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Technical note: Allianz Climate and Energy Monitor

Assessing the needs and attractiveness of low-carbon investments in G20 countries

Allianz

NEW CLIMATE INSTITUTE

GERMANWATCH

Allianz Climate Solutions

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Allianz Climate Solutions is the competence center of Allianz Group for climate change and renewable energy. We offer insurance and advisory services on financing issues for renewable energy projects to both external clients and Allianz entities. Furthermore, we are responsible for climate-related advisory and strategy development of Allianz and are an incubator for climate-related product development.

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Introduction

The Paris Agreement adopted at the 21st session of the Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC) set a clear global emissions reduction goal of achieving net zero greenhouse gas (GHG) emissions reductions during the second half of the 21st century (UNFCCC, 2015). An achievement of the Paris Agreement goals would mean that global energy supply would need to be decarbonized mainly through a massive deployment of renewable energy at an unprecedented pace, which in turn signifies major business opportunities for the renewable energy-related sectors in the next decades.

A boost in investments in assets with such a long lifetime as energy infrastructure demands an investment climate that suits the preferences of long-term investors. The rationale that guides investment decisions in a country has been a topic of longstanding discussion in scholarly and policy circles. Naturally, national level drivers are important contributors in an investor's decision-making. However, another layer of nuance is added by the sector- and technology-specific determinants. Furthermore, particularly sector-specific policy and regulatory drivers have an important role in stimulating investor interest. With climate and energy policy increasingly converging, policy and regulatory determinants for renewable energy investments are of much higher significance compared to more traditional areas of investment. Prior experience with a technology and its market maturity are other sector-specific variables that build investor confidence. Therefore, understanding the attractiveness of a country for low-carbon investing requires a careful consideration of the sector's policy dynamics, particularly the adequacy and reliability of low-carbon energy policies, in conjunction with drivers that define the broader ease of investing in a country.

However, investment attractiveness presents only a part of the picture in light of the changing investor sentiment on low-carbon investing. The range of voluntary initiatives proposed by the finance community including banks, institutional investors and public agencies prior to and during the COP21 signaled potential appetite to proactively understand areas where investments are most needed, in addition to investing in most attractive destinations. Notably, these needs exist both in low-carbon infrastructure development as well as in climate-proofing existing and new infrastructure and in making it resilient and robust to future climate variability. Certainly, this is also an area where a concrete technical and regulatory response is yet to develop.

Against this background, Allianz Climate Solutions GmbH has contracted NewClimate Institute and Germanwatch to develop a composite index as an information and communication tool that tailors the drivers for investment attractiveness for the G20 countries and captures the investment needs for a low-carbon and climate-resilient electricity infrastructure. The 'Allianz Climate and Energy Monitor' (hereafter, 'the Monitor') aims to be a channel of communication between the investor community and policy-makers to set investments in energy infrastructure on track towards global climate goals, while also indicating towards investment opportunities for building climate resilience in the sector.

The coverage of the Monitor is unique as it brings together dimensions of policy, finance and resilience, thus deviating from a range of traditional renewable energy indices. Some other value additions of the Monitor are:

- It reflects the dynamic interaction between energy and climate policies in countries from a private investor perspective
- It balances current performance and future policy trajectory
- It indicates investment needs for climate resilience

The Monitor covers G20 member states (Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Republic of Korea, Mexico, Russia, Saudi Arabia, South Africa, Turkey, the United Kingdom and the United States of America)[1] because of their defining role in the current and future trajectory of global power supply and demand and the climate leadership role desired from them. G20 countries host two-thirds of global population and contribute to nearly 80% of world GDP. The G20 are also major energy supply centers, producing over 80% of the global energy; power sector forming a major proportion of this. Thus, they make a crucial sample to assess.

This document explains our methodological framework and approach towards developing the Monitor.

1 The European Union as a supranational body is excluded from the assessment.

Conceptual framework of the Monitor

The Monitor ranks G20 member states on their relative fitness as potential investment destinations for building low-carbon electricity infrastructure, judged against their current and future investment needs in the sector.

Electricity infrastructure is defined as the physical infrastructure required for producing, transporting and storing electricity from fossil fuel and renewable energy sources. Of these, the Monitor's assessment scope includes renewable energy production only, excluding fossil fuels, nuclear power and large hydro[2] as well as transportation and storage infrastructure.

The Monitor is a composite of two broad pillars – the investment attractiveness and the investment needs of countries.

The **investment attractiveness** of a country is assessed through four categories — the policy support for climate and renewable energies (categories 1 and 2: 'Policy adequacy' and 'Policy reliability of sustained support') and in-country market maturity to build and maintain green electricity infrastructure (category 3: 'Market absorption capacity'); and the overarching country-level factors that facilitate investments and business in a country (category 4: 'National investment conditions'). Each category further includes a set of indicators (explained in the later sections).

The **investment needs** are assessed by a single category assessing the 'Future needs for investing in the electricity infrastructure' which in turn is a composite of three indicators: the current and future *absolute investment needs* in the power sector for building less carbon-intensive and climate-robust energy infrastructure; and *needs relative to current consumption*, reflecting where development needs dictate need for investing. In addition, a *vulnerability indicator* is defined to signal relatively greater investment needs into the electricity infrastructure for building resilience from climate change impacts.

Figure 1 provides an overview of the categories, indicators and proxies used for assessment and evaluation approaches taken for assessment for the components of each pillar. The detailed assessment approach and the underlying data for these is discussed in the following sections.

2 Large hydro and nuclear were omitted from the assessment due to the sustainability concerns of these technologies. The methodological scope of each category did not present the need to use a specific definition of 'large' hydro, except in policy adequacy. There we only included policies covering hydroelectricity based the country's own definition of 'large' and 'small' (E.g. for India up to 25 MW is considered small hydro; while for Canada projects up to 50 MW are defined as small hydro).

The following steps were followed in arriving at the scores for each pillar:

1. **Data treatment:** In certain instances, the collected raw data required adjustments for further assessment. This included rescaling variables on a 0-100 scale (e.g. for World Governance Indicators under 'national investment conditions' which were from -2.5 to 2.5) or unit conversions (e.g. for renewable energy targets under 'policy adequacy').

2. **Addressing skewness and extreme values:** An initial review of the data revealed asymmetrical distribution (or skewness) and the presence of significantly extreme values in some indicators. We used a two-step approach to reduce the effect of outliers and skewness. For smoothening the skew, we undertook data transformation for indicators which deemed to have large skewness. In addition, to avoid extreme values to dominate in the aggregation and normalization scheme, we saturated all indicators at the 90 and 10 percentiles. That is, the data points greater than the 90th percentile are trimmed down to the 90th percentile value and values smaller than the 10th percentile are elevated to the 10th percentile value. While we note the lowered emphasis of the trimmed values when using this approach, it is deemed necessary for the aggregation algorithm to make sense and does not change the relative position of the countries with these values. Sophisticated statistical approaches to tackle skewness and extreme values were of limited use due to the small sample size.

