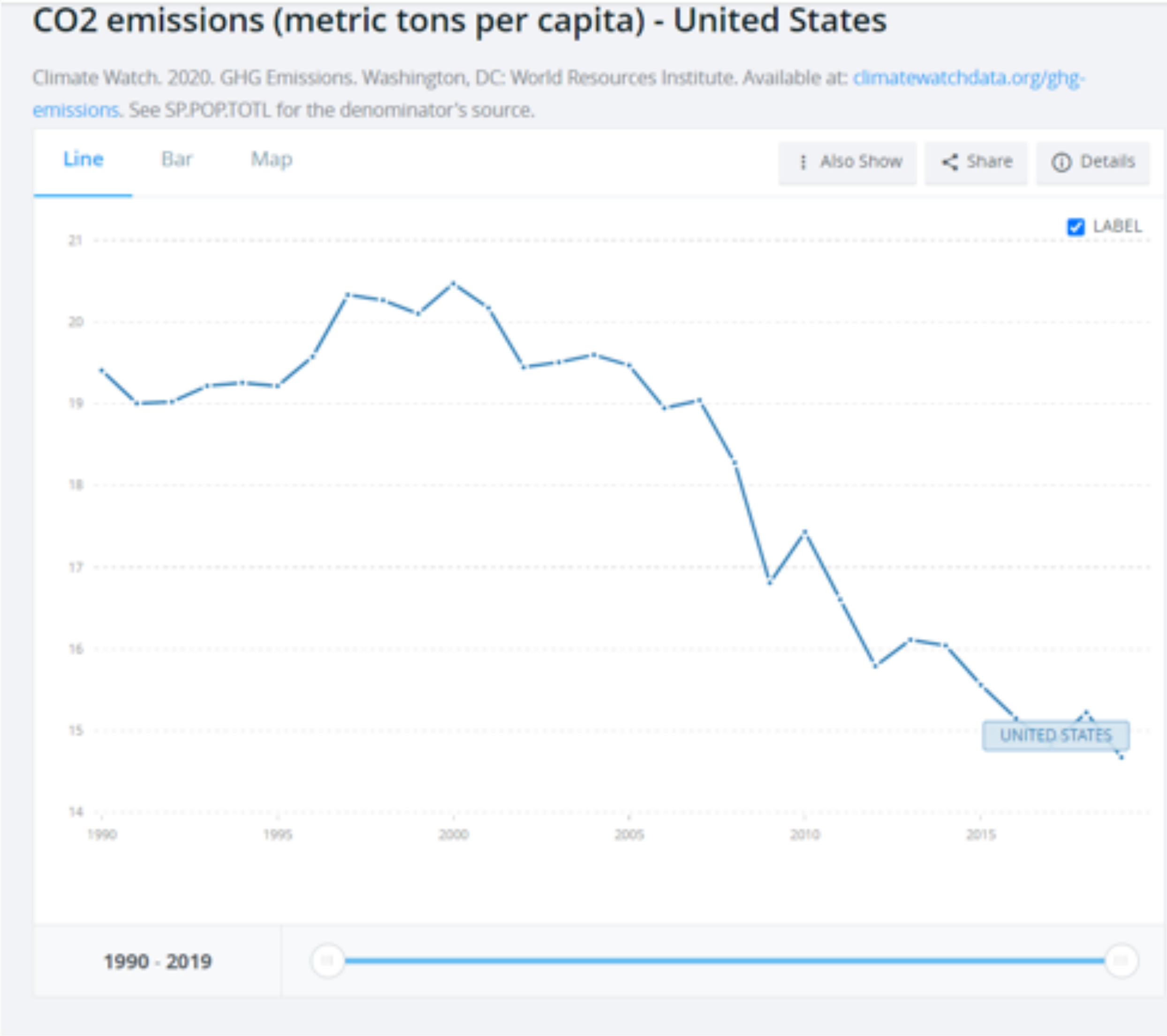
Illustrative GRAPH: Vertical axis: per capita GHG emissions for the WORLD



Illustrative GRAPH: Vertical axis: per capita GHG emissions for Cote d'Ivoire



Illustrative GRAPH: Vertical axis: per capita GHG emissions for the United States



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Knowledge Nugget #3
Tension between money and Innovation

(reading time: 2 minutes)

Main message: Public and private money have not sufficiently been flowing to redesign, concept, early-stage development and R&D. Pension money has focused on construction and commercial operation phases. Public money shows a 30-year slump between 1980 and 2010. Public spending on R&D only recently recovered to a level after the oil crisis. While both private and public money flows are needed to fund the reinventing of our energy landscape, the graphs do not reflect this societal urgency.

Historically, there are high failure rates in early project preparation phases, early-stage development (e.g. lab scale prototypes) or advanced development (e.g. full scale prototype). During these very high-risk phases, the financial guarantees, grants, technical assistance (e.g. stakeholder communication support) should be made available by public-private financial arrangements. Feasibility studies and proofs-of-concept are needed to de-risk the construction and scale-up phase of innovations. Finance for 2 to 10% of the total project cost should be mobilised in an early stage to deliver technically, financially and socially feasible projects. There should be more creativity pouring into public-private financing before the "kick-start" of the low carbon projects. Right now, the capital flows in at the start of the construction phase, working towards the Commercial Operations Date (COD). Also, during commercial operation, money from institutional investors is available for further expansion of capacity.

The tension between money and innovation / R&D becomes even more apparent when we look at the public spending for energy related R&D. The term R&D is mentioned more than 200 times in the IPCC paper. The term innovation is mentioned over 1000 times in the IPCC paper. Still, while the need for R&D and innovation is high, the funding remains historically "moderate".

Focus of institutional investors is not on the concept, early and advanced development phases

