Investments for Green Recovery and Transformational Growth 2020–30

Technical Note

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Introduction

SYSTEMIQ has aggregated a range of estimates in order to come to a picture of low-carbon investment opportunities across the 2020s. In this Technical Note, we outline the sources, assumptions and methodology applied to come to high-level figures for the following elements of analysis:

- **Investment universe:** aggregating estimates of investment opportunities and expenditure required across Physical and Natural Capital
- **Low-carbon investment opportunities:** investment opportunities in low-carbon solutions in Energy, Agriculture, Food and Land Use (AFOLU) and Adaptation and Resilience.
- **Geographic breakdown of investment:** distribution of investment opportunities across advanced, emerging and developing countries, the G7 and China.

Investment Universe

Physical Capital

Estimates of investment (current and 2020-30) into physical capital are presented in four categories: Energy, Transport, Water and Sanitation, and Telecoms and Digital. The components of these investments, sources and assumptions applied are outlined in Table 1. Given the paper's focus on low-carbon investment opportunities, assumptions behind Energy are more fine-tuned and subject to triangulation. Further detail is provided in the 'Low-carbon investment opportunities' section. The estimates for Transport, Water and Sanitation and Telecoms and Digital are included to provide context for these low-carbon solutions. They are sourced directly from existing estimates and we have applied only limited triangulation or assumptions onto these figures.

Table 1: Current investment levels and investment opportunities (2020–30) in Physical Capital

Category	Current investment p.a. (US$tn)	Investment p.a. 2020–30 (US$tn)	Assumptions	Source
Energy: power (fossil and RE transmission, distribution, storage), energy efficiency - buildings and industry, hydrogen (production, transport, storage), carbon capture, use and storage (CCUS), energy-related infrastructure for transport (EV charging, sustainable aviation fuels, e-aviation, green shipping fuel, zero-emission vessels).	1.9 *1.1 fossil fuel* *0.8 low-carbon*	2.8–3.3 *0.5–0.75 fossil fuel* *2.3–2.5 low-carbon*	**Fossil fuel:** **Current investment**: IEA Oil and Natural gas, Coal and fossil fuel generation investment 2015–19 **Investment 2020-30**: IEA Oil and Natural gas, Coal and fossil fuel generation investment 2020–30; BNEF Coal, gas, Peaker Gas, Oil global investments 2020-30. **Low-carbon current investment:** - Power Generation & Storage: $0.3tn - Electricity networks: $0.3tn - Energy Efficiency – Buildings: $0.15tn - Energy Efficiency – Industry: $0.04tn - EV Charging Infrastructure: >$0.01tn - SAF CAPEX: >$0.01tn **Low-carbon opportunity 2020–30:** various; see 'Low Carbon Investment Opportunities'	Fossil fuel current and 2020–30; low-carbon current: IEA 2020[i]; IEA 2019[ii]; IEA 2019[iii]; BNEF 2020[iv]; expert input For low-carbon opportunities 2020–30, see below
Transport: light rail and bus rapid transit systems, road infrastructure investments, airports and seaports.	1.3	2.7	No assumptions applied to OECD figures	OECD 2017[v]
Water and Sanitation: water and sewerage pipes, waste management, water purification.	0.6	0.9	No assumptions applied to OECD figures	OECD 2017[vi]
Telecoms and Digital: mobile (including wireless technologies beyond cellular mobile, fixed-line and broadband), 5G infrastructure and data centres.	0.7 *0.6 telecoms* *0.1 data centres*	1 *0.6 telecoms* *0.4 data centres*	**Telecoms:** no assumptions applied to OECD figures. **Data centres:** $140bn p.a. investment and spend on global data centres; growing at 20% CAGR across 2020s. Average p.a. figure for 2020s taken. Estimates do not include anticipated additional CAPEX investment anticipated to roll-out 5G.	OECD 2017[v]; Synergy Research Group 2020[vii]
TOTAL	**4.5**	**7.4–7.9**		

Table 2 provides a comparison of the estimates SYSTEMIQ has collated alongside recent estimates.