3. **Normalization:** Next, indicators were normalized to make them comparable to each other for aggregation. Following OECD Guidebook on constructing composite indicators (Nardo et al., 2008); each indicator was normalized as follows:

   $$X_{i(nom)} = ((X_i - X_{worst}) / (X_{worst} - X_{best})) * 100$$

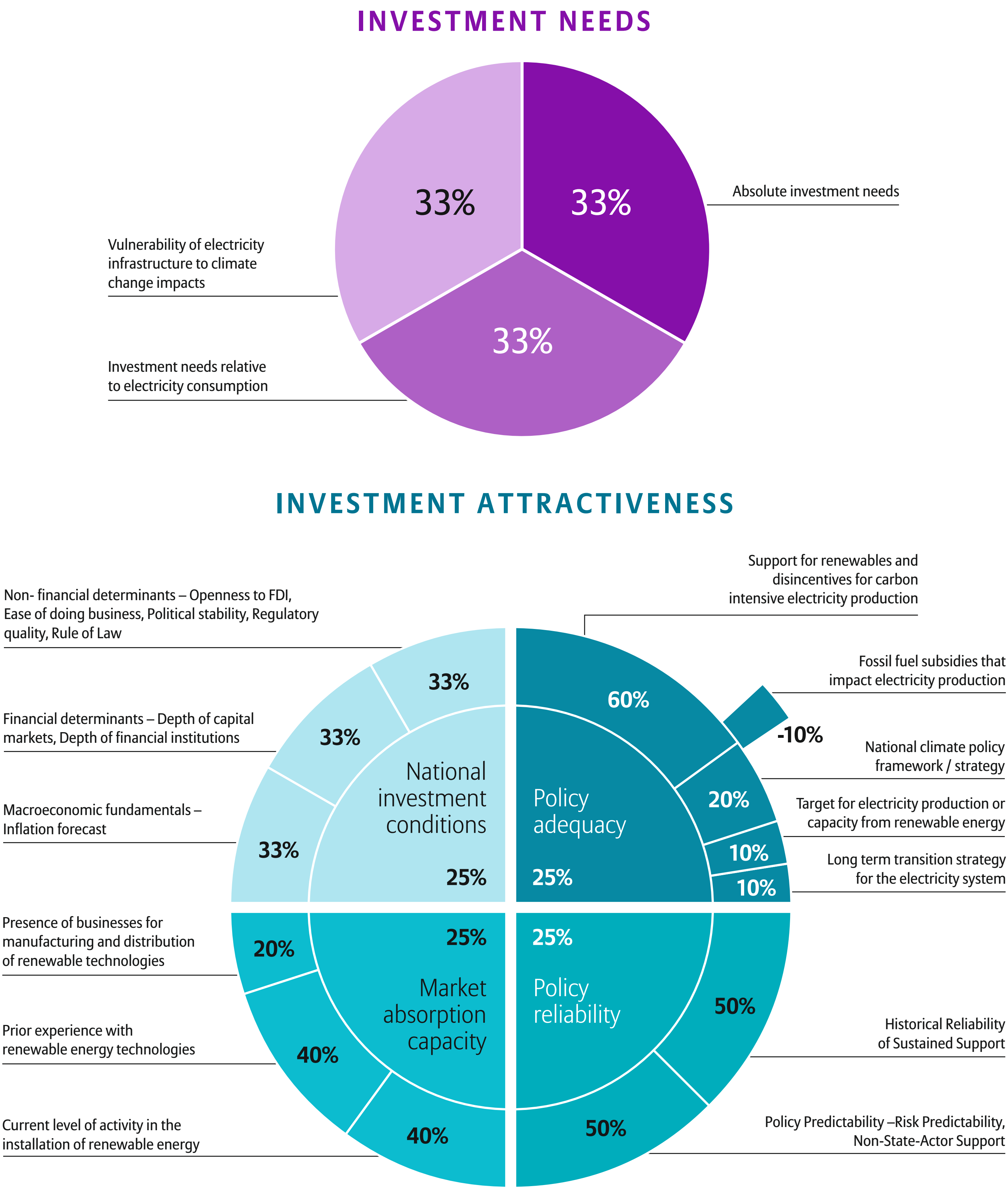
   where, $X_{i(nom)}$ is the normalized value of an indicator i

   In this manner, scores lied between the best score in the sample (100) and the worst score in the sample (0) for each normalized indicator.

4. **Weighting and Aggregation:** Following normalization, we use a weighting scheme to aggregate the scores of indicators to arrive at the pillar scores. For investment needs, this is done by using an equal weighting for all indicators; while for investment attractiveness, expert judgement is used to assign weights to indicators for arriving at category scores, which are then weighed equally to arrive at the pillar scores. The rationale for weighting is explained in the subsequent sections.

5. **Rating and ranking:** To improve the representation of final results, the final scores for each pillar were represented in five point ratings – very low (countries with a score between 0 up to 20), low (20-40), medium (40-60), high (60-80), very high (80-100). Countries are ranked for each pillar based on their final scores in each pillar.

FIGURE 1: Overview of the categories and the assessment approach



Note: The weights are rounded to one decimal digit

Pillar 1 – Investment Attractiveness

Category 1: Policy adequacy

Policy adequacy assesses if a country has a clear, coherent and ambitious policy framework for tackling climate change and its consequences, in particular with respect to low-carbon electricity infrastructure.

ASSESSMENT APPROACH

'Policy adequacy' measures a country's compliance with a good practice policy package that leads to a substantial increase of renewables in the share of electricity. The main elements of such a package are differentiated into some policy incentives (comprised of four indicators) and policy barriers (comprised of one indicator). These are presented in *Table 1* and explained in the following paragraphs.

Three potential approaches were considered for defining the methodology for this category. The first approach implied counting the number of policies impacting renewable energy production in a country. NewClimate Institute has used this approach in assessing country performance against a good practice policy package in the past. However, it does not address the stringency of those policies and does not comprehensively assess their potential impacts. The second approach was mainly qualitative, involving scoring based on expert judgement through yearly survey data. Such an approach is used in the Climate Change Performance Index (CCPI), which compares 58 high-emitting countries on their climate protection performance (Burck et al., 2014). However, such an approach was also less desirable as it completely relied on expert judgement.