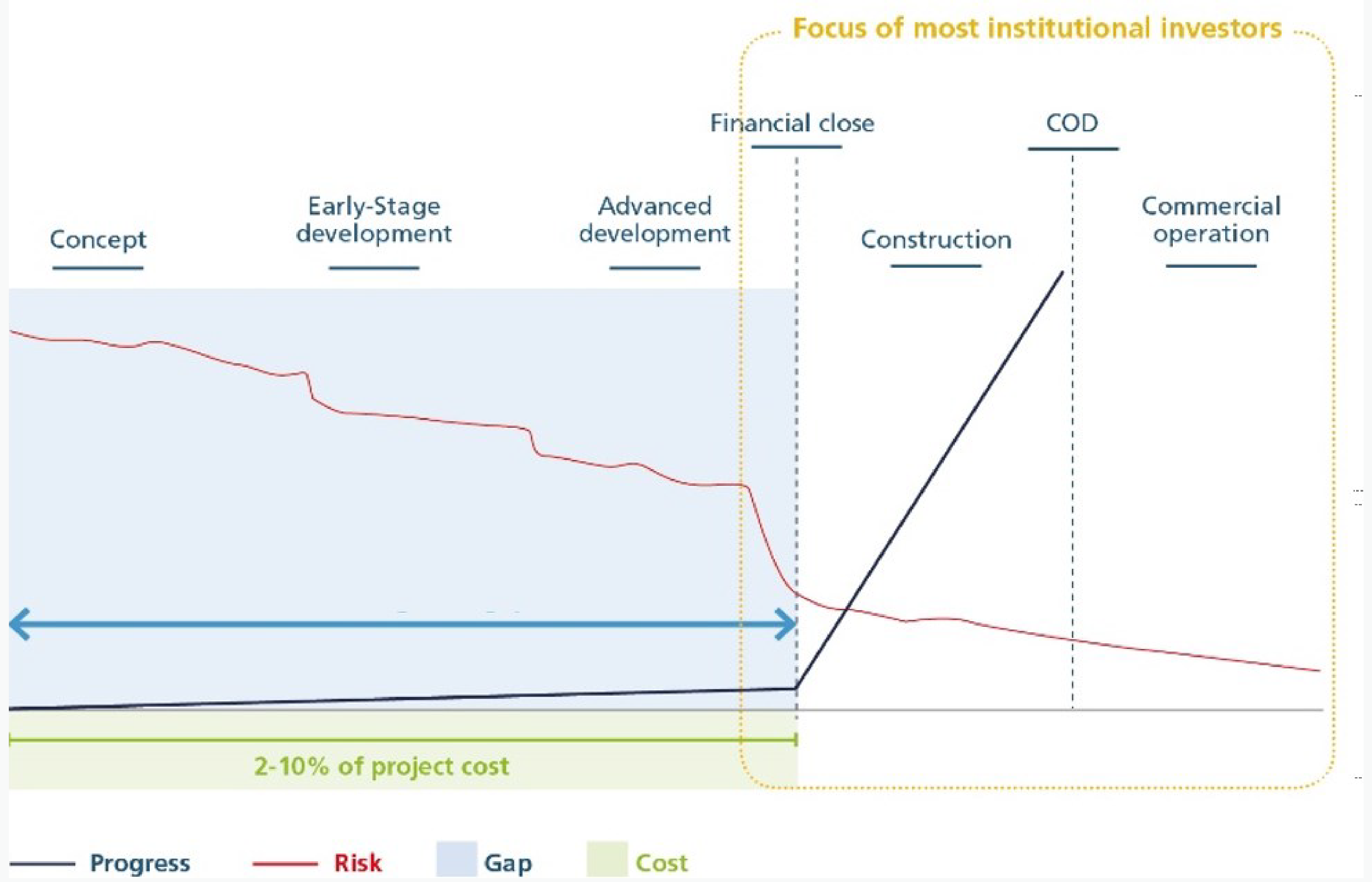

Figure 15.7 Bond refinancing mobilises institutional investors in mature project phase. Derisk early-stage infrastructure projects. Source: Building on PIDG 2019

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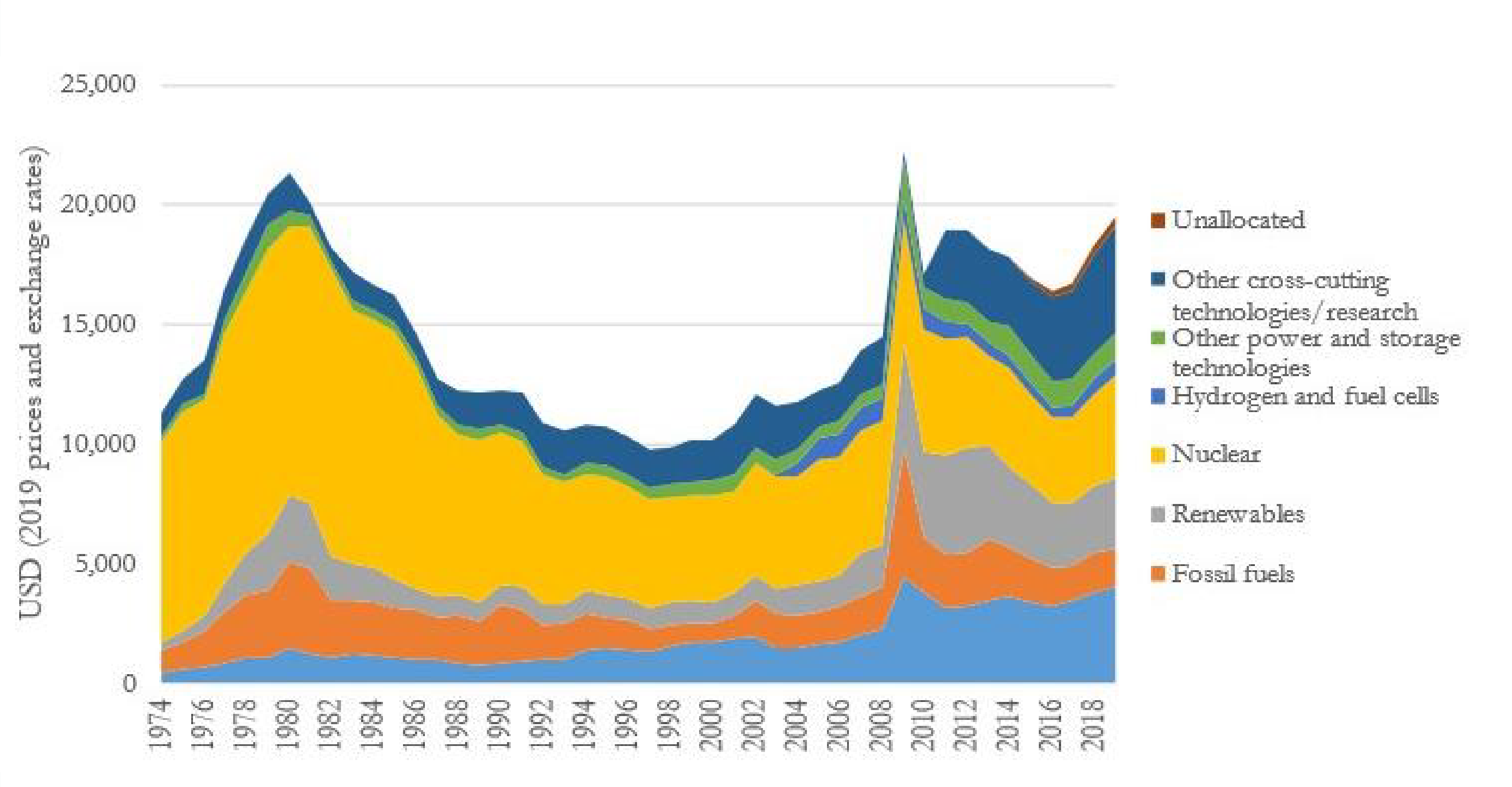
Quite clearly, the graph shows that public spending for energy-related R&D has come out of a slump over the last 30 years, only now reaching levels of public spending comparable with the peak of energy related R&D spending after the two oil crises (1973 and 1979).

Second, the graph shows that gradually funding has moved away from nuclear energy over a period of 30 to 40 years of time. Right now, many are revisiting the low carbon properties of nuclear energy as part of the solution to stop uncontrolled climate change.

Third, the graph shows the increase in spending on cross cutting technologies, like smart grids and infrastructure for electrification.

Slump in Energy related R&D spending between oil crisis and now



Box 16.3, Figure 1 Fraction of public energy RD&D spending by technology over time for IEA (largely 17 OECD) countries between 1974 and 2018. 18 Sources: IEA RD&D Database, 2019 (IEA 2019). (extracted on November 11, 2020).

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Knowledge nugget #4: National Climate legislation seems to be stalling over last 5 years

(reading time: 2 minutes)

Main message: National legislation is lagging in relation to international, diplomatic agreements such as the Paris Agreement.

You might think that we are heading straight to climate disaster when you read this graph. At the surface it looks like really, really bad news. To a certain extent it is, because this means that only 47% of Global GHG emissions are covered by national climate legislation. National climate legislation means that it has been voted and approved by national parliament as a national law. Another condition for this statistic is that the legislation includes the reduction of GHGs in its title or objectives.