Table 2: Comparing Physical Capital investment figures to recent estimates

Physical Capital	SYSTEMIQ	NCE 2016[viii]	Bhattacharya 2016[ix]	OECD 2017[x]
Energy	2.8–3.3	3.3	3.9	2.1
Transport	2.7	1	2	2.7
Water and Sanitation	0.9	1.5	0.9	0.9
Telecoms	1	0.5	1	0.6
TOTAL	**7.4–7.9**	**6.3**	**7.8**	**6.3**

On energy specifically, SYSTEMIQ estimates that the average annual investment across the 2020s is $2.8–3.3tn (low and high carbon). This is ~$2tn lower than the $5tn in 2030 estimated in the recent *Net Zero by 2050* report by the International Energy Agency (IEA). The key areas of difference are:

- SYSTEMIQ estimates average annual investment across the 2020s, whereas IEA estimates investment in the year 2030. Given it is anticipated that investment will increase across the decade, it is to be expected that the IEA figures are higher.
- **~$1tn lower estimate for electricity system, renewable and bioenergy vs IEA.** Likely drivers of difference include (i) the Energy Transitions Commission assumes greater ambition on battery cost declines, (ii) the IEA NZ scenario significantly front-weights investment needs of transmission and distribution in the 2020s compared to the ETC, (iii) SYSTEMIQ has featured estimates for wind and solar investment figures only, not bioenergy and other renewables (included in IEA estimates; IEA also has more emphasis on bioenergy relative to other NZ outlooks).
- **~$0.5tn lower estimate for end-use electrification vs IEA.** The IEA includes spending on batteries for vehicles and industrial equipment for electricity-based material production routes, whereas our estimates do not include end-use products as this spending is instead of high-carbon alternatives and at similar levels of expenditure (e.g. electric vehicle cost to manufacture to be similar to ICE by mid-2020s).
- **~$0.15tn lower estimate for hydrogen vs IE** due to differences in assumptions on hydrogen ramp-up. The ETC estimates 50 Mt demand in 2030 based on modelling and industry interactions, whereas IEA suggests 150 Mt.
- **~$0.15tn lower estimate for CCUS vs IEA.** This is likely due to different assumptions on storage requirements, in line with a net zero trajectory as IEA puts more emphasis on use of CCUS to reach net zero.

Natural Capital

Two separate methodologies were adopted to calculate the investment opportunity and current investment levels for natural capital. This is a different approach to the one taken for physical capital, for which many of the available estimates cover both the *investment opportunity* and *current investment levels*, expressing the opportunity as a gross figure, i.e. the sum of projected incremental investment and existing/continued investment. By contrast, estimates for Agriculture, Food and Land Use (AFOLU) focus on the increase in investment required, targeting sustainable investments only, rather than gross investment (i.e. they do not include continued existing/ neutral investment levels across agriculture, food and land use).

Investment opportunity, 2020–30

Estimates of the investment opportunity into natural capital are presented in four categories: Protection and Restoration of Nature; Productive, Sustainable and Efficient Agriculture; Healthy Diets; Rural Infrastructure (i.e. roads and internet connectivity; excluding cold chain storage and irrigation, which are grouped within Productive, Sustainable and Efficient Agriculture). The components of these investments, sources and assumptions applied are outlined in Table 3a.

The first two categories (Nature and Agriculture) represent critical low-carbon solution areas, which are the focus of further analysis by SYSTEMIQ. The latter two (Healthy Diets and Rural Infrastructure) are critical to deliver on the Sustainable Development Goals but do not directly deliver on climate goals. It is also likely that there are significant overlaps between the Rural Infrastructure estimates and the Transport, Telecoms and Digital estimates included in Physical Capital. These categories are not included in SYSTEMIQ's in-depth assessment of low-carbon investment opportunities.

Table 3a: Annual investment opportunities (2020-30) in Natural Capital

Category	Investment p.a. 2020–30 (US$tn)	Assumptions	Source
Protect and Restore: sustainable management, conservation and restoration of forests and peatlands, mangroves, saltmarshes and seagrasses	0.07–0.25	**Terrestrial:** $44–210bn p.a.**:** low estimate from FOLU *Growing Better* report; high estimate from UNEP, WEF, ELD (2021), *State of Finance for Nature* **Marine:** $27–38bn p.a. estimate from Paulson Institute and TNC *Financing Nature* report. For further detail, see 'Low Carbon Investment Opportunities'	FOLU 2019[xi]; UNEP, WEF, ELD 2021[xii]; Paulson Institute and TNC 2020[xiii]
Sustainable, Efficient and Productive Agriculture: regenerative farming, farm inputs, irrigation efficiency and expansion, digital tech, urban farms, composting, reducing food loss and waste, diversifying protein supply	0.14–0.16	Relevant investment categories, including: - Regenerative farming practices: $5–6bn p.a. - Productivity and efficiency: $86–88bn p.a. Assume irrigation expansion and efficiency enhancements on larger area of cropland. - Reducing Food Loss and Waste: $29bn p.a. - Diversifying Protein Supply: $24–33bn p.a. For detail, see 'Low Carbon Opportunities'	FOLU 2019[xi]
Healthy Diets: product reformulation, school feeding, investments to deliver on global nutrition targets, R&D	0.03	Relevant investment categories, including: - Product Reformulation: $17bn p.a. - Global Nutrition Targets: $7bn p.a. - Targeted School Feeding: $5bn p.a. - R&D: $2bn p.a.	FOLU 2019[xi]
Rural Infrastructure: access to markets, clean energy, clean cooking; internet connectivity	0.04–0.05	Relevant investment categories, including: - Rural infrastructure: $32bn p.a. - Clean cooking access: $4bn p.a. - Connectivity (internet): $6bn p.a.	FOLU 2019[xi]
TOTAL	**0.29–0.49**		