The final approach considered was developed in Höhne et al. (2011). It involves a qualitative assessment employing a benchmarking approach for scoring using both quantitative and qualitative data. The method defines a set of incentives and barriers for a specific desired outcome (in this case, a policy framework that facilitates a substantial increase in the share of renewables), and scores them based on predefined scoring benchmarks. The incentives scores are first aggregated using a weighting scheme to obtain the incentives' value, to which barriers are added as discount factors in the final aggregation process (explained in the following paragraphs). **This approach was finally selected as it best suited the nature of assessment required for this category.**

TABLE 1: Composition of 'policy adequacy' category

	INDICATOR	SCORING BENCHMARKS	WEIGHT
Policy Incentives (i)	1 National climate policy framework / strategy	**100:** Strong national climate strategy for 2020/2030 with national legal force (parliament decision, executive order or equivalent) and sufficiently ambitious to deviate significantly from reference emissions or towards zero emissions in the electricity sector in 2050 **75:** Legally enforced climate strategy of medium ambition level **50:** Climate strategy exists but the ambition level is not high or without legal force **25:** Climate strategy exists but ambition unclear / undefined **0:** No national climate strategy	**20%**
Policy Incentives (i)	2 Target for electricity production or capacity addition from renewable energy resources (excluding large hydro)	**100:** Equivalent of minimum increase of share of 1.5%-points per year of renewables over the next 10 years **75:** Between 1% and 1.5% **50:** Between 0.5% and 1% **25:** Below 0.5% **0:** No renewable energy target	**10%**
Policy Incentives (i)	3 Long-term transition strategy for the electricity system	**100:** Long-term strategy for the transition to a zero-carbon electricity system to balance supply and demand, e.g. through grid extensions, smart grids, storage **50:** Initial strategy but not comprehensive **0:** No strategy	**10%**
Policy Incentives (i)	4 Support scheme for renewables or disincentives for carbon intensive electricity production	**100:** Legally enshrined, long-term support schemes that provide favorable conditions for all renewable technologies over fossil fuel-fired technologies are implemented. Examples include pricing policies (e.g. feed-in tariffs) for renewables and mid-term investment certainty being applied to all renewable technologies (excl. large hydro), and clear disincentives for carbon-intensive electricity production (via an overarching carbon tax, ETS scheme, emission standards etc.) which in turn provide room for renewables' growth. **75:** Policies described above are implemented, but without assurance of their long-term implementation. **50:** Pricing policies are implemented only for selected renewable technologies and/or quantity-based policies (e.g. renewable portfolio standards and tendering schemes) that provide favorable conditions for mature renewable technologies over fossil fuel-fired technologies are implemented. **25:** Other support schemes for renewables that do not necessarily provide sufficient incentives to level the playing field for renewables (e.g. tax breaks and accelerated depreciation). **0:** No support for renewables / disincentives for carbon-intensive resources	**60%**
Policy Barrier (*PB*)	5 Fossil fuel subsidies that impact electricity production	**0:** No fossil fuel subsidies **-100:** Fossil fuel subsidies or financial barriers to renewable energy	Maximum **10% discount** of the total score for "Policy incentives"

3 www.climateactiontracker.org (accessed 7 April, 2016)

It must be noted that the majority of incentives and barriers analyzed in this study are distinct from those in Höhne et al. 2011, and their respective scoring approach is also based on a newly defined set of benchmarks *(see Table 1)* and a different set of weights to suit the defined set of incentives/barriers.

For each country, the following calculations were done to arrive at its score for policy adequacy:

The overall policy adequacy for renewables was determined by multiplying the scores of policy incentives with discount factors for each indicator as stated in the equation below (Höhne et al., 2011):

$$policy\,adequacy_{total} = incentives_{total} \text{ x } (1 - discount\,factor_{PB}) \qquad (1)$$

The weighted value of all policy incentives was determined as follows:

$$incentives_{total} = \sum_{i=1}^{n} (score_i \text{ x } weight_i) \qquad (2)$$

where, i = incentive indicator and n = total number of indicators (4)

The discount factor reflecting the policy barrier i.e. fossil fuel subsidies was calculated as follows:

$$discout\,factor_{PB} = \frac{score_{PB} \text{ x } weight_{PB}}{100} \qquad (3)$$

INDICATORS AND SCORING METHODS

Policy incentives measure the impact of policies favorable to an increase in renewable electricity production. Four incentives were used in the assessment of policy incentives:

1. National climate policy framework / strategy

This indicator assesses the legal status and ambition of the overall climate strategy of the country. An ambitious national climate strategy would inevitably have an impact on the incentives and investments channeled for renewables power generation, considering the sector's GHG contribution in most countries and need for deep decarbonization.

National climate policy framework / strategy scoring encompasses three aspects: ambition, legal status, and comprehensiveness.

- Ambition is determined based on the ratings by the Climate Action Tracker[3]: sufficient, medium, inadequate. If a country has an implemented (legal or executive) and comprehensive strategy, but the ambition is low (inadequate), it gets a score of 50. A score of 75 is given if the ambition is medium, and the full score, 100, is obtained if the ambition is high (sufficient).

4 http://www.lse.ac.uk/GranthamInstitute/legislation/ (accessed 7 April, 2016)

- Legal status of assessed climate strategies is based on the Climate Legislation Study database developed by the Grantham Institute, London School of Economics and Political Science, (hereinafter, LSE database),[4] which gathers and assesses national documents that have a legal or executive status. If the strategy was included in the LSE database, it was assumed that it is legally enforced, or has an executive status. If the climate strategy was not covered by the LSE database, further research was undertaken to determine the legal status of the policy. A country obtains full score on the legal status if its strategy is legally enforced or has an executive status.

- Comprehensiveness of climate strategies was gauged based on how clear, detailed, and well-defined the objectives and measurements in the strategy were.

2. Target for electricity production or capacity addition from renewable energy resources

This indicator assesses stringency of national targets to increase the renewables' share in the electricity production. Renewable energy targets in the electricity sector are highly encouraging for future investments as they give an indication of the governmental commitment and future project pipeline.

The indicator was defined as annual increase in the share of renewables in electricity production or consumption.

While a range of reliable data sources exist for this indicator, the definition of renewable energy targets varies cross countries. In some countries, current and targeted shares of renewables are provided as percentages of electricity production (or supply), while in others, they are defined as percentages of electricity consumption or demand or as capacity of renewables. Some adjustments were undertaken to address this inconsistency. First, we assumed that production levels roughly match consumption levels in countries; therefore, the two target types can be compared. Second, when calculating the annual increase in the share of renewables, it was ensured that the same variables types (production or consumption) are used per country. Third, when targets were given in installed capacity (e.g. in gigawatts), and not as share or quantity of electricity production/consumption (e.g. in gigawatt-hour), unit conversion was undertaken using capacity factors determined from World Energy Outlook's 2015 global values (for Turkey) or country specific values (for China)[5].

3. Long-term transition strategy for the electricity system

This indicator assesses status and ambition of the strategy related to the infrastructure required for electricity production from renewables. It is considered that an ambitious overarching climate strategy and strong support for renewables are insufficient in the absence of a long-term transition strategy for the incorporation of these technologies in the electricity system.