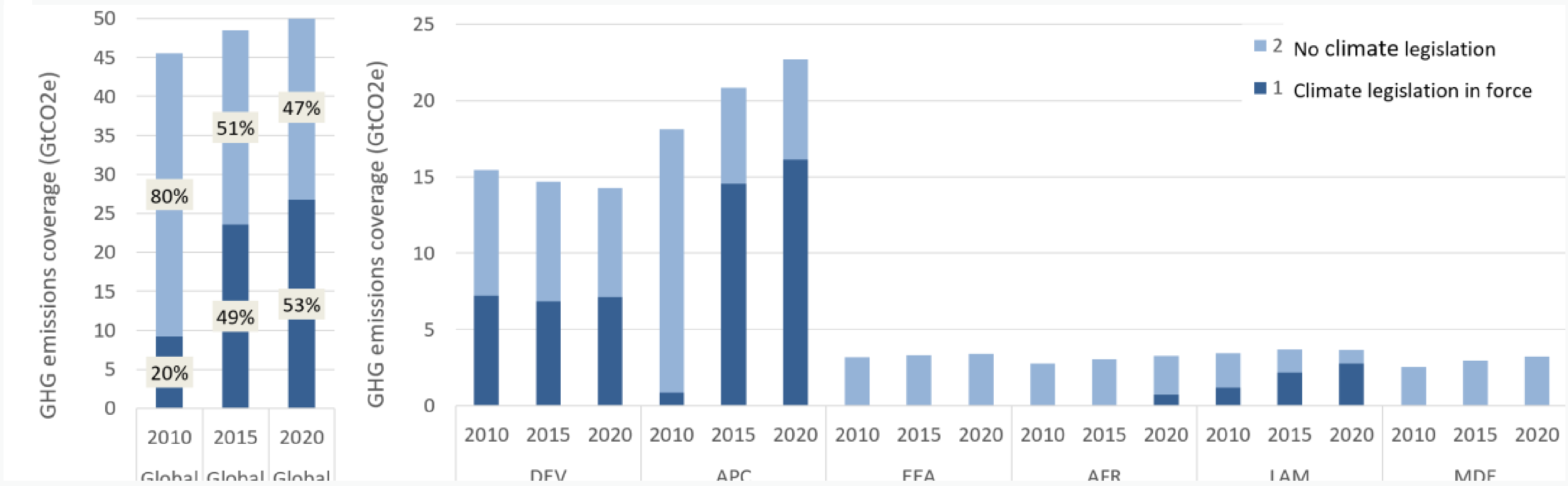
The legend is composed of these elements:

- DEV = Developed countries
- APC = Asia and developing Pacific;
- EEA = Eastern Europe and West-Central Asia;
- AFR = Africa; LAM = Latin America and the Caribbean;
- MDE= Middle East.

But luckily it is not only up to national parliaments to vote climate legislation, multilateral agreements cover a larger part of global GHG emissions as well.

By 2020 already 90% of the Global GHG emissions is covered by a GHG emissions target, either executive (e.g. country is signatory to carry out the UNFCC's Paris Agreement) or legislative (target is defined as part of the legally binding nature of the Kyoto Protocol). The Kyoto Protocol in 1997 excluded strongly growing developing countries (e,g, People's Republic of China) from binding targets, and the USA failed to sign up to Kyoto. This failure of international climate diplomacy was corrected in 2015 in Paris. Especially the wealthiest countries and a growing number of low and middle income / developing countries have published economy-wide GHG emissions targets that covered 90% of global emissions in 2020 compared to 49% in 2010 (before Paris Agreement). All in all, this forms a glimmer of hope since climate legislation supports the growth of appetite of financial investors.

Coverage of Global GHG emissions by national climate legislation



Coverage of global GHG emissions by UNFCC Kyoto Protocol or Paris Agreement

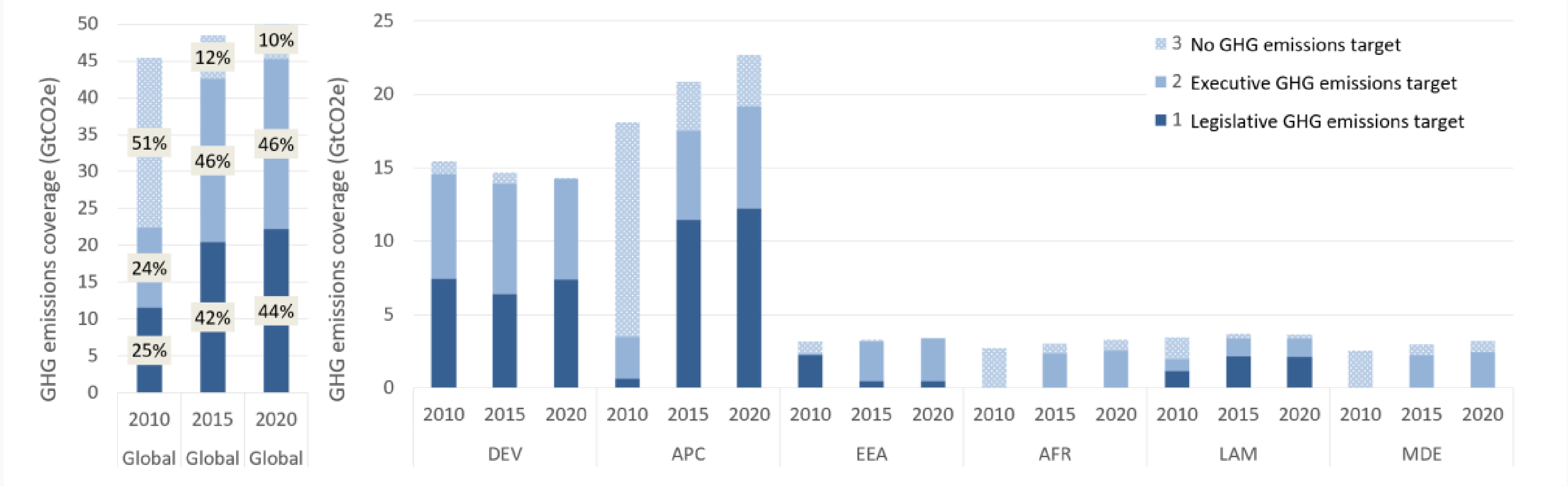


Figure TS.24: Prevalence of Legislation and Emissions Targets across Regions

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Knowledge nugget #5: Avoid, Improve and Shift approach to climate mitigation

(reading time: 2 minutes)

Main message: Human behaviour change carries great potential for climate mitigation. We can avoid, improve and shift carbon intensive behaviours. Social norms and conventions play an important role in these behavioural changes.

The x's are averages. The boxes represent the 25th percentile, median and 75th percentiles of study results. The whiskers or dots show the minimum and maximum mitigation potentials of each option. Negative values (in the red area) represent the potentials for backfire due to rebound, i.e., a net-increase of GHG emissions due to adopting the option. This is particularly at play with the choice of vehicles; when shifting from an ICE (Internal Combustion Car) to a hybrid electric vehicle, or plug in hybrid electric vehicle, or even battery electric vehicle, all run the risk of rebound effects (increased usage).This Avoid – Improve – Shift overview presents another glimmer of hope. We can do it, but we need to change some of our most carbon intensive ways. While humans are the cause of the surplus of greenhouse gas emissions in our atmosphere, humans are also the solution. Our change in human behaviour is part of the solution as long as we keep on focusing on "Avoiding, Improving and Shifting" our consumption towards less carbon intensive solutions. To fulfil these human needs we have a choice, although not always a simple one.

Choosing low-carbon options, such as car-free living, local holiday planning, plant-based diets or very little animal products (vegetarian), low-carbon sources of electricity and heating at home (solar, geo-thermal), not having pets and avoiding air travel, can reduce an individual's carbon footprint by around 10 tonnes of CO2-eq per year. To give a reference point: an average carbon footprint by a US citizen is around 15 tonnes of CO2-eq per year. The average carbon footprint worldwide is around 5 tonnes of CO2-eq per year.