Current investment levels

There lacks an aggregate estimate of total investment (public and private) into agriculture, food and land use. This is partly due to significant data and classification challenges (see Box 1).

Without reliable data into private investment levels, SYSTEMIQ aggregated the market size of the main suppliers of agricultural inputs and equipment, alongside estimates of investment into conservation and land. This generates an aggregate figure for investment in agriculture, food and land use, recognising that it is likely a slight over-estimate, given market size is not limited purely to investment. The total comes to $0.93tn. We rounded to $1 trillion to account for the fact that this is probably an underestimate. We assume that market size captures investments made by both public and private sectors, as they would flow through these markets. Table 3b provides this aggregate figure. It also indicates estimates of investment by different sources of capital within this aggregate figure.

Table 3b: Current Investment Levels in Agriculture, Food and Land Use

Category	Investment p.a. (US$tn)	Source of Capital High/low carbon	Source
Farm Equipment, Inputs and Infrastructure (includes working capital and investment capital)			
Farm/Agricultural Equipment (incl. irrigation)	0.139	Private and public Low- and high carbon	Grand View Research, 2019[xiv]
Agrochemical (fertilizers, pesticides and herbicides)	0.243	Private and public Low- and high carbon	Statista, 2021[xv]
Seeds	0.059	Private and public Low- and high carbon	Markets and Markets, 2020[xvi]
Greenhouses	0.030	Private and public Low- and high carbon	Markets and Markets, 2020[xvii]
Cold Chain Storage	0.183	Private and public Low- and high carbon	Modor Intelligence, 2019[xviii]
Silos and Storage Systems Market	0.001	Private and public Low- and high carbon	Markets and Markets, 2020[xix]
Cattle Feed	0.077	Private and public Low- and high carbon	Grandview Research, 2020[xx]
Animal Feed Additives	0.038	Private and public Low- and high carbon	Grandview Research, 2020[xxi]
Fishery Sector Equipment	0.013	Private and public Low- and high carbon	Allied Market Research, 2019[xxii]
Total	0.78		
Ag- and Food Tech			
Agtech (intersection between agriculture and technology, includes vertical farming, AI and precision agriculture)	0.003	Private and public Low carbon	Finistre, 2019[xxiii]
Alternative proteins (technologies and ingredients to replace meat-based proteins)	0.002	Private and public Low carbon	McKinsey, 2020[xxiv]
Total	0.005		
Conservation and Restoration of Biodiversity, Sustainable Land Management			
Voluntary carbon markets and NBS: voluntary forest carbon market, payments for REDD+, Philanthropy/foundation and conservation NGOs for carbon markets	0.001	Private and public Low carbon	Paulson and TNC 2020[xxv]
Biodiversity and conservation: sustainable supply chains; green financial products (equity)	0.010	Private Low carbon/ conservation	Paulson and TNC 2020[xxvi]
Biodiversity and conservation: domestic budgets and tax policy; ODA (bilateral, multilateral, official funds)	0.090	Public Low carbon/ conservation	Paulson and TNC 2020[xxvii]
Biodiversity and conservation: natural infrastructure; green financial products; biodiversity offsets; philanthropy, foundations, conservation NGOs	0.040	Private and public Low carbon/ conservation	Paulson and TNC 2020[xxviii]
Total	0.14		
TOTAL AFOLU	**0.93**		

Box 1: Challenges in estimating AFOLU current investment levels

Estimating current levels of investment in AFOLU raises significant challenges, including:

- **Lack of consistent and comprehensive data** due to overlapping datasets; stock and flow variables used interchangeably as 'investment'; and difficulties in tracking investments made by smallholder farmers in informal markets
- **Lack of publicly available aggregates of private investment** into agriculture, food and land use. FAO provides estimates of Private Credit into Agriculture, Forestry and Fishing. However, there is not yet an estimate of the proportion of private credit that is used for investments versus recurring costs, or even the proportion that is saved (i.e. not invested or spent at all). Other estimates focus on sustainable investments, not into agriculture more broadly.
- Challenges in distinguishing between **sustainable vs. unsustainable** investments.
    - **Not all investments are classified and tracked as sustainable or unsustainable.** Climate Policy Initiative and similar entities are able to track investments that are marked as geared towards climate or development goals. Yet many investments that enhance natural capital are not logged as such. Likewise, investments that damage nature are not necessarily tracked.
    - **Many investments into AFOLU are not *by definition* low-carbon or high-carbon** but depend on the specific context. For example, an investment into farm machinery might help to increase yields, reducing the need to expand farmland into forests and other natural ecosystems. Yet that same investment into farm machinery could increase the value of expanding farmland into natural ecosystems, as improved yields deliver higher rewards. The enabling environment for sustainable food systems is therefore critical to determine sustainable outcomes.

Investment Opportunities in Low-carbon Solutions, Adaptation and Resilience

Energy

Sources and assumptions used to estimate low-carbon investment opportunities linked to energy are outlined in Table 4.

Table 4: Low-carbon Energy Investment Opportunities

Investment Area	Investment p.a. 2020–30 (US$tn)	Assumptions	Source
Electricity Generation, Storage and Networks	1.5–1.6	**Electricity Generation and Storage ($0.75–0.8tn):** constructing ~30TW solar and wind by 2050 (1.3TW today). Construction rate increases from c.50GW/yr 2017–19 to 4–7x through 2025–30, and to 9–14x through 2040s. Storage: c.15% total investment. Estimates are in line with assumptions underpinning 2020–50 estimates outlined in Energy Transitions Commission (2021), *'Making Clean Electrification Possible: 30 Years to Electrify the Global Economy'*. ETC analysis was conducted to inform 2020–30 estimates used here.	ETC 2021[xxix]
		Electricity Networks ($0.75tn): majority for expansion and reinforcement as electricity plays a much larger role in the energy system. Assume flat investments 2021–50 due to need to build out network in advance of connecting more RE/EVs. Estimates are in line with assumptions underpinning 2020-50 estimates outlined in Energy Transitions Commission (2021), *'Making Clean Electrification Possible: 30 Years to Electrify the Global Economy'*. ETC analysis was conducted to inform 2020-30 estimates used here.	ETC 2021[xxx]
Energy Efficiency – buildings and Industry	0.6–0.8	**Energy Efficiency – Buildings ($0.4–0.5tn):** Low estimate: IEA Sustainable Recovery Plan target for 2021–23 ($420bn) High estimate: Assume $420bn p.a. investment 2021–23 (in line with IEA Sustainable Recovery Plan, then apply 4.5% growth rate to match building construction rate (assume building construction growth rate matches 2014–18 growth rate)	IEA 2020[xxxi]; UNEP 2020[xxxii]
		Energy Efficiency – Industry ($0.2–0.3tn): **Low estimate:** IEA Sustainable Recovery Plan target for 2021–23 ($200bn) High estimate: assume increase in investment beyond 2023; Turkey case-study triangulation indicates $0.3tn figure.	IEA 2020[xxxiii]; Turkey case study