The scoring encompasses two major aspects: level of ambition of the strategy and the period covered by the strategy i.e. short-term (2020 – 2030) and long-term (around 2050).

- If the country had a long-term strategy which considered deep decarbonization (>80%) of the electricity system (high ambition level); a score of 100 was given.

5 http://www.worldenergyoutlook.org/weo2015/ (accessed 07 March, 2016)

- If a country strategy (either short- or long-term) included a grid expansion/ improvement plan to accommodate the increase in renewables but did not aim for deep decarbonization of the electricity system (low ambition level), it was rated as 50.

- Minimum score, 0, was given where no comprehensive strategy for grid expansion/improvement existed, even if the country took some action on developing the grid in the past.

- The transition strategy scoring approach was intentionally kept simpler than other indicators to limit subjectivity in assessment.

4. Support scheme for renewables or disincentives for carbon-intensive electricity production

This indicator assesses policies that increase the economic viability of renewables or decrease the attractiveness of carbon-intensive electricity production in order to create more favorable conditions for renewables relative to fossil based electricity generation

The score of support schemes is determined based on the mix of incentives and disincentives for both renewables and fossil fuels in electricity production. As for previous indicator, benchmarks were developed for scoring countries on a five-point scale of 0-100:

- Our assessment gives maximum 75 points for the type of currently implemented policy instruments and 25 points for whether countries have legally enshrined the long-term support for renewable electricity up to 2030. The latter is idealistic but important nevertheless because many countries have strong support schemes such as feed-in tariffs (FITs), which provide long-term predictability for projects implemented today but the future of the scheme itself is uncertain or subject to major changes due to varying reasons including political instability. Our assessment found that none of the 19 countries have legally secured the implementation of renewable electricity support measures up to 2030.

- With regard to the scoring of policy instruments, price-based policies such as FITs with a long-term predictability of 10-20 years provide in principle more favorable conditions for renewable electricity generation relative to fossil fuel-fired power generation. Hence, 75 points are given for countries that have FITs for all major renewables sources (hydro, solar, wind, and biomass), and 50 points when only a few of these sources are covered by the mechanism. Moreover, if a project scale limit exists, the score is also lowered. This does not happen if feed-in tariffs exist for all scales, but the prices are scale-differentiated. 75 points are also given when policies that provide clear disincentives for carbon-intensive electricity production (overarching carbon tax, ETS scheme, emission standards etc.), which in turn provide room for renewables' growth, are implemented.

- Quantity-based policies such as tender schemes and renewable portfolio standards (obligation schemes) generally set more favorable conditions for selected renewable technologies compared to fossil fuel power generation. However, in comparison with FITs, quantity-based policies often do not provide long-term predictability to investors and also do not necessarily provide strong incentives for emerging renewable technologies. Therefore, 50 points are given when such mechanisms exist for renewable electricity in general, and 25 points when it covers only a few of these sources.

- For other support schemes such as tax relief and accelerated depreciation, we considered that they are insufficient on their own to bring renewables at the same level of attractiveness as fossil fuels, nor higher, and normally yield 25 points. However, in this case an expert judgement was made, based on both incentives for renewables, disincentives for fossil fuels and the existence of fossil fuel subsidies.

More generally, in addition to the above rules, case-by-case judgements are made based on all renewables support schemes in that country and the support of disincentives for renewables, and assessing possible synergies between these. For instance, although Canada did not have strong incentives for renewables, we gave it a higher score (50 points) as a result of its regulations on coal-fired power generation and the lack of fossil fuel subsidies. Similarly, although UK's FITs do not cover all scales of renewable electricity generation projects, the Carbon Levy weighed in its favor.

Support schemes for renewables and disincentives for fossil fuel electricity production were assumed to be the most important indicator as economic viability is a decisive variable in an investor's decision. Hence, these were given the highest weighting when aggregating this category.

Policy barriers assess the presence and the impact of possible policy barriers on the renewable energy uptake in a country. Initially, two policy barriers were identified:

1. Fossil fuel subsidies that impact electricity production

This indicator assesses financial support for electricity production from fossil fuels. Several studies were reviewed to determine the scores for fossil fuel subsidies[6,7,8,9]. In our assessment, we considered both direct subsidies to electricity production from fossil fuel sources as well as various forms of upper stream subsidies for exploration and extraction of fossil fuels used for electricity generation (mainly coal and natural gas).

The review of the aforementioned literature indicates that none of the countries assessed in this report are completely free of direct or indirect subsidies for fossil fuel-fired electricity generation and consumption, although the scale of subsidies differs very largely across countries.

The benchmarking approach for this indicator is similar to that for policy incentives. However, the scoring in this case starts from -100 (high impact of barrier) to 0 (low impact or absence of barrier). A score of 100 points is given to countries having any of the aforementioned fossil fuel subsidies, while the maximum score, 0, is given to those that do not have any fossil fuel subsidies. Due to the limitations in the available data, we treated all countries with fossil fuel subsidies equally regardless of the scale of subsidies provided in each country.

2. Administrative environment

'Administrative environment' analyses timing and requirements for the approval of a typical renewable electricity production project. Administrative environment specific to renewable energy projects had to be dropped from the final assessment due to data acquisition issues[10]. Nonetheless, the general administrative environment in a country is considered under "National Investment Conditions" category.

6 http://www.oecd.org/site/tadffss/data/ (accessed 22 March, 2016)

7 http://www.worldenergyoutlook.org/resources/energysubsidies/fossilfuelsubsidydatabase/ (accessed 22 March, 2016)

8 http://www.oecd.org/tax/taxing-energy-use-2015-9789264232334-en.htm (accessed 22 March, 2016)

9 http://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/9234.pdf

10 A similar indicator is covered in the (to be released) update of the World Bank's RISE Index. We envisage including the relevant data from RISE for including 'Administrative Environment' in the future editions of the Monitor.

Fossil fuel subsidies and the administrative environment could have been part of the incentive indicator, but they were considered to have a high impact potential, and therefore, are assessed separately as barriers.

DATA SOURCES

The NewClimate Institute's climate policy database[11] was used as a starting point in data collection for the required analysis. Where information provided by policies in the database was insufficient for making a judgement, additional country-based information was sought.

11 www.climatepolicy database.org (accessed 7 April, 2016)

Category 2: Policy reliability of sustained support

Reliability of Sustained Support scores the reliability and predictability of a country's support for a low-carbon energy infrastructure. Thus, this category assesses if countries historically provided a sufficient and coherent climate policy especially in the electricity sector and the likelihood of major upheavals regarding the current political framework.