Possible behaviour changes that promote low carbon lifestyles

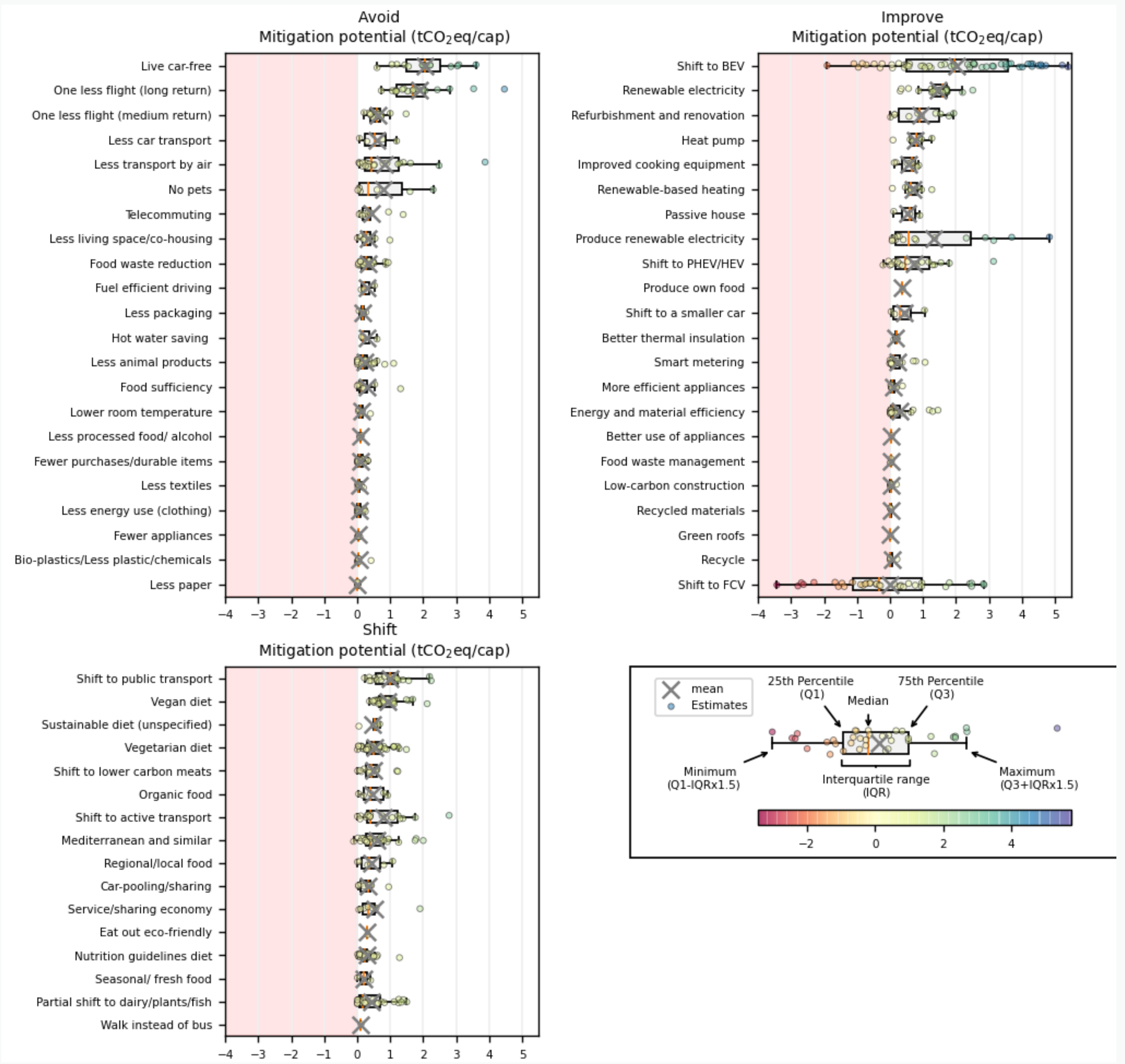
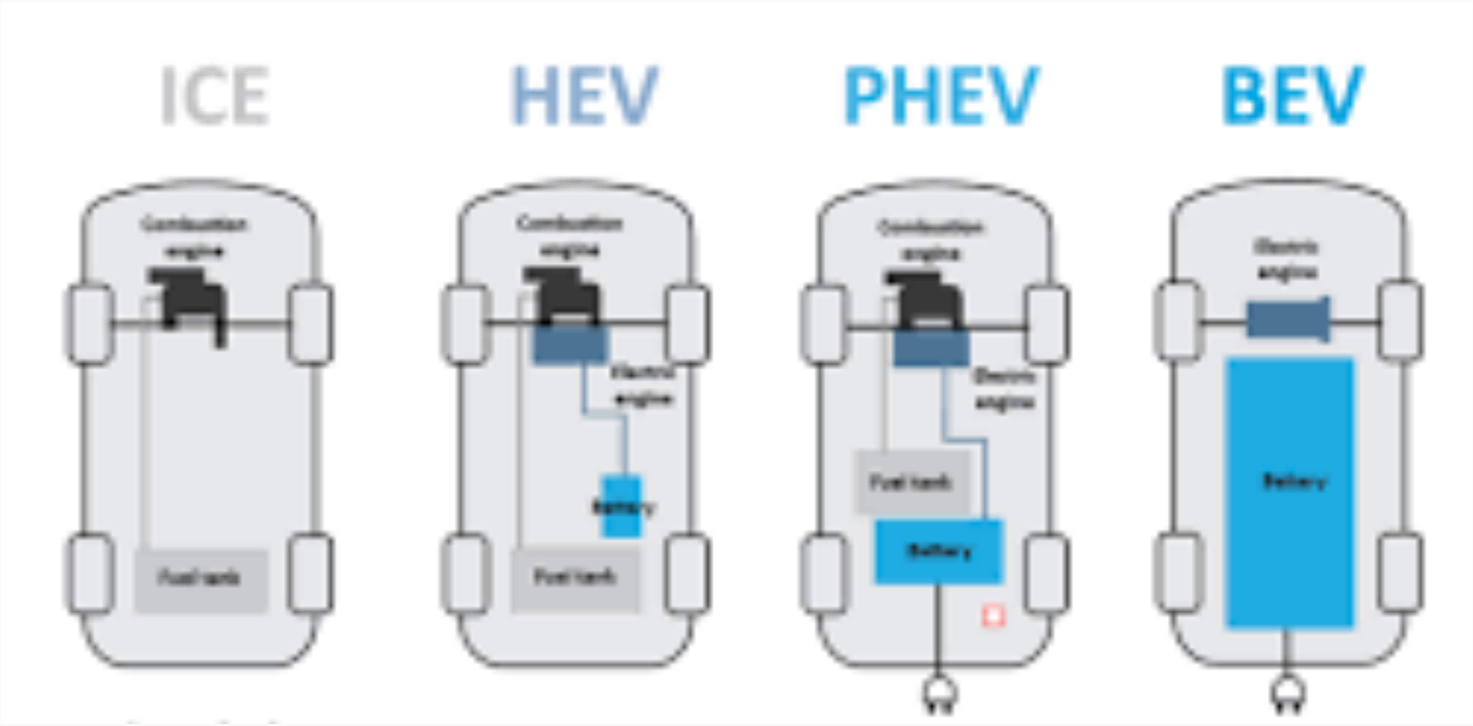


Figure 5.8 Synthesis of 60 demand side options ordered by the median GHG mitigation potential found across all estimates from the literature.

