DISCUSSION BRIEF

Estimating international mitigation finance needs: A top-down perspective

Introduction

In the run-up to the UN Climate Change Conference (COP20) in Lima, Peru, several countries have made substantial pledges to the Green Climate Fund, which is expected to become a primary channel for international finance for mitigation and adaptation in developing countries. By most estimates, however, current and pledged climate finance falls far short of what is needed, particularly if emissions are to be kept at levels consistent with a warming trajectory of no more than 2°C.

This gap in mitigation finance concerns both global investment needs and "North-South" financial commitments to assist in the deployment of low-carbon technologies in developing countries (IEA 2012; IEA 2014b; IEA 2014a; Gupta and Harnisch 2014). The COP in Lima provides a forum to start crafting international agreements on climate finance in preparation for the post-2020 agreement to be approved at COP21 Paris next year. This process may be more effective if it is informed by reliable estimates of investment needs globally, in the developing world, and in individual countries, so that countries can set their ambitions for increased climate finance appropriately.[1]

This discussion brief, adapted from a memo prepared for Oxfam International, reviews and distils the findings of key global studies that have sought to gauge mitigation finance requirements. In addition to the estimates they provide at the global and regional levels, these studies can provide "top-down" perspectives on national finance requirements that can complement the "bottom-up" estimates developed at the country level. While country-specific studies are invaluable, reflecting unique opportunities and constraints, they can also be difficult to compare across countries. Individual global studies, in contrast, can provide some level of consistency in assumptions, approaches, and estimates across countries and regions – though as noted below, the ability to downscale to all but the largest countries is quite limited.

The Intergovernmental Panel on Climate Change (IPCC) *Fifth Assessment Report* includes a chapter synthesizing the current state of knowledge on mitigation finance needs (Gupta and Harnisch 2014) . Figure 1, reprinted from that report, illustrates the very wide span of estimates for *incremental* investment needs – i.e. above and beyond business-as-usual levels, from the literature reviewed by the IPCC at the time. For example, the compiled studies suggest that incremental investment needs in energy efficiency could be as low as US$1 billion or as high as US$641 billion per year (low and high points of the blue bar, second from the right),[2] averaged over the period 2010–2029. Given such a wide range, median estimates – in this case, US$336 billion per year for energy efficiency – cannot be viewed as reliable reference points, nor is averaging across studies (with inconsistent assumptions) generally viewed as valid (Rosen and Guenther 2014).