In order to decide whether to engage in foreign energy markets investors need to fully comprehend the sector's political framework within that country. They need to know about the state's general level of support for a low-carbon transition and the sustainability respectively coherency of the support. By accounting for both variables, investors can identify countries that seem responsive towards climate change action but lack a coherent long-term approach. On the other hand, countries that are very determined in their approach but lack the necessary level of support for a low-carbon transition can also be assessed accordingly.

Furthermore, it is important for investors to anticipate future developments concerning the political framework. By assessing the political consensus between parties on the importance of climate change policy in general and support policies for renewables in particular, the likelihood of a policy change – which is itself dependent on the prospects of a change of government – can be estimated. Decision-making is not only influenced by political parties, but also by non-state actors such as interest group. Hence, the strength of lobby groups supporting a low-carbon transition is weighed against organized fossil-fuel interests.

However, estimating dissent between parties or the likelihood of a change of government in non-democratic countries is hardly appropriate, which is why these countries are significantly downgraded in terms of their predictability.

The index is differentiated in two umbrella indicators – Historical Reliability and Policy Predictability. Both are comprised of two sub-indicators. These are presented in *Table 2* and explained in the following paragraphs.

ASSESSMENT APPROACH

Both umbrella indicators were assessed on a 0-100 scale and aggregated using an equal weighing scheme. The assessment approach is summarized in *Table 2* and explained in the following paragraphs.

TABLE 2: Composition of 'Policy reliability of sustained support' category

		INDICATOR	ASSESSMENT	SCORING	WEIGHT
Historical Reliability of Sustained Support	1	Sustained Support	Average support	Average CCPI Energy Scores 2011-2016 **0 - 100**	Multiplier Factor for the Historical Reliability Indicator
	2	Historical Reliability	Fluctuation in support	Standard Deviation of CCPI Energy Scores 2011-2016 **0 - 100**	**50%**
	3	Risk Predictability	Party consensus concerning climate change policy/renewable energy Policy	Expert Judgement **0 - 100**	**12,5%**
	4		Risks in the next elections, that the current policies on climate and energy will be ignored/invalidated by the new government	Expert Judgement **0 - 100**	**12,5%**
	5		Freedom House Index Score	***0.5 / *0.75 / *1**	Multiplier Factor for the Risk Predictability Indicator
Policy Predictability	6	Non-State-Actor Support	Strength of lobby-groups demanding politics for more support of fossil fuels	Expert Judgement **0 - 100**	**12,5%**
	7		Strength of lobby-groups demanding politics for more consequent renewable energy laws	Expert Judgement **0 - 100**	**12,5%**

INDICATORS AND SCORING METHODS

1. Historical Reliability of Sustained Support

This umbrella indicator measures the degree to which countries historically provided a sufficient and coherent climate and energy policy.

In order to assess the Historical Reliability, countries are evaluated based on their past performance in terms of promoting a low-carbon transition. Two main factors are considered:

- *Sustained Support:* assesses the countries general level of support for a low-carbon transition in the energy sector in the past
- *Historical Reliability:* assesses the general coherence of support for a low-carbon transition in the energy sector in the past

Sustained Support: A country's level of Sustained Support for a low-carbon transition is assessed by determining its average performance in terms of introducing effective energy policy measures. Performance is estimated based on expert judgements.

Historical Reliability: A country's reliability regarding its support for a low-carbon transition is assessed by tracing the states' level of Sustained Support for a low-carbon transition in the energy sector over the past seven years. Estimating the fluctuation in support allows identifying countries that are rather volatile in their support.

However, the possibility that major fluctuation could be attributed to major performance improvements is accounted for by relating the variation to the average level of support over that same time period. The same logic applies for countries that follow a coherent approach but lack a sufficient level of support for a low-carbon transition.

SCORING APPROACH

The general level of support for a low-carbon transition is based on countries' performance in terms of introducing effective climate change policies in the past. Performance is estimated by calculating the average country score in the category "Energy Policy" in the Climate Change Performance Index (CCPI) between 2011 and 2016. The results are transformed to a 0 - 100 scale (where a high score accounts for a high average score in the CCPI).

Both results are aggregated in the following manner:

$$\textit{Historic Reliability of Sustained Support} = \textit{Score : Historical Reliability} \ x \ \left(\frac{\textit{Score : Sustained Support}}{100}\right) \quad (4)$$

The Historical Reliability of Sustained Support score amounts to 50 percent of the overall Reliability of Sustained Support score.

2. Policy Predictability

This indicator measures a country's anticipated reliability of support for a low-carbon transition. The approach to assess the policy predictability contains two perspectives:

- *Risk Predictability:* assesses the *level of political consensus* concerning renewable energy and *risks* that future governments will reverse a country's climate change policy while accounting for issues with non-democratic countries.
- *Non-state-actors' support:* assesses the *strength of lobby-groups demanding support for fossil fuels* and the *strength of lobby-groups demanding support for renewable energies*.

Risk Predictability: Following Schmidt (1996) partisan influence in democracies on public policy is, albeit limited, nonetheless significant as parties are expected to act upon their agenda once they form the government. Assessing party positions (i.e. the level of Political Consensus) therefore is a promising approach in order to anticipate major policy changes.

The extent to which parties influence public policy is dependent upon certain institutional constraints such as the existence of strong decentralized structures. However, given the limited scope of the analysis and the general focus on state-level, the variable will not be included in the equation.

Consequently, for a policy change to be realized a change of government is necessary. Therefore, in order to *anticipate* a country's reliability for a low-carbon transition (i.e. estimate its predictability), the likelihood of a change of government – and its potential implications for the support of climate policy measures – is included as a variable.

However, in light of the possibility that in some (non-democratic) countries party competition might de facto be non-existent – meaning a high consensus – while at the same time a change of government is rather unlikely, another proxy is included: Based on the assumption that non-democratic countries can be attributed with certain drawbacks such as a lack of transparency and major information asymmetries, the *Risk Predictability* score for these countries will be capped by accounting for each country's score on the Freedom House Index (Freedom House 2016).

Non-state actors' support: Based on the assumption that interest groups significantly influence countries decision-making, the strength of two major lobby-groups is estimated and taken into account accordingly. Hence, strong support for fossil fuels accounts for a low predictability and therefore a lower reliability of sustained support for a low-carbon transition.

SCORING APPROACH

Differences in party positions regarding renewable energy are based on the level of political consensus concerning renewable energy which is estimated based on expert judgements. The results are transformed to a 0 - 100 scale (where a high score accounts for a high consensus)

The risk that future governments will reverse a country's climate change policy is based on the likelihood of a change of government and its potential implications for the support of climate policy which are estimated based on expert judgements. The results are transformed to a 0 - 100 scale (where a high score accounts for low risk of a policy change)

In order to identify non-democratic states, countries will be categorized into three groups based on the Freedom House Index:

free - partly free - not free

Based on their assigned category, the countries' aggregated and scaled score in terms of political consensus and election risk is multiplied by a specific factor. 'Free' countries keep their initial score (*1), while partly-free (*0.75) and not-free (*0.5) countries' will be downgraded accordingly.