Difference in types of vehicles



ICE= Internal Combustion Engine
HEV = Hybrid Electrical Vehicle
PHEV = Plug-in Hybrid Electrical Vehicle
BEV = Battery Electrical Vehicle

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(reading time: 2 minutes)

Main message: The just transition principle can also be visualised by adding decency levels to the discussion about services, like housing, mobility and food. These graphs show that fighting poverty and combating climate change are two sides of the same coin. While high income countries can have service levels above the decency line for both top and bottom incomes, their challenge remains to manage the gap between the top and bottom incomes of society. Low-income countries have an additional challenge of improving service levels for the bottom tier of incomes, above the decency level or poverty line.

If we are talking about just transition, we touch upon social issues related to climate action. For a just transition, countries that take climate action will also need to assess the differences in service levels based on income differences. The global inequality at the level of human wellbeing can be analysed not based on usage, but on the basis of accessibility of a certain technology or service.

While for food there are significant differences, there are service levels achievable above decent living standards across all continents. An equal distribution of food is a key enabler to achieve decency levels around the globe for food. Housing, mobility, communication via mobile phones, and access to high-speed internet are the largest differences and the biggest challenges. The red lines in the various sub-graphs represent the values that are proposed as decent standards of living thresholds.

Countries also need to track the evolution of within-country differences in service levels as a function of income differences, as shown here for the Netherlands (bottom and top 10% of incomes) and India (bottom and top 25% of incomes)

Decency levels of services to citizens are different across countries and influence policy needs

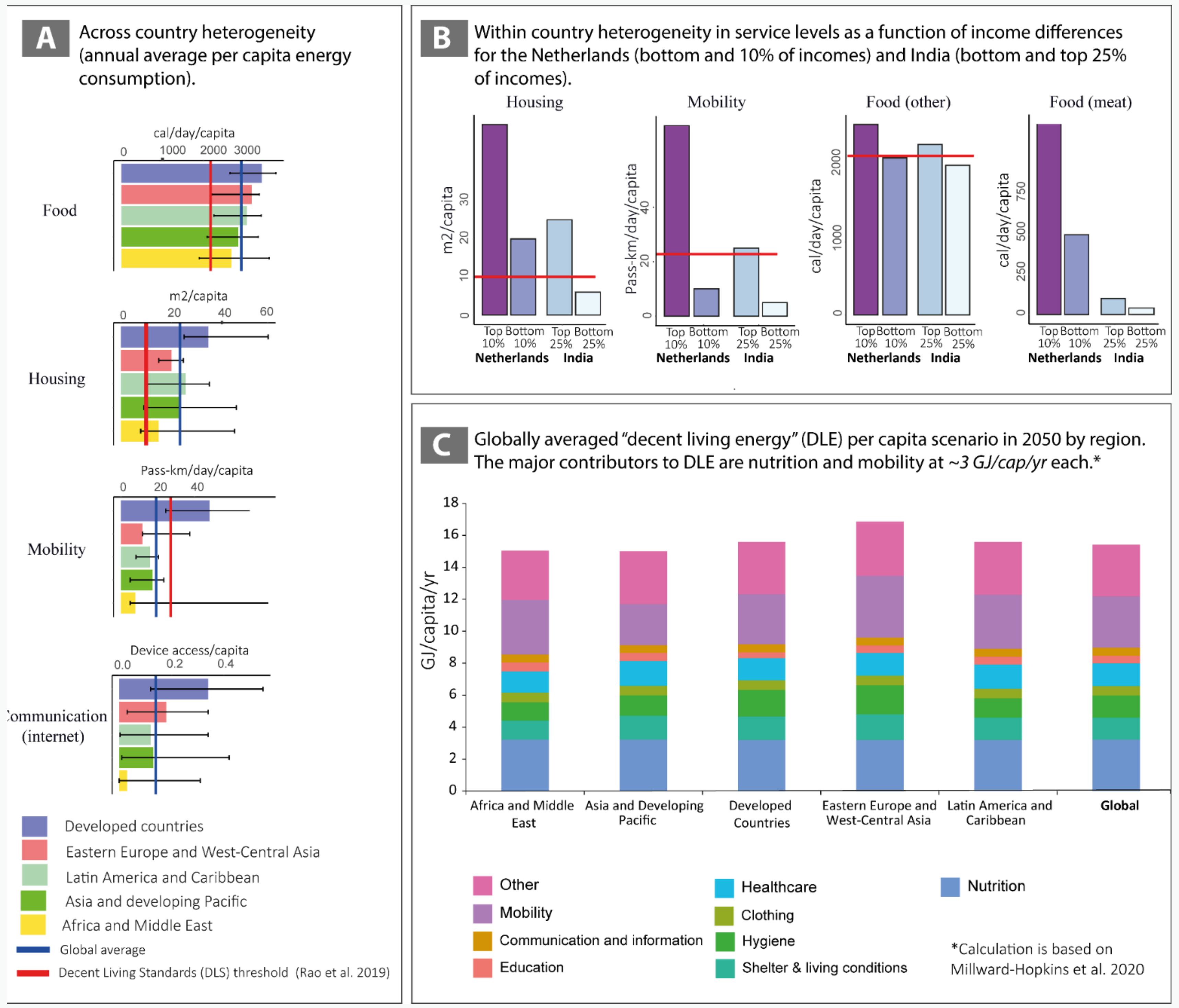


Figure 5.2 2 Heterogeneity in access to and availability of services for human well-being within and across countries.

Decency levels of services to citizens are different across countries and influence policy needs

What does TLDR stand for?

Our TLDR service saves you time, but how much?

Why is the word Anthropogenic crucial in this

TLDR IPCC and what does it mean?

Knowledge Nugget #1: We are not on track

Knowledge Nugget #2 Human development and "How one carbon trajectory does NOT fit all"

Knowledge Nugget #3 Tension between money and Innovation

Knowledge nugget #4: National Climate legislation seems to be stalling over last 5 years

Knowledge nugget #5: Avoid, Improve and Shift approach to climate mitigation

Knowledge nugget #6: within country differences of service levels to the population

Knowledge nugget #7: Speed of adoption linked to number of experiments and scale of climate mitigation technologies

Knowledge nugget #8: We can decarbonize in the right way, only if we also change to circular business models and procedures

Knowledge nugget #7: Speed of adoption linked to number of experiments and scale of climate mitigation technologies

(reading time: 2 minutes)

Main message: Learning plays a key role in climate mitigation. The speed and scale of our ability to deploy low carbon technologies drives down unit cost and prompts mass adoption. The IPCC documents these trends for various technologies and shows increased use of low carbon technologies to be connected to fallen unit costs.

Although the world still does not have the technological answer to the climate change problem, there is hope. In 1905, Einstein' Photon Theory stated that light is bundled up into photons. Einstein then theorised that when a photon falls on the surface of a metal, the entire photon's energy is transferred to the electron. This process forms the basis of Solar PV, which reached civilian homes after development in the context of space and defence programs. These scientific contributions in the 1800s and early 1900s, in Europe and in the US, provided a fundamental understanding of the ways that light interacts with molecular structures. A breakthrough followed at a corporate laboratory in the US in 1954 that made a commercially available photo voltaic device (read: solar panel) available and led to the first substantial orders of solar panels, by the US Navy in 1957.

Although hard to predict, we should expect technological progress and breakthrough technologies to follow a shorter time path than was the case with photovoltaics.

From 2010–2019, there have been sustained decreases in the unit costs of solar energy (85%), wind energy (55%), and lithium-ion batteries (85%), and large increases in their deployment, e.g., >10x for solar and >100x for electric vehicles (EVs), varying widely across regions (Figure SPM.3).