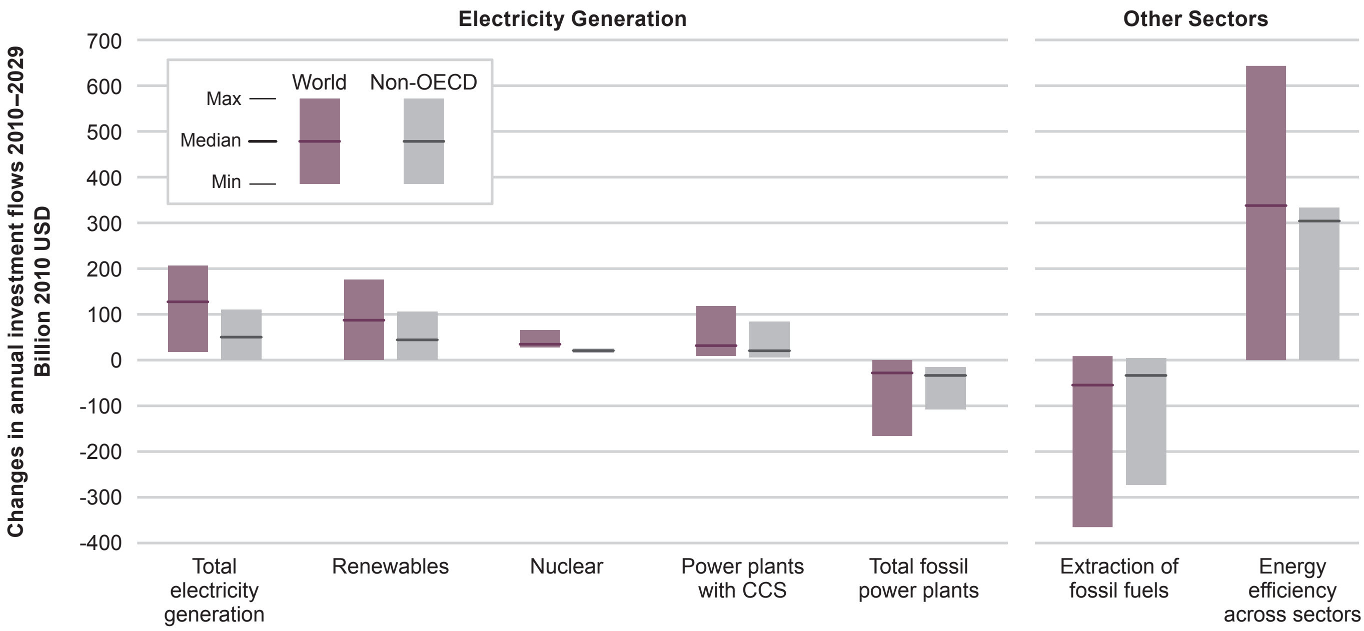

Figure 1: Change of annual investment in mitigation scenarios, 2010–2029, as estimated by the IPCC (Gupta and Harnisch 2014, Figure 16.3). The bars represent the range of incremental investment needs (low-carbon pathway minus baseline) and the lines give the median estimate across the range of studies (number of studies shown in row below the table). Estimates for both world (blue) and non-OECD (yellow) are shown.

1 Note that we use the terms finance and investment relatively interchangeably in this memo, though definitions and coverage of categories of finance vary among studies. Buchner et al. (2013) used the term "climate-specific finance" as "referring specifically to capital flows targeting low-carbon and climate-resilient development with direct or indirect greenhouse gas mitigation or adaptation objectives" (p.2). We consider only mitigation finance here, which corresponds to roughly 95% of climate-specific finance to date (Gupta and Harnisch 2014).

2 Most dollar values reported in this memo are for the 2010 currency year. Some may reflect more recent years (e.g. 2012), but given low inflation rates, the differences are negligible in comparison with large uncertainties surrounding the finance estimates themselves.

Box 1: Summary of metrics and terms used in this brief

The table below depicts the general relationship among key parameters and common metrics (shaded cells) reported in the climate finance and mitigation costing literature. As shown, the simplest metric is total investment in climate-specific technologies, while all other metrics draw from this along with additional parameters.

	Investment (capital) costs			**Fuel and operating costs**		**Total costs**
	Climate-specific	Fossil fuel power & supply	Net climate-relevant	Climate-specific	Fossil fuel power & supply	
Low-carbon scenario	**Total investment (A)**	B		J	K	
Baseline scenario	C	D		N	O	
Incremental	**Incremental investment (E = A-C)**	F = B-D	**Incremental, net investment** (G = E+F)	P = J-N	Q = K-O	**Incremental, net cost (S = G+P-Q)**

Glossary of terms

Climate-specific: Depending on source categories, this includes supply-side low-carbon power – renewables, nuclear, fossil fuel with carbon capture and storage (CCS) – and demand-side energy efficiency.
Fossil fuel power & supply: Includes fossil fuel supply-side power and other (extraction, refining, transport) sectors.
Net: The combination of climate-specific and (avoided) fossil fuel supply investment costs.

While energy efficiency finance needs may be particularly difficult to estimate, as discussed further below, all cost and investment projections are subject to very large uncertainties. These projections depend on a host of often highly speculative assumptions – on everything from mitigation technology costs and the drivers of business-as-usual emissions growth, to the future price of oil. Therefore, where we present singular estimates of future finance needs, they should be viewed as illustrative rather than in any way definitive.

Throughout this brief, we focus on investments over the next 15 to 20 years (to 2030 or 2035), to reflect both the possible time horizon of an agreement that might emerge from COP21 in Paris, as well as the time intervals typically reported by global studies.

Studies considered

We begin by reviewing mitigation scenario results from modelling studies analysed by the IPCC, as well as those that have been published more recently, as shown in Table A1 in the Annex . We then cull this list of studies based on a number of factors: wide usage or citation in climate policy and literature; data availability for investment metrics and categories; time and geographic coverage; complete description of baseline and low-carbon scenarios; and use of current modelling parameters on technologies and technology costs. On this basis, we look most closely at the following four studies:

- McCollum et al. (2013), which presents results from five separate modelling teams, included in the IPCC analysis (Figure 1);
- The *Global Energy Assessment*, which presents the MESSAGE model results of Riahi et al. 2012 (GEA 2012), also included in the IPCC analysis (Figure 1);
- The International Energy Agency's 2012 *Energy Technology Perspectives* report (IEA 2012), not included in the IPCC analysis; and
- The IEA's 2014 *World Energy Investment Outlook* (IEA 2014b), also not included in the IPCC analysis.