The results are aggregated in the following manner:

$$Risk\ Predictability = \left(\frac{Score;\ Political\ Consensus + Score;\ Election\ Risk}{2}\right) x\ FHI\ Factor \qquad (5)$$

The strength of non-state actors' support for a low-carbon transition is based on the strength of lobby groups demanding more consequent renewable energy laws which is estimated based on expert judgements. The results are transformed to a 0 - 100 scale (where a high score accounts for a strong non-state support for renewable energies)

The strength of non-state actors' support for fossil fuels is based on the strength of lobby groups demanding more support of fossil fuels which is estimated based on expert judgements. The results are transformed to a 0 - 100 scale (where a high score accounts for a weak non-state support for fossil fuels)

The results are aggregated in the following manner:

$$Non-State-Support = \left(\frac{Score;\ Support\ FF + Score;\ Support\ RE}{2}\right) \qquad (6)$$

Risk Predictability and Non-State-Support are weighed equally and amount to 50 percent of the overall Reliability of Sustained Support score. Overall aggregation approach.

The two umbrella indicators Historical Reliability and Policy Predictability will be weighed equally and mount up to a final score between 0 and 100.

$$Reliability\ of\ Sustained\ Support = \left(\frac{Score;\ Historical\ Reliability + Score;\ Policy\ Predictability}{2}\right) \qquad (7)$$

12 More information on the CCPI methodology: https://germanwatch.org/en/download/8579.pdf

13 More information on the CCPI methodology: https://germanwatch.org/en/download/8579.pdf

DATA SOURCES

Data on a country's Historical Reliability are gathered from the Climate Change Performance Index (CCPI). The annually published index compares the climate protection performance of 58 countries that together are responsible for more than 90 percent of global energy-related CO_2 emissions. However, the CCPI is mainly based on emission data while our interest lies with political outputs in terms of climate change policy. Hence, we only extracted data from a specific indicator (i.e. climate policy) which rates countries according to their governments' efforts to avoid climate change. The data is assessed annually in a comprehensive research study. Its basis is the performance rating by climate change experts from non-governmental organizations within the evaluated countries. By means of a questionnaire, they give a judgement and rating on the most important measures of their governments. The questionnaire covers the promotion of renewable energies, the increase of efficiency and other measures to reduce CO_2 emissions in the electricity and heat production sector, the manufacturing and construction industries, or transport and residential sectors.[12]

Data on a country's Policy Predictability were collected in a qualitative matter. In order to account for the fact that the countries vary on numerous scales, we reached out to climate policy experts with country-specific insight and asked them to answer questions on:

- the degree of political consensus concerning climate change policy/renewable energy policy
- the likelihood of a change of government (and possible implications for climate change policies)
- the strength of fossil fuel lobby groups
- the strength of renewable energy lobby groups

The questionnaire included for each of the four questions a range between two positions. For instance, by the first question regarding political consensus, the experts had the option to make a range between "accepted consensus" and "no agreement". Hence, these expert's evaluations could be used to assess a country's Policy Predictability.

Experts were recruited from non-governmental organizations within the countries. All participants are familiar with the work of Germanwatch since they regularly contribute with their expertise to the CCPI[13].

Non-democratic countries were identified via the Freedom House Index (Freedom House 2016), which ranks countries according to their liability in terms of guaranteeing political rights and civil liberties.

Category 3: Market absorption capacity

Market absorption capacity assesses the market's maturity and capacity to implement low-carbon energy infrastructure. Here, an assessment is made of the human and corporate capacities to drive the demand, supply and distribution of renewable energy technologies.

ASSESSMENT APPROACH

As a first step in structuring this category, five possible factors that determine market absorption capacity were identified. These five factors are considered for the development of the categories indicators, but are not all assessed directly:

- **Prior experience with technologies:** Countries with significant historical experience in the production, installation and usage of specific renewable technologies (solar and wind power in the current assessment) are likely to have developed favorable conditions for increased uptake. In these countries, suitable facilities for production and infrastructure for distribution are likely to be in place. Furthermore, advanced technical skills for development, construction, installation and maintenance of renewable technologies are likely to be readily available through a significant existing work force within the sector.

- **Prevalence of manufacturing and distribution companies:** The majority of the world's largest companies in the renewable energy industry are multinational companies that establish presences in countries with a potentially conducive market environment around the world. The presence of these companies in a country is an indication of the perceived market potential. Furthermore, a larger number of renewable energy companies operating within a country indicates a higher level of competition in the market, improved availability of technologies for project developers and end-users, increased likelihood of enhanced distribution networks in the country, and a greater availability of technical capacity with regards to skilled labor.

- **Technical human capacity:** Although not all countries need to be on the cutting edge of global technological advance, each country needs the capacity to understand, adopt, and if necessary adapt, global technologies for local needs (Desai et al., 2001). Technical human capacity is relevant for market absorption capacity on two levels. In the present, the current availability of skilled technicians is vital to the efficient production, installation and usage of renewable energy systems. Looking into the future, the quality of universities and the volume of students pursuing degrees or training programmes related to engineering or energy systems, is an indication of the technical capacity that will be available to bolster market absorption capacity in the short- and longer-term future.

- **Technological readiness:** Technological readiness affects the ability to adopt and make use of the most modern solutions. At the rudimentary level this includes the penetration of modern communications infrastructure across businesses, whilst at the most technical level it includes the penetration of advanced machinery for precision manufacturing and high-tech infrastructure and processes for distribution. An economy with a greater technological readiness is likely to create a higher demand for modern solutions, as well as having the capacity to fulfil such demand.

- **Research, development and innovation:** Beyond the capacity to adopt new global techniques, countries also need capacity to invent and adapt new technologies for local needs (Desai et al., 2001). The importance of this factor for renewable energy is not great in all countries, since global technologies for wind and solar in particular are usually universal and require limited adaptation to local conditions. However, exploitation of potentials for locally variable technologies such as geothermal and biomass energy, usually requires strong leadership from the host country on the research and development of locally appropriate solutions.

From these five factors described above, 'technical human capacity', 'technological readiness' and 'capacity for research, development and innovation' were excluded. While these may be assessed on a general level, information specific to renewable energies on these factors is available. In place of these, an assessment is performed on the 'current level of activity in the sector', which takes into account all of these three factors to certain extent. **Thus, the 'prior experience with (renewable) technologies' and the 'prevalence of businesses for manufacturing and distribution (of renewables)' are evaluated for assessing the market absorption capacity for renewable energies.**

Table 3 presents an overview of these evaluation criteria, including proxies for each. Consistent with the insight that investors place less significance on local manufacturing capacity than on the actual installation of systems that may have been manufactured elsewhere, less weighting is given to the indicator for the presence of businesses for manufacturing and distribution of renewable technologies. This remains a factor in our evaluation since the presence of these businesses covers not only manufacturing capacity but also the depth and competition within supply chains, as well as being a general indicator of the attractiveness for foreign investment.