Falling unit cost goes hand in hand with mass adaption of low carbon technology

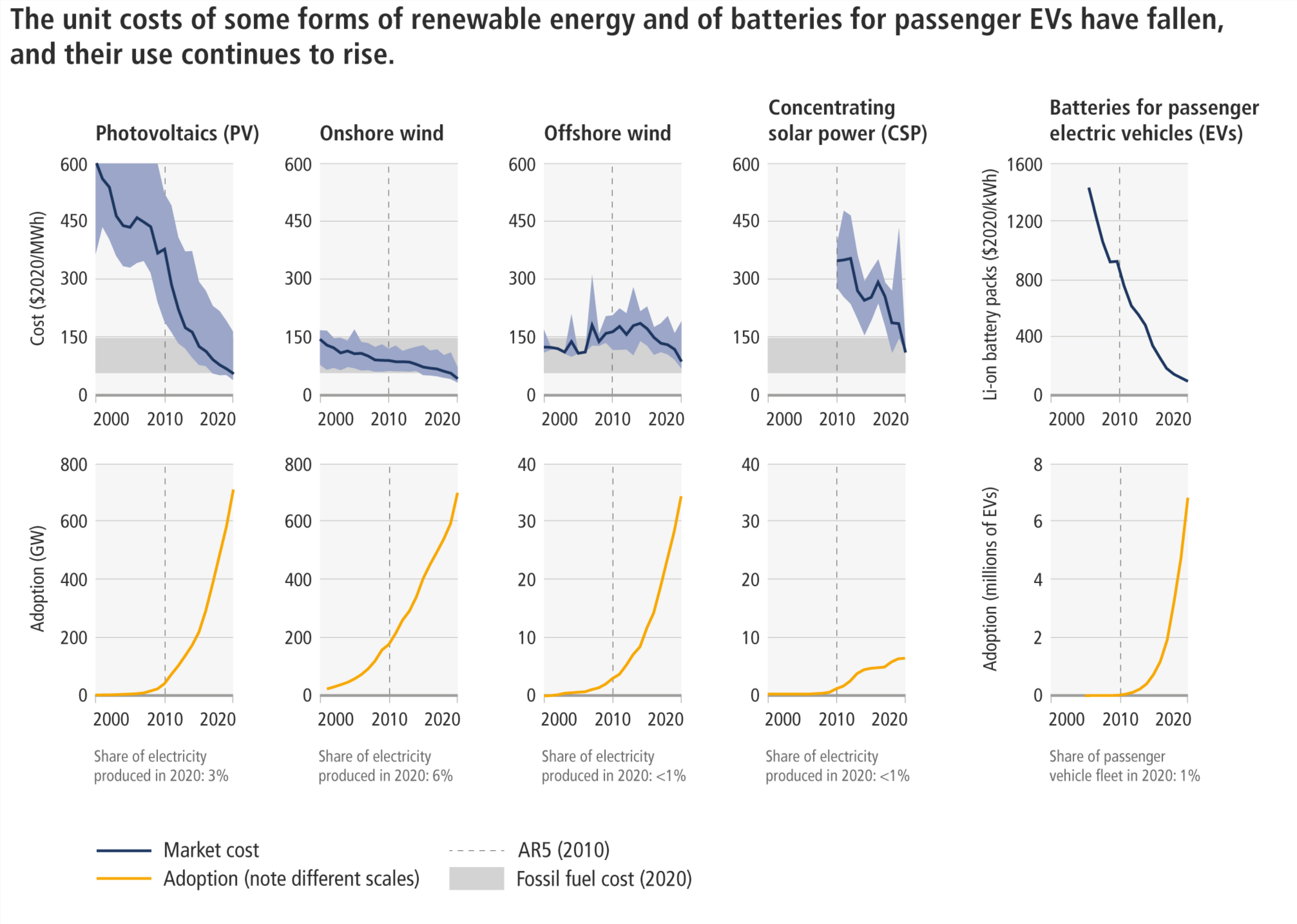
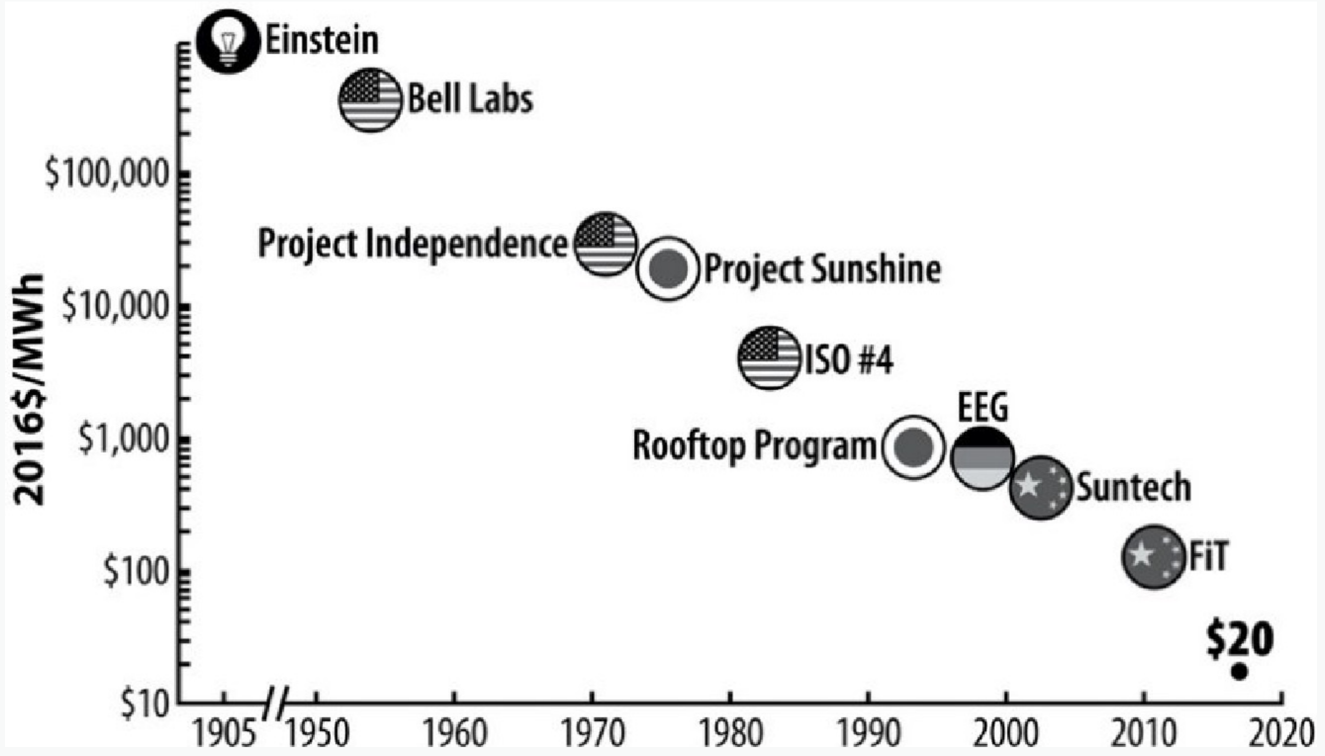


Figure SPM.3: Unit cost reductions and use in some rapidly changing mitigation technologies

From Einstein's idea about photons and electrons to commercially available solar solutions



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The mix of policy instruments which reduced costs and stimulated adoption includes public R&D, funding for demonstration and pilot projects, and demand-pull instruments such as deployment subsidies to attain scale.

An important indicator for progress of the deployment of decarbonisation technologies is the speed of the growth of technologies related to Demand (e.g. Heat Pump), Storage (e.g. EV Battery) and Supply (e.g. solar photo voltaic, concentrated solar, wind). The speed and scale of the roll-out of these technologies are interlinked with the speed of our human learning rates and the number of experiments that are occurring.