We focus most heavily on the *World Energy Investment Outlook* (IEA 2014b), as it is widely referenced, rich in detail, and its findings are generally in the middle range of studies considered. Per the caveat above, we do not suggest viewing these as "best estimates" simply because they lie near the middle range.

Choosing the relevant metrics

The IPCC review of climate finance notes: "Scientific literature on investment and finance to address climate change is still very limited and knowledge gaps are substantial; there are no agreed definitions for climate investment and climate finance" (Gupta and Harnisch 2014, p.3). The lack of agreed definitions – and thus, of a common metric – is a particular challenge for any analysis of climate finance, but there are reasons why different metrics are used.

Some metrics, as explained below, are easier to track, such as total investment. Some are more indicative of the level of additional effort needed, such as incremental investment. And some seek to reflect the overall incremental costs to society, on the notion that is the amount of finance that should flow to address climate change. Arguably, the choice of which finance metric(s) to feature is as important as the numerical value that is attached to it. We describe the various metrics in the following sections and provide a summary of terms, parameters, and metrics in the box above.

Incremental vs. total investment

Across projections of future finance needs, the most common metric reported and discussed is **incremental capital investment**, which reflects **total capital investment** minus investment in a reference case or business-as-usual scenario (Nelson et al. 2014). Since total investment reflects spending that would occur "anyway" in the absence of any further climate action or agreements, incremental investment is highly relevant for climate policy, as it embodies the notion of "new and additional" finance. However, since it is virtually impossible to measure or monitor reference case investment (as it is inherently a counterfactual), the numbers used for total capital investment more often reflect current levels of investment (e.g. as reported in Gupta and Harnisch 2014; Buchner et al. 2013; IEA 2014b). Therefore, below we report on both total and incremental levels of investment where possible.

Table 1: Annual incremental investment needed under various low-carbon scenarios, averaged across years covered (2010 US$, billion/year)

	Years covered	Difference between reference and low-carbon scenario emissions, 2030 (Gt CO_2)[a]	Low-carbon power[b] (A)	Efficiency[c] (B)	Other climate-specific[d] (O)	Climate-specific (C=A+B+O)	Fossil fuel power[b] (D)	Fossil fuel supply[e] (E)	Total fossil fuel (F=D+E)	Other[d] (G)	Net climate-relevant (C+F+G)
IMAGE model (McCollum et al. 2013)	2010-30	9.5	0	34	2	36	-23	-21	-44	-18	-26
MESSAGE model (McCollum et al. 2013)	2010-30	13.0	58	62	19	139	-10	-26	-36	-3	100
TIAM-ECN model (McCollum et al. 2013)	2010-30	13.1	57	43	2	102	-19	16	-3	-9	90
REMIND model (McCollum et al. 2013)	2010-30	15.3	237	139	31	407	-60	-45	-105	-55	247
WEIO (IEA 2014b)	2014-35	15.7	209	350	28	587	-32	-196	-228	-44	315
ETP (IEA 2012)	2010-30	19.0	259	520	Not reported	779	-104	Not reported	-104	-15	660
GEA (2012)	2010-30	23.6	115	181	Not reported	296	-2	-155	-157	15	154
WITCH model (McCollum et al. 2013)	2010-30	24.8	418	173	57	648	-170	-532	-702	-26	-80

a. Emissions reductions are fossil fuel and industry CO_2 only.

b. Low-carbon power includes nuclear, renewable, and fossil fuel power plants with CCS (although it is not possible to separate CCS from fossil fuel power in second MESSAGE study above). All other fossil fuel power plant investment is included under fossil fuel power.

c. This column represents demand-side efficiency investments. For WEIO, this column also includes electric vehicles (about US$100 billion of the US$350 billion per year shown above, assuming no investment in the reference scenario).

d: Studies differ widely in how they consider, categorize, and report other investment types. Other, climate-specific investment may include some combination of biofuels, uranium extraction, and R&D investments. Other investment may include additional fossil fuel related investments (e.g. synthetic fuels) and transmission and distribution investments. GEA does not report other climate-specific separately from other investments.

e: I ncludes non-power related oil (upstream, transport, and refining), gas (upstream and transport), and coal (mining and transport) investments (IEA 2014b); fossil fuel extraction, petroleum refining, and synthetic fuels production (all models from McCollum et al. 2013) and fossil fuel extraction (GEA 2012).