Electric Vehicle Charging	0.07	Residential, super-fast, truck and bus chargers. Excl. distribution network reinforcements (above).	ETC 2020[xxxiv]
Aviation: SAF CAPEX and e-aviation	0.025	**SAF CAPEX ($0.01tn):** assumes aspirational 10% SAFs by 2030. Vast majority of investment is after 2025 (and scales much further beyond 2030).	WEF and McKinsey 2020[xxxv]; Expert input
		E-aviation related ($0.015tn): Energy efficiency R&D investment levels maintained.	Air Transport Action Group 2020[xxxvi]
Shipping: Green shipping fuel and zero-emissions engines	0.03–0.04	Assumes 5% green shipping fuel globally + 15% domestic shipping is zero-emission vessels. **~85–90% of investment is a sub-set of H2 so not included in TOTAL figure.**	UMAS, GMF, Marine Capital 2020[xxxvii]
Hydrogen production and storage	0.02	H2 production facilities, backbone pipes, storage, incl. 7.6 TW electrolysis, 0.7 TW blue hydrogen capacity, salt caverns and other storage, gas pipeline retrofit. Estimates are in line with assumptions underpinning 2020–50 estimates outlined in Energy Transitions Commission (2021), *Making the Hydrogen Economy Possible: Accelerating Clean Hydrogen in an Electrified Economy.* ETC analysis was conducted to inform 2020–30 estimates used here.	ETC 2021[xxxviii]
Carbon Capture, Utilisation and Storage (CCUS)	0.04–0.05	ETC estimates $0.16–0.19tn investment p.a. 2020–2050; assume ~one-quarter of rate in 2020s, due to significant ramp-up post 2030.	ETC 2020[xxxix]
TOTAL	**2.3–2.5**		

AFOLU

Sources and assumptions used to estimate AFOLU investment opportunities are outlined in Table 5.

Table 5: Low-carbon AFOLU Investment Opportunities

Investment Area	Investment p.a. 2020–30 (US$tn)	Assumptions	Source
Protecting and Regenerating Nature	0.07–0.25	*Forests: Lower Estimate*	
		Forest restoration ($29-49bn): 294Mha forest and peatland restored at $1,200–2,000/ha (costs mainly dependent on labour and type of restoration intervention)	FOLU, 2019[xl]
		REDD+ forest conservation programme ($14bn): REDD+ financing to halt deforestation reaches $50bn p.a. in 2030, growing from $1bn in 2019	FOLU, 2019[xli]
		Forest management ($1bn): total area of existing forest grows by 80Mha by 2030, with gradual increase of total ha managed at $20–30/ha	FOLU, 2019[xlii]
		Forests: Upper Estimate	
		Forest protection, restoration, afforestation and peatland restoration ($210bn): UNEP, WEF, ELD (2021), *State of Finance for Nature*	UNEP, WEF, ELD 2021[xliii]

		Marine Ecosystems	
		Mangrove restoration ($0.3–1.6bn): restore global distribution to 1980 baseline by 2050. Assume flat investment 2020–50.	The Paulson Institute and TNC, 2020[xliv]
		Seagrass restoration ($22bn): restore coverage to 1879 baseline by 2050. Assume flat investment 2020–50.	The Paulson Institute and TNC, 2020[xlv]
		Saltmarsh restoration ($5–14bn): restore to historical baseline by 2050. Assume flat investment 2020–50.	The Paulson Institute and TNC, 2020[xlvi]
Sustainable, Efficient, Productive Agriculture	0.14–0.16	**Productive and Regenerative Agriculture ($90–94bn):** - Regenerative farming practices on 50% farmed land - 150m low skilled farmers receive extension services and capital equipment improved across ~400m ha - Irrigation efficiency improved on 20% currently irrigated cropland in developing countries - New irrigation infrastructure for 30m ha cropland by 2030 (expanding irrigated land by ~10%) - Precision agriculture machinery and tech investment - 15% urban farmed vegetables and fruits consumed in cities produced in vertical/ greenhouses - 10% inedible food composted via anaerobic digesters - R&D in ag increases from 0.7–1% global GDP	FOLU, 2019[xlvii]
		Reducing Food Loss and Waste ($29bn): - Consumer demand management in advanced economies (<10% total investment) - Reducing post-harvest waste in developing countries - Reducing supply-chain waste	FOLU, 2019[xlviii]
		Diversifying Protein Supply ($24–33bn) - 14% plant-based meat market revenues invested p.a. - 33% plant-based dairy market revenues invested p.a. - Insect protein production grows to 0.7–0.9m tonnes - Additional 16m MT bivalve production - Additional 4.5m MT finfish aquaculture production - 50% of 19m aquaculture farmers receive training on sustainable production	FOLU, 2019[xlix]
TOTAL	0.2–0.4		

Adaptation and Resilience

Table 6 outlines the range of sources on adaptation and resilience costs reviewed to inform figures quoted by SYSTEMIQ. The UNEP *Adaptation Gap Report* was selected as the most recent and comprehensive assessment of costs in developing economies. SYSTEMIQ does not provide an estimate of the investment requirements in advanced economies as these are not readily available.