In comparison to modular small-unit size technologies, the empirical record shows that multiple large-scale mitigation technologies offer fewer opportunities for learning. When there are fewer opportunities for learning, there are also minimal cost reductions and the adoption of the technology has grown more slowly. So, the larger the climate mitigation solution, the fewer the number of experiments and the slower the learning goes.

Source: Creutzig et al., 2019; based on Sweerts et al., 2020. Based on a technology learning curve, the cost reduction potential of biomass boilers, heat pumps, ventilation, air-conditioning, thermal storages, electricity storages, solar PVs and solar thermal systems range between 15% and 65% cost reduction in 2050. These are obviously ballpark figures that depend on many dependents such as the amount of spending on R&D and many legal changes that accelerate developments.

One such learning curve that is of particular interest and will determine much of the speed of the decarbonisation efforts by 2050 is the development of the (green) hydrogen value chain. Since the hydrogen value chain is composed of many sub-technologies, there is no single estimation of the value chain technology learning curve yet.

Learning curve matters for the speed of roll-out of low carbon technologies

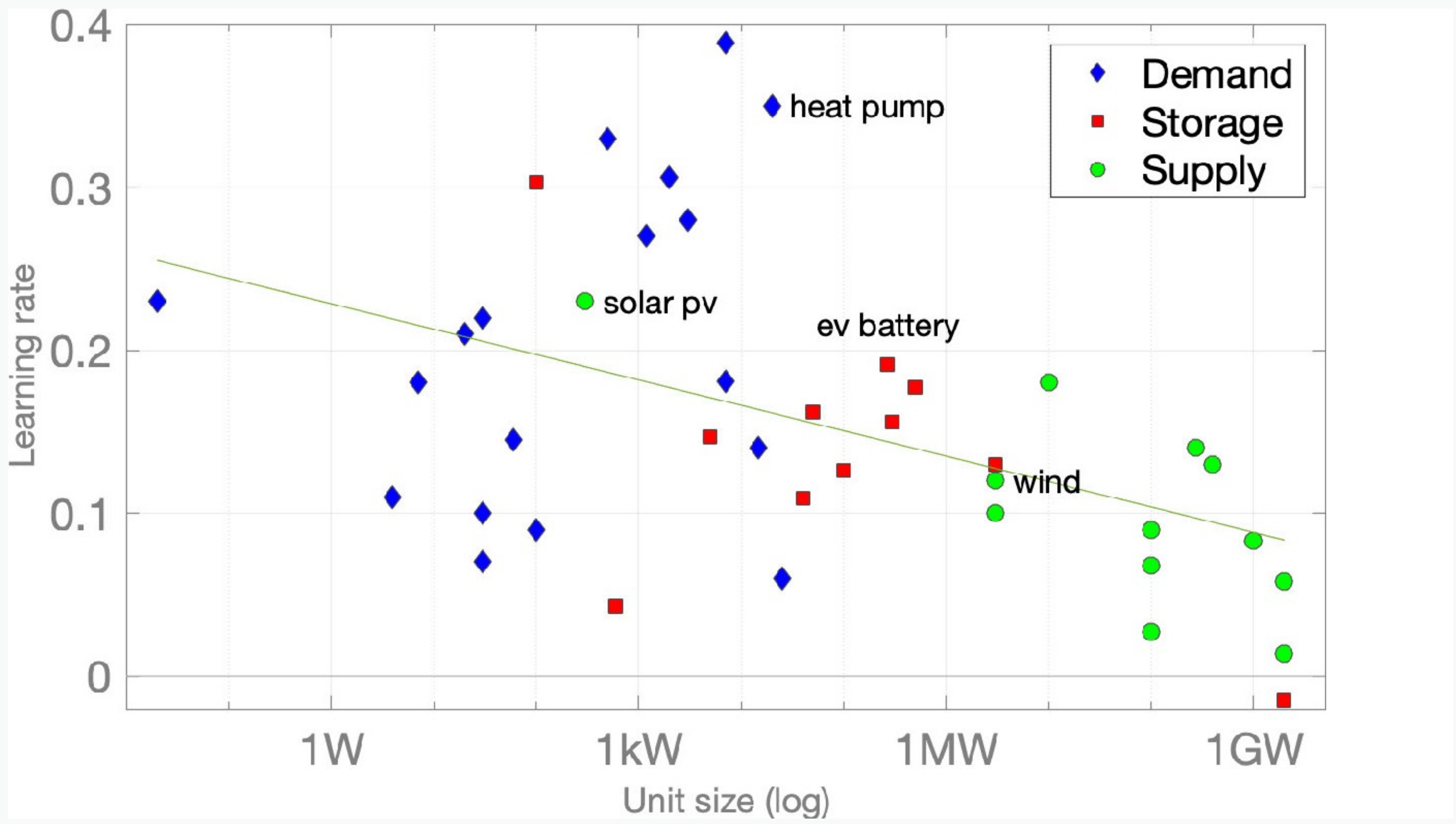

Figure 5.15 Demand technologies show high learning rates. Learning from small-scale granular technologies outperforms learning in larger supply side technologies. Line shows learning rate for all 41 technologies plotted.

Complex value chains contains various means and processes with different learning curves