Climate-specific vs. net, climate-relevant finance

Another important aspect of finance metrics is whether they consider impacts on overall capital flows across key emitting sectors (e.g. power generation, other energy supply, industry, buildings, transport, agriculture, forestry) – what some term **climate-relevant finance** – or only **climate-specific finance**, capital flows specifically directed towards low-carbon development, where emission reduction or carbon sequestration is either a stated objective or main outcome (Corfee-Morlot et al. 2009; Buchner et al. 2011; Clapp et al. 2012).

Most estimates of climate-specific finance, whether current or projected, consist largely of investment in low-carbon electricity (renewable energy, nuclear energy, or carbon capture and storage), energy efficiency, biofuels, and land use and forestry investments. In a low-carbon future, such investments may displace significant amounts of investment in fossil fuel power generation as well as extraction and delivery. As a result, the **net climate-relevant** (climate-specific minus fossil fuel infrastructure avoided) investment in a low carbon scenario will tend to be a far lower amount than the climate-specific finance needed.

While the climate finance discussion may tend to focus more on the latter metric (climate-specific), effects on net, climate-relevant finance may also be germane. Whether climate-specific or net, climate-relevant investment is the appropriate metric may hinge on the degree to which lower (avoided) investments in fossil fuel supply and power could or would be reallocated towards climate-specific activities. For some sectors, such as power supply investment, such redirection may readily occur, especially where certain investors (e.g. utilities) deliver the same commodity (e.g. electricity) regardless of whether it is produced from fossil fuel or low-carbon resources. However, it is far less clear whether reductions in upstream fossil fuel supply investment can lead to increased investment in renewable energy supply or energy efficiency measures, as the investors and products may substantially differ. There are thus reasons to report both **climate-specific** and **net climate-relevant investment requirements**.

Incremental costs vs. investments

In many cases, incremental costs are reported in lieu of or in addition to incremental investments (McKinsey & Company 2009; McKinsey & Company 2010; IEA 2012; IEA 2014a; Nelson et al. 2014).[3] Incremental costs account for differences in operation and fuel expenditures in addition to incremental upfront investments. In general, a low-carbon scenario will yield significant fuel (and operating cost) savings, and therefore incremental cost estimates are generally significantly

3 Another consideration is that of stranded assets, which is explored in IEA (2014b) and Nelson et al. (2014).

smaller than those for incremental investments. Thus, some argue that incremental costs are a better metric than incremental investments, since the former captures the financial (fuel savings) benefits that can accrue in a low-carbon future.

However, as with the savings from avoided investments in fossil fuel infrastructure, it is not always clear whether fuel cost savings can flow to climate-specific investments. Such fuel savings do not alter the amount of investment capital required for a low-carbon future. Therefore, we maintain a focus on investment needs in this brief. Still, as discussed below, some have suggested that the appropriate level of climate mitigation finance from developed to developing countries lies somewhere between the level of incremental investment and the incremental cost of relevant actions in developing countries (Olbrisch et al. 2011).

Public vs. private finance

Climate-specific finance comes from both public and private sources. (Figures presented in this brief do not, unless indicated, distinguish between the two sources.) Public finance has historically been the main focus of policy debates around climate finance, but it constitutes well under half of current investments – 38% in estimates by Buchner et al. (2013). Often public finance is intended to leverage increased private finance, but just how much is leveraged by a given amount of public funds (the "leverage ratio") will vary based on the sector, region, and actors involved. Yet as the IEA (2014b) notes, "relatively small assumptions on leverage ratios have significant effects on the estimate of the scale of investment in energy efficiency". As leverage ratios are not well understood, we make no attempt assess financing needs based on public/private split. The IEA (2012) finds that the necessary financing levels are likelier to be reached if public financing is "targeted at incremental costs not compensated by fuel savings while leveraging private finance for the cost-effective component of these investments".

Current annual climate-specific investment for mitigation

Buchner et al. (2013) estimate that global climate-specific finance totalled US$359 billion in 2012, down slightly from US$364 billion in 2011.[4] Of the 2012 total, US$337 billion, or 94%, went to mitigation activities (the rest was for adaptation). Citing data limitations, Buchner et al. (2013) report only public, not private, investment in energy efficiency – US$32 billion. In contrast, the IEA (2014b) estimates energy efficiency investments in 2013, including both public and private, at US$130 billion. We use this value for energy efficiency, since it provides a more comprehensive picture of current financing.[5]Thus we estimate total current annual climate-specific investment in mitigation at about US$435 billion (337–32 +130).

Buchner et al. (2013) report that 76% of total climate-specific investment in 2012 was spent in the country where it originated. Much of the remainder was public-sector finance flowing from developed countries to developing countries, estimated at US$35-49 billion. Total North-South flows, including private finance as well, were only slightly higher, estimated at US$39–62 billion.