In providing estimates, it is important to note significant challenges in estimating adaptation and resilience costs. Various issues make it very difficult to provide a definitive cost of adaptation, and in turn to accurately estimate the adaptation funding gap. Hence, none of the sources reviewed claim to represent total global investment requirements, but state their figures as 'Costs of adaptation'. Challenges include:

- **Lack of scientific assessments:** assumptions are made on adaptation goals and targets, involving various framings and objectives depending on actors (private, public) and scale (local to global).
- **Varying assumptions on levels of trade-off** between costs and benefits of adaptation and the residual risks after adaptation
- **Consideration of the future adaptation gap** involves complex ethical and scientific issues.

Table 6: Overview of recent estimates of Adaptation and Resilience costs

Source	Scope	Investment requirement ($ p.a.)	Details
UNEP 2016, 2020[l]	Developing	$140–300bn	**Cost of adaptation in developing countries by 2030,** including planning, preparing for, facilitating and implementing adaptation measures, incl. transaction cost. - $70bn adaptation costs today, rising to $140–300bn by 2030, then $280–500bn by 2050 - $22bn p.a. global public financing for adaptation (2015–16). Results in a funding gap of ~$120–280bn by 2030 if investments don't grow.
IPCC, 2014[li]	Developing	$70–100bn	**Cost of adaptation in developing countries by 2050**
UNFCCC, 2008[lii]	Developing	$30–70bn	**Cost of adaptation for developing countries by 2030**
	Global	$50–170bn	**Cost of adaptation globally by 2050**
World Bank, 2010[liii]	Global	$70–100bn	**Cost of adapting 2010-2050** under a 2°C scenario
Global Commission on Adaptation, 2019[liv]	Global	$180bn	**Examples of investment opportunities** in adaptation and resilience that can deliver significant returns: $1.8tn between 2020–2030 generates $7.1tn net benefits. Report explicitly states the figure does not represent total A&R investment requirements. Examples include: Strengthening early warning systems, new resilient infrastructure, improved crop production, protect mangroves, resilient water resource management
De Bruin 2014[lv]	Global	$19–$429bn	**Cost of adaptation p.a. globally** 2010-50 under a 2°C scenario

Breakdown of investment opportunities by geography

SYSTEMIQ applied a top-down methodology to estimate the geographic breakdown of global investment opportunities across advanced, emerging and developing economies, the G7 and China. Classifications of advanced, emerging and developing economies draw on the World Bank Group's income groups: advanced = high income countries; emerging = upper-middle income countries; developing = lower-middle and low income countries.

Sources and assumptions used to estimate the geographic breakdown of low-carbon investment opportunities are outlined in Table 7.

Table 7: Breakdown of Investment by Geography

Numbers rounded to nearest 5%

Investment Area	Geographic breakdown	Assumptions	Sources
Overall	• G7: 25% • China: 25% • Advanced: 40% • Emerging: 40% • Developing: 20%	Assumptions conducted per sector. See below.	
Electricity generation and storage Electricity networks	• G7: 25% • China: 25% • Advanced: 40% • Emerging: 45% • Developing: 15%	• Global investment figures are based on ETC, IEA and BNEF pathways. • Distributed investment according to (i) projected investment 2020–30 and (ii) power system size • IEA World Energy Outlook 2020 Sustainable Development Scenario provides 2020-30 investments by region. Using this, we calculate each region's share of global investment. (e.g. N. America = 16% global cumulative power investments 2020-30). This factors in likely scale-up of relevant region's power systems. • IEA Data and Statistics provides Electricity Generation figures for each country - i.e. the size of its power system. Using this, we calculate each country's share of the total power system in the region in which it sits. (e.g. USA = 81% of total North America power system size) • We categorise each country as advanced, emerging and developing to determine the share of total power system size for each country wealth category within each region. We use the IEA's country groupings to ensure that our estimates align with their assumptions. (E.g. USA and Canada = Advanced and account for 93% of N. America power size; Mexico = Emerging and accounts for 7% N. America power size). • We multiply the country wealth category's share of regional power system size by the region's share of global investment to establish the country wealth category's share of global investment (e.g. Advanced economies = 93% of N. America power system; N. America = 16% of global power investments; Advanced economies in America = 15% of global power investments). • We aggregate regions to come to a global figure for each of the wealth categories.	• IEA 2020[lvi] • IEA Data and Statistics[lvii]
Energy Efficiency – Buildings	• G7: 40% • China: 25% • Advanced: 60% • Emerging: 30%	• Global investment figures are based on IEA Energy Efficiency 2020 and UNEP Global ABC projections. • Distributed investment based on current regional breakdown, assuming that region-specific year on year change in 2020s aligns with that of 2014–19.	IEA 2020[lviii]; UNEP 2020[lix]