The subsequent paragraphs explain the scoring scheme for proxies that define each indicator and the data collection approach.

TABLE 3: Composition of 'market absorption capacity' category

INDICATOR	PROXY	SCORING BENCHMARKS	WEIGHT
Prior experience with renewable energy technologies	Total installed capacity of solar and wind energy (per capita) (MW) Share of renewables (excluding all hydro) in electricity generation	Normalization and aggregation of absolute data	**40%**
Current level of activity in the installation of renewable energy	New installed capacity of solar and wind energy over past three years (per capita) (MW)	Normalization and aggregation of absolute data	**40%**
Presence of businesses for manufacturing and distribution of renewable technologies	Locations of headquarters and regional and national offices for the 30 largest renewable energy companies in the world, according to the Renewable Energy Industrial Index (RENIXX).	**100:** Presence of almost all of the world's largest multinational renewable energy companies in the country **75, 50, 25:** Degree of business presence **0:** No presence of the world's largest multinational renewable energy companies in the country	**20%**

INDICATORS AND SCORING METHODS

1. Prior experience with renewable energy technologies

This indicator demonstrates the historical deployment of renewable energy technologies in the country as a means of assessing the experience accumulated in the installation and regular operation of renewable energy systems, and their integration into national electricity infrastructure.

The following data is collected for the construction of the indicator:

- **Share of renewables (excluding hydro) in total electricity generation (%)**

- **Total installed capacity** per capita
  - Total installed capacity of wind electricity (per capita) (MW)
  - Total installed capacity of solar electricity (per capita) (MW)

Although both data sets present similar information, there are subtle differences between the two that favor the consideration and compilation of both sets of information into one aggregate score. The share of renewables demonstrates the countries' total stock of renewable energy relative to total electricity generation, and therefore indicates the importance of renewables for the national energy system and the extent to which renewables are successfully integrated into the provision of national energy demand. However, for countries with significantly lower energy demand per capita, or even suppressed demand due to delayed development trajectories, a higher share of renewables does not necessarily indicate a greater level of experience and capacity to work with the technologies when compared to a country with a similar or lower share of renewables but a much greater total energy supply per capita. As such, the total installed capacity per capita is considered alongside the share to reflect both of these factors.

For total installed capacity per capita, wind and solar technologies are assessed as a proxy for all non-hydro renewables, due to the high relevance of these technologies, and the stronger availability and reliability of data, compared with other renewable technologies such as geothermal and biomass.

SCORING APPROACH

The two data sets for installed capacity – *total installed capacity of solar electricity per capita and total installed capacity of wind electricity per capita* – are aggregated with equal weighting in order to produce a combined score for total installed capacity of wind and solar energy. This combined score for installed capacity is then aggregated along with the *share of renewables in total electricity generation*, to produce the final indicator.

For aggregation of the proxies, the spread of country data for each is normalized to a value between 0 and 100, and an average of the two data sets is taken as the final value.

2. Current level of activity in the installation of renewable energy

Information on the current level of activity provides a strong indication of multiple conditions for market absorption capacity: high levels of activity confirm the availability of technical expertise, technological readiness and the ability to adopt and adapt technologies for local use, whilst also demonstrating proficiency in supply and distribution chains for renewables. Although this indicator is influenced by factors that fall outside of market absorption capacity, such as policy incentives, this impact is reduced by its use as one of three indicators that are aggregated for assessment of market absorption capacity.

The following data is collected for the construction of the indicator:

- **Average annual new capacity installed in the previous three years (2012-2014)** (per capita)
    - Average annual new solar electricity capacity installed in past 3 years (per capita) (MW)
    - Average annual new wind electricity capacity installed in past 3 years (per capita) (MW)

Wind and solar technologies are assessed as a proxy for all non-hydro renewables, due to the high relevance of these technologies, and the stronger availability and reliability of data, compared with other renewable technologies such as geothermal and biomass.For total installed capacity per capita, wind and solar technologies are assessed as a proxy for all non-hydro renewables, due to the high relevance of these technologies, and the stronger availability and reliability of data, compared with other renewable technologies such as geothermal and biomass.

SCORING APPROACH

The secondary data sets are normalized and aggregated with equal weighting to produce the scores for *new capacity installed in the previous year* and *forecast new capacity installed in the coming three years*, and these scores are then aggregated to produce the final indicator score.

3. Presence of businesses for manufacturing and distribution of renewable technologies

This indicator looks at the global distribution of the world's largest companies for renewable energy, and assesses their presence in each of the G20 countries. The presence of a larger number of companies indicates deeper, more reliable, and more competitive domestic markets for renewable energy technologies.

Data for largest renewable energy companies globally is gathered from the locations of headquarters and regional and national offices for the 30 largest renewable energy companies in the world in the Renewable Energy Industrial Index (RENIXX).

SCORING APPROACH

For each country, it is determined what percentage of the 30 largest renewable energy companies in the world have a physical presence, in terms of a physical office address, within the country. The data is normalized as per the standard approach elaborated in this technical note.

DATA SOURCES

1. **Prior experience with renewable energy technologies:** Data on installed capacities for the most active countries is collected from the annual report of the International Energy Agency (IEA) Photovoltaic Power Systems Programme (PVPS) (IEA, 2015b) and the annual report of Global Wind Energy Council (GWEC, 2015a). These reports contain data for 15 and 17 of the G20 countries analyzed under this methodology, respectively. For a handful of countries that are inactive or barely active in wind and solar energy that are not covered by the aforementioned sources, information is obtained from assumptions based on electricity generation statistics from the IEA (IEA, 2015a).

   The share of renewables (excluding hydro) in total electricity generation is calculated based on the World Energy Statistics and Balances database of the IEA (IEA, 2015a). The balances exclude output from pumped storage plants in their definition of hydro, in contrast to the IEA World Energy Outlook which include them (IEA, 2015e). This might cause minor differences in the calculations of the renewables share, depending on the amount of existing pumped storage in a country, but do not affect the overall score.

2. **Current level of activity in the installation of renewable energy:** Data for new capacity installations is obtained from the same sources as for the previous indicator i.e. the annual reports of PVPS and GWEC (GWEC, 2015b; IEA, 2015c), combined with interpretations of IEA statistics (IEA, 2015a).