In the sections that follow, we review and distil projections of investments needs for a low-carbon future (compatible with a 2°C target), as averaged across the next 15 to 20 years, in order to generate comparable annual figures.[6] While annual investment needs continue to increase during this time period, the average provides a useful point of comparison against current annual climate-specific finance. Since flows from developed to developing countries are a focal point of international negotiations, we look separately at total global and total non-OECD (as proxy for developing countries) estimates of investment needs, as well as consider a handful of individual countries.

Global investment needs

Incremental investment needs

As noted above, incremental investment needs provide an important perspective on the overall investment impact of shifting to a low-carbon emissions pathway. Table 1 summarizes global incremental investment needs as projected by the four main reports (eight model results) examined. The table is organized in (descending) order of projected reference scenario emissions in 2030 (third column of Table 1). A higher emissions baseline generally indicates a greater emissions reduction needed to achieve a 2°C compatible emissions trajectory.[7] The level of projected business-as-usual (BAU) emissions is thus a key factor in the level of incremental investment found to be needed.

The estimates for incremental climate-specific finance range from US$36 billion to US$779 billion. The estimates for net incremental global climate-relevant finance, which are pushed downward by projected reductions in fossil fuel investment, range from a negative US$80 billion (i.e. US$80 billion less would be needed), to US$660 billion. In comparing these figures, we find several patterns worth noting:

- In all but one study (GEA 2012), reference scenario (BAU) emissions, the primary determinant for emissions reductions, are well correlated with investment needs for low-carbon power (positive correlation) as well as fossil-fuel supply and power (negative correlation).
- Net incremental investment requirements are less than climate-specific incremental investment requirements in all scenarios, primarily due to avoided (negative incremental) fossil fuel investments. By two estimates, the avoided fossil fuel investments exceed climate-specific investment needs.
- Other incremental investment requirements are small relative to the climate-specific and fossil-fuel power & supply categories, and the sign depends on the study and the types of investments considered.

In addition to the incremental investment costs summarized in Table 1, the World Economic Forum (2013) and McKinsey & Company (2010) estimate an incremental need of $40 billion per year through 2030 for the forestry sector.

4 As this brief was going to press, the Climate Policy Initiative released climate-specific finance estimates for 2013 that are about US$28 billion lower than for 2012. The drop is attributed largely to declining renewable energy technology costs (Buchner et al. 2014).

5 Energy efficiency investments reported by other sources, as complied in Table 4.1 of IEA (2014b) are greater. They range from central estimates of approximately $150 billion to $365 billion.

6 This is likely to coincide generally with the time horizon for international agreements emerging out of COP21 in Paris. The time horizons considered in the studies we review vary, but generally include the period 2010–2030, except for IEA (2014b), which reports cumulative 2014–2035 investments.

7 Emissions reductions are for fossil fuel and industry CO_2 only, as this is the consistent available metric across the suited of studies.

Table 2: Annual total climate-specific investment needed under various low-carbon scenarios, averaged across years covered (2010 US$, billion/year)

	Years Covered	Difference between reference and low-carbon scenario emissions, 2030 (Gt CO_2)[a]	Low-carbon power[b] (A)	Efficiency[c] (B)	Other climate-specific (O)	Climate-specific (C=A+B+O)
IMAGE model (McCollum et al. 2013)	2010-30	9.5	291	49[3]	41	381
MESSAGE model (McCollum et al. 2013)	2010-30	13.0	215	81[3]	67	363
TIAM-ECN model (McCollum et al. 2013)	2010-30	13.1	329	61[3]	40	430
REMIND model (McCollum et al. 2013)	2010-30	15.3	544	169[3]	57	770
WEIO (IEA 2014b)	2014-35	15.7	527	717	42	1286
ETP (IEA 2012)	2010-30	19.0	427	1975	Not reported	2402
GEA (2012)	2010-30	23.6	264	181[3]	Not reported	445
WITCH model (McCollum et al. 2013)	2010-30	24.8	796	222[3]	122	1140

a. Emissions reduction are for fossil fuel and industry CO_2 only.

b. Low-carbon power includes nuclear, renewable, and fossil fuel power plants with CCS (although it is not possible to separate CCS from fossil fuel power in second MESSAGE study above). All other fossil fuel power plant investment is included under fossil fuel power.

c. This column represents demand-side efficiency investments. For WEIO, this column also includes electric vehicles (about US$100 billion of the US$350 billion per year shown above, assuming no investment in the reference scenario).