	• Developing: 10%	• IEA Energy Efficiency 2020 provides regional breakdown of investment in energy efficiency in buildings 2014°19 and year on year change 2014–19. • We assume that the average year on year change 2014–19 is maintained in each region across the 2020s. This enables us to calculate region-specific cumulative investment across the 2020s. • Applied sense-check: calculated % increase in urban population 2020 vs 2030 for each region and applied to current investment figures. Resulting share of investment by region aligns. • Calculate share of global cumulative investment 2020–30 per region; allocate investment as such. • To translate geographic regions into wealth categories, assume the same split of advanced/ emerging/developing per region as for power system size (above). • The result skews towards advanced economies. It should be noted that this is partly due to (i) the far higher base that advanced economies start on, (ii) the relatively colder climates of advanced economies and fact that space heating accounts for significant share of energy efficiency investment requirement, (iii) the opportunity to embed energy efficiency into building design and energy delivery as emerging and developing economies urbanise – with the potential for no/marginal additional investment required if thoughtful design is applied up-front.	
Energy Efficiency – Industry	• G7: 20% • China: 40% • Advanced: 30% • Emerging: 60% • Developing: 10%	• Global investment figures are based on IEA and IRENA, cross-referenced with a country-specific case study (Turkey). • Distributed investment according to current energy consumption in industry. • IEA Data and Statistics – Data tables, Energy Balances: provides total ktoe consumption for 'Industry' Using this, we calculate the total ktoe for industry for each country, and the share of global total that this represents. • We assume that 2018 share can serve as a proxy for the 2020s, given those areas with greatest energy consumption levels today will require the most urgent investment to boost energy efficiency. • We categorise each country as advanced, emerging and developing to determine the share of total ktoe for each country wealth category. • We multiply these percentages by the global investment figures to come to a figure for each of the wealth categories	IEA 2020[lx] IRENA 2019[lxi]
EV Charging	• G7: 30% • China: 50% • Advanced: 45% • Emerging: 50%	• Global investment figures are based on ETC Mission Possible projections. • Distribute investment according to projected 2030 EV Sales. • BNEF provides country-specific estimates for China, Europe, USA, India, Japan, S. Korea, Australia, Rest of World.	ETC 2020[lxii] BNEF 2020 [lxiii]

	• Developing: 5%	• We categorise specific countries according to advanced, emerging, developing. For Europe: assumed all advanced (as advanced countries within Europe will lead on EV up-take). For Rest of World (8% of total): assumed 35% will be advanced, 35% emerging, 30% developing (i.e. 3% advanced, 3% emerging, 2% developing out of global total). • We multiply the % of total EV sales in 2030 by the global investment figures to come to a figure for each of the wealth categories.	
SAF CAPEX and e-aviation R&D	• G7: 40% • China: 15% • Advanced: 80% • Emerging: 20% • Developing: 0%	• Global investment figures are based on ETC analysis and estimate of investment relative to current R&D investment. • Distributed investment according to current and projected ambitions re Sustainable Aviation Fuels, informed by input from ETC.	WEF 2020[lxiv] ETC analysis
Green shipping fuel + R&D	• G7: 35% • China: 25% • Advanced: 60% • Emerging: 35% • Developing: 5%	• Global investment figures are based on UMAS GMF projections. • Distributed investment in line with hydrogen distribution, given shipping fuel figures are a sub-set of hydrogen investment.	GMF 2020[lxv] ETC analysis
Hydrogen Production and Storage	• G7: 35% • China: 25% • Advanced: 60% • Emerging: 35% • Developing: 5%	• Global investment figures are based on ETC projections. • Assume that majority of investment will be in advanced economies, with projects in emerging countries dominated by China. • There are significant opportunities for emerging and developing economies to produce hydrogen (e.g. Morocco, Namibia, Chile) but these are likely to scale after 2030. • Informed by technical and financial capacity (including GDP); current projects and early-stage developments; distribution of refineries and ammonia plants, steel plants and ports.	ETC 2021[lxvi]
Carbon Capture, Use and Storage	• G7: 50% • China: 5% • Advanced: 85% • Emerging: 10% • Developing: 5%	• Global investment figures are based on ETC Making Mission Possible projections. • Assume that advanced economies will dominate CCUS in the 2020s due to significantly greater technical capacity and dominance of existing projects and early-stage developments in advanced economies. Assume that 10% of investment will be in emerging, driven by China due to existing projects and early-stage developments.	ETC 2020[idem]
Adaptation and Resilience	• G7: 0% • China: 0% • Advanced: 0% • Emerging: 30% • Developing: 70%	• Global investment figures are based on UNEP Adaptation Gap report, which calculates costs for developing countries specifically. The report does not specify which regions are included in 'Developing' classification. However, assume that ~30% of the quoted figures are in SYSTEMIQ's categorisation of 'Emerging' economies. Therefore split 30°70 accordingly.	UNEP 2020[lxvii]