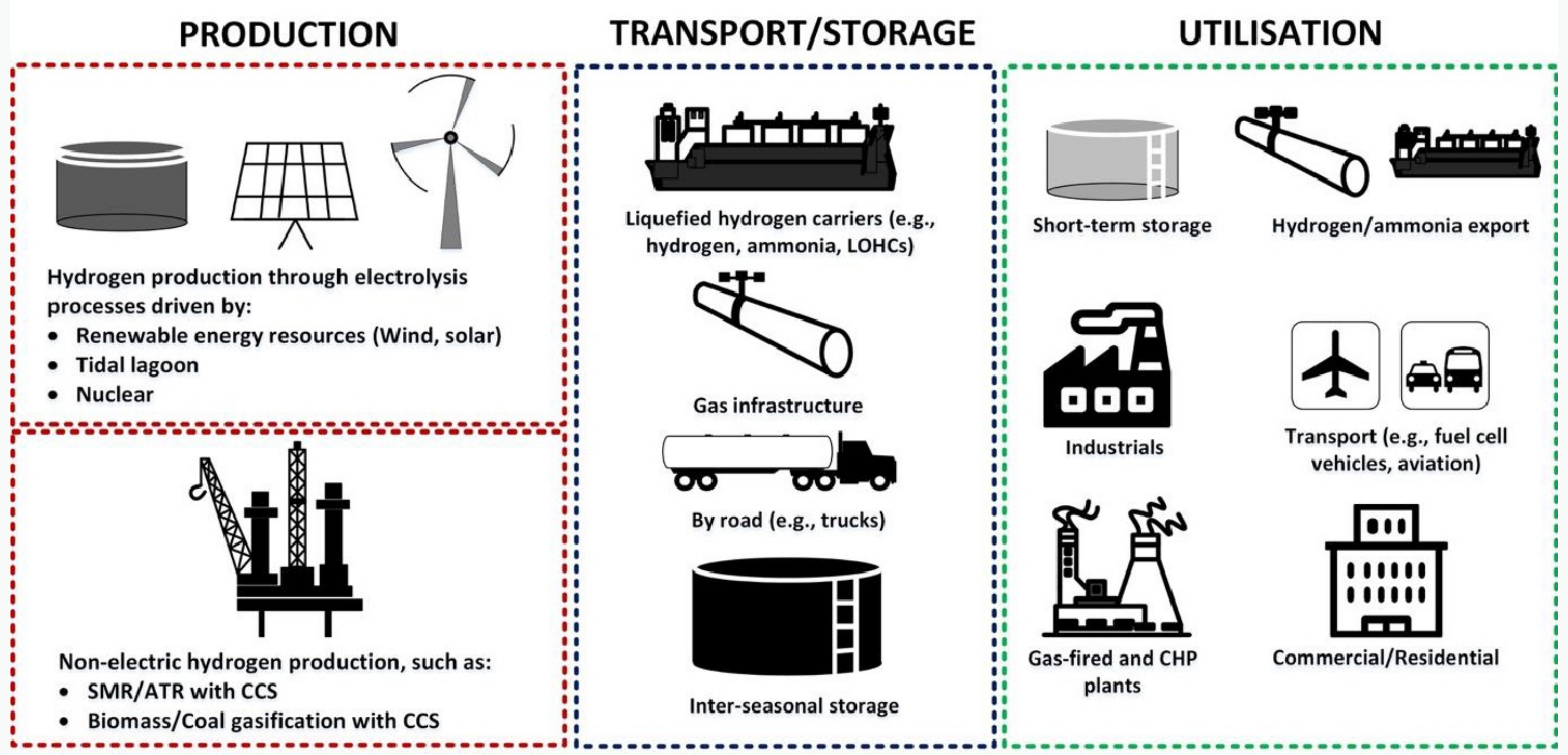

Figure 6.17 Hydrogen value chain. Hydrogen can be produced by various means and input and fuel sources. These processes have different emissions implications. Hydrogen can be transported by various means and in various forms, and it can be stored in bulk for longer-term use. It also has multiple potential end uses. CHP: Combined Heat and Power

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Main message: There is a lack of integration of material efficiency and circularity policies with energy and climate policies. Increased circularity is intertwined with the success of climate policies and technologies aimed at decarbonisation. Climate policy is a much-needed precursor to the global acceptance of policies that stimulate a higher degree of circularity.

There are various climate and energy policies that are needed for robust system change, that leads to material efficiency and circularity:

- Policy for circularity and material efficiency
- Policy for energy, supply and CCUS infrastructure
- Public spending - R&D investment and support
- Policy to promote new technologies and practices
- Policy on carbon pricing and regulation
- Policies that manage and create demand, pull policies e.g. quotas and procurement

These are the different types of technologies that could bridge the gap between energy and climate policies and material efficiency and circularity

- End of life reuse and high-quality recycling technology
- Zero emissions electricity technologies
- New technologies, electrification and CCUS
- Energy efficiency across the life cycle of technologies
- Low carbon design for materials used in low carbon technologies

With these climate preconditions in the form of technologies and policies, a circular economy can materialise where we balance the amount of virgin and secondary materials to meet the human needs of our economies.

Climate policy and technology are a precondition to the transition to a circular economy

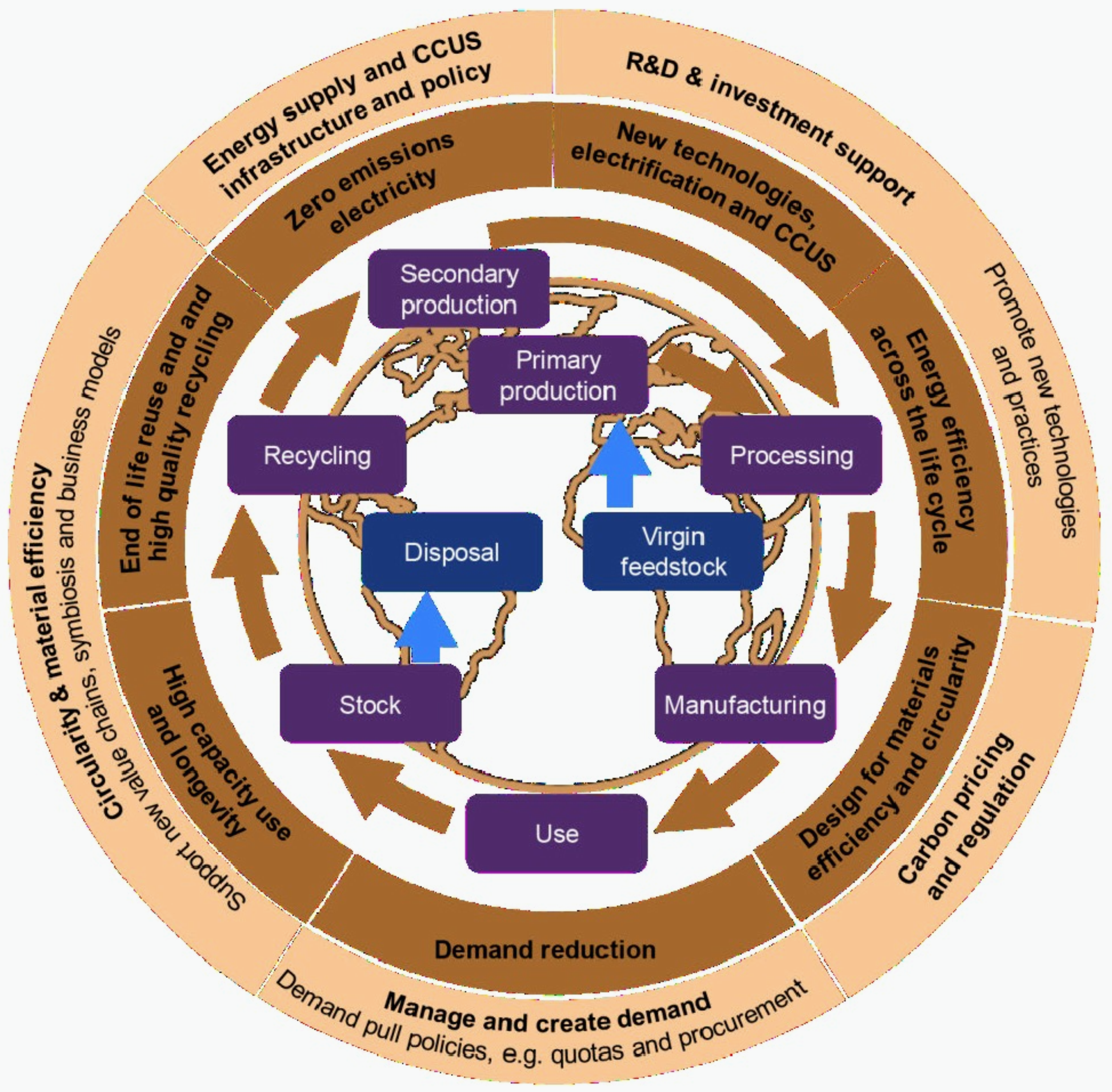

Figure 11.15 Schematic Figure showing the life cycle of materials (purple and blue), mitigation options (light brown) and policy approaches (beige).

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Thank you for spending your valuable time with us.

"It's easy to feel overwhelmed by the latest report of the Intergovernmental Panel on Climate Change (IPCC).
The IPCC released their 3000 page assessment report on climate mitigation as a means to inspire policymakers to promote decarbonisation of our economies.
While the content gives scientific backgrounds to the required system change, the sheer size and complexity of the IPCC publication can lead to despair.
Our goal is to make the information in this IPCC report more accessible to you, so you can start contributing to decarbonisation. If anything the eight fact snacks and the publication show that system change is multi-faceted."

Watch the video **here.**

Curious to read the full length reports:
Go to the IPCC **website**:

- Read the Summary for Policymakers
- Read the full report
- Read the IPCC's FAQ
- Go to the IPCC Interactive Atlas

See you during the next episode of #TLDR, with yet another report that is too long, so you didn't want to read it.

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Disclaimer

"Thank you to Sjors Mineur, Tessa Klimp and Marcus Moonen from CIRCL."

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