Total investment needs

As noted above, total climate-specific investments are easier to monitor and measure, and therefore may provide some advantages as a metric for gauging and tracking future climate-specific finance. Table 2 shows the results of same eight modelling studies as in Table 1, except in terms of total rather than incremental investment needs. Again, the estimates vary widely: from a low of US$363 billion to a high of US$2.4 trillion for climate-specific finance. Table 2 does not show total required investments in the forestry sector, which the World Economic Forum (2013) estimates at $104 billion per year.

Quantifying the level of energy efficiency investments, both current and projected, presents many challenges.[8] Comparability across studies is limited by widely varying definitions and methodologies – in particular, for the fraction of a given investment (e.g. an efficient refrigerator) that is considered an investment in "efficiency" (e.g. the added cost for that efficient refrigerator as compared with a reference technology). Furthermore, under certain "reference scenarios", there is a very substantial amount of investment occurring that could be termed "efficiency" (IEA 2012; IEA 2014b). For example, every purchase of a compact fluorescent light (CFL) or light-emitting diode (LED) could be considered an efficiency investment, even though most projections show these technologies dominating residential lighting markets in the coming years, regardless of policy intervention. Therefore, for the remainder of this briefing paper, all efficiency investment projections are reported as incremental investment needs, due to the limitations of total investments discussed in the previous section.

Total global investment needs relative to current levels

Table 3 compares projected global investment needs from the World Energy Investment Outlook (IEA 2014b), and the highest and lowest estimates of the eight studies considered in the tables above with the most recent estimates of annual climate-specific mitigation (IEA 2014b; Buchner et al. 2013). The needed change in global investment (projected investment needs minus current investment levels) over the next 15–20 years ranges widely, from no increase to a 170% increase (US$760 billion), depending on the study. Given the wide range of projections for climate-specific investments, a best estimate remains elusive.

Non-OECD investment projections

The degree to which investment needs are concentrated in developing countries, and the extent to which they should be met by North-South financial flows, are two issues of particular relevance for international climate negotiations. While developed countries have previously indicated an intention to finance the "agreed full incremental costs" for climate mitigation measures (UNFCC 1992, Article 4.3), no operational definition of "full incremental costs" exists (Olbrisch et al. 2011). As noted earlier, Olbrisch et al. (2011) suggest that the appropriate level of North-South funding is likely to be somewhere between incremental cost and incremental investment levels, but they stress that these two bounds "can inform, but do not determine, the amount of international financial support needed by developing countries".[9]

Non-OECD countries, collectively, are likely to require the majority of global climate-specific investment needs over the upcoming 15-20 years and beyond. Similar to Table 3, Table 4 summarizes investment levels and needs, in this case for non-OECD countries. However, these values cannot be directly compared with Table 3 due to the limited scope of energy efficiency investments considered by Buchner et al. (2013). Given that the Buchner et al. (2013) estimate

8 As stated in the *World Energy Investment Outlook* (IEA 2014b): "Energy efficiency investment is notoriously difficult to track because it is carried out by a multitude of agents, households and firms, often without external financing. It often constitutes only a portion of broader investment and is not accounted for explicitly. Assessing efficiency investment is further complicated by the definitional and data quality issues related to energy consumption in various end-uses. While there is steadily increasing interest in energy efficiency by decision makers, financial institutions and energy consumers, there is no systematic, standardized tracking of energy efficiency investment."

9 While incremental investments do not account for significant fuel cost savings, incremental costs do not capture full incentive or programme costs and assume cost savings from certain activities to be directly available to offset higher costs for other actions (Olbrisch et al. 2011).

Table 3: Annual, global climate-specific investment needs (averaged across next 15–20 years) relative to current levels of investment (billon 2010 US$ per year). Projected needs drawn from IEA (2014b) for energy and World Economic Forum (2013) for forestry. Amounts in parentheses represent the low and high study estimates from Tables 1 and 2.

	Total low-carbon power (Table 2)	Incremental efficiency (Table 1)	Total forestry and other climate-specific[b] (Table 2)	Combined climate-specific[c]
Current[a]	262	130	43	435
Projected average annual investment needs (to 2030/35)	527 (215 – 796)	350 (34 – 520)	146 (104 – 226)	1,023 (448 – 1,195)
Increase in finance needed	265 (-47 – 534)	220 (-96 – 390)	103 (61–183)	588 (13 – 760)
As % (rounded)	100% (-20% – 200%)	170% (-70% – 300%)	240% (140% – 430%)	140% (0% – 170%)

a. As discussed above, we use two sources to estimate current investment. We draw low-carbon power and forestry and other investment flows from Buchner et al. (2013), representing data from 2011 and 2012. We draw incremental efficiency investment from IEA (2014b), based on 2013 data.