		• As mentioned above, there lacks comprehensive global estimates of the investment required in Adaptation and Resilience. It is anticipated that investment will be required in advanced economies and in China to adapt to climate impacts.	
Protect and Restore – Terrestrial and Marine	• G7: 2% • China: 2% • Advanced: 10% • Emerging: 75% • Developing: 15%	*Estimates for nature protection and restoration cover only investment within a given country. Considering the global public good feature of natural capital in emerging markets and developing countries and taking account of financial challenges confronted by these countries, advanced economies – including the G7 – should provide strong support to these countries in this area.* Terrestrial • Forest restoration: distribute investment in line with afforested land cover estimated by GLOBIOM model, which is used to calculated global estimate. • REDD+ and forest management: Roe et al. estimate the land-based mitigation potential of the top 25 countries in the world, which themselves are estimated to account for 80% of land-based mitigation potential globally. We assume that this represents a sufficiently large share of global mitigation potential to serve as a proxy for the global total. • Roe et al. divide land-based mitigation across a range of categories, including agriculture-related activities, as well as forest- and peatland-related mitigation. Using this, we distribute investment in line with land-based mitigation potential, selecting forest- and peatland-related categories from the list provided. • We categorise each country as advanced, emerging and developing to determine the share of total land-based mitigation potential. • We multiply the % of land-based mitigation potential by the global investment figure to establish figure for each wealth category. Marine • Global investment figures are based on TNC Financing Nature. • Distribute investment in line with mitigation potential. • Roe et al. include reduced coastal conversion among their categories of land-based mitigation potential. Using this, we distribute investment in line with mitigation potential. • We categorise each country as advanced, emerging and developing to determine the share of total mitigation potential. • We multiply these % of mitigation potential by the global investment figure to establish figure for each wealth category.	FOLU 2019[lxviii] Roe et al. 2019[lxix] Hamilton et al. 2016[lxx] Spalding, et al. 2003[lxxi] Chris J Mcowen et al. 2017[lxxii]

Regenerative and Productive Agriculture	• G7: 15% • China: 10% • Advanced: 20% • Emerging: 45% • Developing: 35%	• Global investment figures are based on FOLU Growing Better report. • Distribute investment in line with ha of agricultural land, in line with methodology FOLU Growing Better uses for global estimate. • FAO STAT provides estimates of agricultural land (in ha) – including crop and pastureland – by country. Using this, we calculate each country's share of global agricultural land. • We categorise each country as advanced, emerging and developing to determine the share of global agricultural land for each country wealth category within each region. • We multiply the % of agricultural land by the global investment figure to establish figure for each wealth category. • In the case of Closing the Productivity Gap and increasing irrigation efficiency, FOLU Growing Better assumes that all investment will be directed towards developing countries. In these cases, we split between emerging and developing countries based on share of agricultural land.	FOLU 2019[lxxiii] FAO STAT[lxxiv]
Food Loss and Waste	• G7: 5% • China: 10% • Advanced: 10% • Emerging: 50% • Developing: 45%	• Global investment figures are based on FOLU Growing Better report. • Consumer demand management: FOLU assume 100% investment is in advanced economies. • Post-harvest losses: FOLU assume 100% investment is in developing economies. We split between emerging and developing countries based on share of agricultural land. • Reducing supply-chain waste: distribute investment according to share of agricultural land.	FOLU 2019[lxxv] FAO STAT[lxxvi]
Dietary Shift	• G7: 40% • China: 20% • Advanced:60% • Emerging: 30% • Developing: 10%	• Global investment figures are based on FOLU Growing Better report. • Assume majority of investment is in advanced economies (greater technical/ financial capacity for production of cultured meats), but with opportunities for emerging and developing economies in plant-based production and insect protein, relevant to existing culinary cultures.	FOLU 2019[lxxvii]

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