b. Current investment reflects a combination of biofuels and other mitigation measures categories of Buchner et al. (2013). Projected investments combines the World Economic Forum (2013) estimate for forestry investment needs ($104 billion per year) with estimates for total other, climate-specific investment from Table 2.

c. Combined, climate-specific represent the sum of the three columns shown. The ranges show the highest and lowest sums across the 8 scenarios analysed here. The values in the ranges shown do not necessarily match the sum of the values in the ranges for the three columns to the left. For example, the high end of the range for projected average annual investment needs ($1195 billion) represents the WITCH model findings (plus forestry), while the high end of the range for incremental efficiency ($520 billion per year) is drawn from the ETP study.

excludes private finance for energy efficiency, it is likely that the roughly 250% increase in finance that our analysis shows is needed (US$440 billion) would be lower if current energy efficiency investments from private sources were included.

Figure 2 displays additional details on the IEA (2014b) projections of non-OECD investment needs by category. (See Figure 1 for comparison with range of studies in the IPCC analysis (Gupta and Harnisch 2014), though investment categories are not perfectly matched.[10] As shown, non-OECD investments are projected to be the majority of all investment needs through 2035 for all major investment categories, including 55% for low-carbon power and biofuels and 60% for energy efficiency. These shares of investment are similar to incremental energy demand projections from IEA (2012) of 56% (2010–30) and IPCC (Gupta and Harnisch 2014) median projections for renewables of 51% (2010–29).

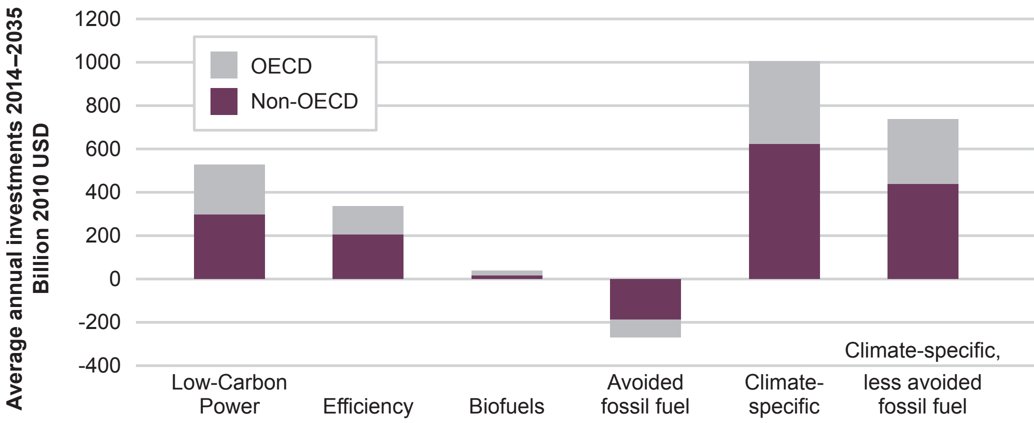

Figure 2: Non-OECD and OECD share of annual average investments (billion 2010 US$) by major investment category, derived from IEA (2014b). * Non-OECD includes projected forestry emissions of $104 billion per year (World Economic Forum 2013).

Individual country investment needs

From the global studies, developing country investment projections are only available at the country level in IEA studies, and only for China, India, or Brazil (IEA 2014b). Outside of these country-level estimates, any developing country estimates are rolled into wider regional estimates. Table 5 reports projected investment needs by major categories for these countries and regions, based on IEA (2014b).

Downscaling regional estimates to specific countries would be problematic, given that countries may vary substantially in resource endowments (both fossil and renewable), technical and economic capacity, and other attributes that will influence total investment needs.

In addition to the national and regional projections from the global studies, a range of country-specific studies have been conducted. These include full-country and sector-specific assessments. Olbrisch et al. (2011) compiled a list of these studies, shown in Table 6, for a handful of countries. Note that the projections for China and India are broadly consistent with the IEA (2014b) projections.

Conclusions

While little certainty exists around the levels of climate finance needed for a low emissions pathway, present levels are insufficient to meet the challenge. Investment in climate-specific mitigation technologies, such as non-fossil fuel energy supply, have grown substantially over the last decade (IEA 2014b), and such growth will need to accelerate, accompanied by a shift away from investments in long-lived fossil infrastructure that can lock-in high emissions and increase the costs of meeting ambitious climate targets.

Not surprisingly, our review of existing studies suggests the gap between current and needed climate finance is greatest among developing countries. Recent projections from IEA (2014b) and WEF (2013) suggest that annual investment needs for a low carbon transition in the South may require

10 We include biofuels (with low-carbon power), power transmission and distribution (with avoided fossil fuel), and forestry (as climate-specific non-OECD) investments that are not included in Figure 1. The low-carbon power and biofuels category in Figure 2 is total, while the IPCC reports incremental.

Table 4: Annual, non-OECD climate-specific investment needs (averaged across next 15–20 years) relative to current levels (billion 2010 US$ per year).

	Total low-carbon power	Incremental efficiency	Total forestry and other climate-specificb	Combined climate-specific	Of which, North-South
Current[a]		180 (limited detail)		180	40
Projected average annual investment needs (out to 2030/35, IEA 2014b and WEF 2013)	296	205	120	621	?
Increase in finance needed		(limited detail)		441	?
As %		(limited detail)		250%	?

a. Current non-OECD investment is taken from Buchner et al. (2013), who, as noted above, do not account for private energy efficiency investments. The IEA (2014b) does not separately report non-OECD current investment.

b. Projected forestry investment needs are taken from WEF (2013), assigning total investment needs to non-OECD countries (US$104 billion/year). The remainder ($16 billion/year) are biofuels-related investment needs taken from IEA (2014b).

Table 5: Country and regional annual average investment needs (billion 2010 US$), for climate-specific (total low-carbon power and biofuels, incremental efficiency) and avoided fossil fuel investments (incremental). All estimates are from IEA (2014b).

	Climate-specific investments (billion 2010 US$, IEA 2014b)			Avoided investments (2010 US$, IEA 2014b)			
	Low-carbon Power	Incremental efficiency	Biofuels	Fossil fuel power (includes T&D)	Upstream fossil fuel	Total avoided investments	Total, as share of climate-specific
China	116	86	4	-18	-17	-35	17%
India	50	27	1	-5	-3	-8	10%
SE Asia	20	17	2	-10	-5	-14	36%
Africa	21	15	0	-7	-19	-26	71%
Brazil	13	13	7	-3	-14	-17	52%
Other Latin Am	10	12	1	-2	-11	-13	55%

Table 6: Country-level annual average investment needs from various studies (billion 2010 US$), as reported by Olbrisch et al. (2011).

Full country estimates	Years	Investments (billion US$)	Currency	Source
China	2010-2030	175	Euros	McKinsey & Company (2009) Project Catalyst
India	2010-2030	49	USD	McKinsey & Company (2009) Project Catalyst
Indonesia	2020	4.3	USD	Regional Economics of Climate Change (RECCS), ADB 2009
Philippines	2020	1.6	USD	Regional Economics of Climate Change (RECCS), ADB 2009
Sector-specific estimates				
Indonesia	2009-2020	1	USD	NEEDS project: Energy, Transport, Industrial processes, agriculture, forestry, waste, peat
Nigeria	2010-2020	1.3	USD	NEEDS project: Energy sector (25% emissions reduction), afforestation, agroforestry
Philippines	2008-2030	1.3	USD	NEEDS project: energy only

investment levels of over $600 billion annually on average over the next 2 decades, far exceeding the roughly $180 billion currently invested as well as the Copenhagen pledge of $100 billion per year in North-South flows by 2020.

Such figures, however, as imprecise as they are, do not tell the full story of how investment flows might change in a low-carbon future. We focus here on total climate-specific investment needs (except for energy efficiency where total investment is not a terribly meaningful metric) because it is much more straightforward to measure and track than incremental investment flows relative to a counterfactual BAU. Nevertheless, it is only the incremental increase in climate-specific investment – a smaller amount than total investment – that needs to be generated by new and additional policies, actions, and funding.

Furthermore, as illustrated in Table 1, a low-carbon transition could free up considerable capital that would otherwise be directed to new fossil fuel infrastructure, as well as sizeable savings in fuel and operating costs. The net effect on financial markets of a low-carbon future could in fact be positive, freeing up investment capital for other purposes (Nelson et al. 2014).

That said, to achieve such an outcome, climate-specific investments must increase substantially, particularly in the form of North-South transfers. In that regard, the new pledges to the Green Climate Fund, as well as the recent G20 leaders' communiqué expressing support for mobilizing finance for adaptation and mitigation, are positive signs.

This discussion brief was written by Kevin Tempest and Michael Lazarus. It is adapted from a briefing produced for Oxfam International.

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Wind turbines in La Serena, in the Coquimbo region of Chile.

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