3. **Presence of businesses for manufacturing and distribution of renewable technologies:** Data was collected from the RENIXX index. RENIXX is a global stock index, comprising the world's 30 largest companies of the renewable energy industry, whose weighting in the index is based on free float market capitalization (Renewable Energy Industry, 2016). Data is collected through manual desk research, by visiting the websites of each of the top-30 listed companies, and extracting information about their regional and national office locations.

Category 4: National investment conditions

National investment conditions category scores countries for their general investment conditions. These influence an investor's perception of risks and returns when investing in a country.

ASSESSMENT APPROACH

Investor preferences are guided by several factors which have been estimated in a variety of ways. A basic model is to represent investments as a function of risk, return and policy (Wüstenhagen & Menichetti, 2012). This category focusses on factors that define investor perception of risks and returns from investing in a geography. These factors can be broadly categorized into three: financial determinants, non-financial determinants and fundamental determinants of macroeconomic stability. Sector specific policy determinants are covered in details under *policy adequacy* and *policy reliability* categories.

1. **Non-financial determinants:** This set of indicators reflects the safety of investments in a country. A high score reflects the ease of investing in a country.

2. **Financial determinants:** Financial determinants facilitate investor confidence towards return on investments in a country.

3. **Macroeconomic fundamentals:** These variables provide some resilience to a country from external shocks; especially so in emerging markets.

A range of potential proxies were identified for each of these. As a next step, a prioritization exercise was carried out, based on literature review, particularly usage in related indexes and policy papers, and by taking on-board Allianz's feedback on the long-list. This was both desirable and necessary to ensure methodological simplicity of this overarching category. An indicator-dense category also risked eliminating any useful differences among indicators due to aggregation. The short-listed proxies are outlined in *Table 4* and discussed in the following paragraphs.

TABLE 4: Composition of 'national investment conditions' category

INDICATOR	PROXY	MEASURED BY	WEIGHTS	
I. Non-financial determinants	1. Openness to FDI in the electricity sector	Scores from the OECD FDI restrictiveness index	6.7%	33.3%
	2. Regulatory ease of doing business	Scores of WB's ease of doing business index	6.7%	
	3. Regulatory quality	Scores from Worldwide Governance indicators (WGI)	6.7%	
	4. Political stability	Scores from WGI	6.7%	
	5. Rule of law	Scores from WGI	6.7%	
II. Financial determinants	6. Depth of capital markets	Sum of: Total Stock market capitalization (as % of GDP) + Outstanding domestic private debt securities (as % of GDP) + Outstanding international debt securities (as % of GDP)	16.7%	33.3%
III. Macroeconomic fundamentals	7. Depth of financial institutions	Private credit (by deposit money banks) to GDP	16.7%	33.3%
	8. Inflation forecast	IMF forecast for average annual % change in Consumer Price Index from 2017-2020	33.3%	

Note: Indicator weights are rounded-off at one decimal digit

INDICATORS AND SCORING METHODS

Non-financial determinants: Long-term investors tend to attach substantial importance to factors that determine the security of investments in a geography. These are measured by the following:

1. Openness to FDI in the electricity sector

The nature and extent of statutory restrictions posed on Foreign Direct Investment (FDI) by countries is crucial for a foreign investor's ease of investing in a geography. We used the country scores for electricity generation sector in OECD's FDI restrictiveness index (2014) for our assessment[14]. The parent index assesses the FDI restrictions related to allowed equity contributions, restrictions in screening and approval procedures, restrictions related to employing foreign personnel and other operational restrictions not covered under the previous heads. The OECD index was chosen over others with similar coverage due to greater data granularity and recent data availability in this.

14 http://stats.oecd.org/Index.aspx?datasetcode=FDIINDEX#, (accessed March 8, 2016)

The parent index scores countries on a 0-1 scale; where 0 represents an open economy (no FDI restrictions) and 1 represents a closed economy (maximum FDI restrictions). These scores were inverted and rescaled to a 0 (closed economy) -100 (open economy) scale to make them consistent with our approach.

2. Regulatory ease of doing business

The regulatory ease of doing business measures the influence of domestic regulatory practices and procedures on the lifecycle of undertaking business in a country[15]. These are comprehensively measured in the World Bank's Ease of Doing Business Index. The parent index covers 10 topic areas with several indicators within each which discuss the *de jure* processes for doing business. For present assessment, we used the country statistics generated from the latest Ease of Doing Business (2015).

3. Regulatory quality

Supplementing the assessment of *de jure* regulatory practices, the regulatory quality indicator captures the 'perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private-sector development' (World Bank, 2015b). We used the data from the 'Regulatory quality' indicator from World Bank's World Governance Indicators (WGI) (2014 assessment).[16]

4. Political stability

Political stability in a country can be major influencer in ascertaining the security of infrastructure investments made by an investor. We have used the 'Political Stability and Absence of Violence/Terrorism' indicator from WGI for this indicator. The parent index provides a perception based probability of 'political instability and/or politically motivated violence, including terrorism in a country'[17].

4. Rule of law

Rule of law reflects the safety of property rights of an investor in a foreign geography. We have used the 'Rule of Law' indicator from WGI for this. It captures the confidence of actors in societal rules particularly on the police and judicial system and the quality of contract enforcement and property rights[18].

15 http://www.doingbusiness.org/rankings, (accessed December 14, 2015)

16 http://info.worldbank.org/governance/wgi/index.aspx#home, (accessed December 14, 2015)

17 Ibid. p.16

18 Ibid. p.16

Financial determinants: Financial depth of institutions and markets in an economy influence the return on infrastructure investments made in an economy. Financial depth can be sub-divided into depth of capital markets and depth of financial institutions in a country.

6. Depth of capital markets

Capital market depth is a proxy of the overall extent of services provided by a country's stock and bond markets (World Bank, 2015a). It reflects the ease with which assets can be bought and sold without substantial effect on their value (market liquidity). It is thus symptomatic of the ease of transaction in a geography for an investor. It is the sum of (1) stock market capitalization as a share of GDP, (2) outstanding volume of domestic private debt securities as a share of GDP and (3) international debt securities as a share of GDP; these are commonly used indicators for assessing depth of stock and bond markets (Cihak, Demirgüç-Kunt, Feyen, & Levine, 2012). The former assesses the value of total listed shares in the stock exchanges of a country relative to the percentage of national economic output. It indicates if the value of stocks in a market are over- or undervalued relative to the size of the economy i.e. if an investor underpays or overpays for stocks in that geography. The latter is a commonly used proxy for the size of bond markets in a country.

Some countries in the sample had missing values (Saudi Arabia for both domestic and international outstanding debt security proxies and India for outstanding international debt securities). After a thorough review of additional data sources, all of which did not provide any values for these two countries, these were assumed to be '0' in the assessment.

7. Depth of Financial Institutions

Depth of Financial Institutions is measured by *private sector credit* to GDP ratio. Private credit to GDP ratio measures the credit given to private entities by deposit money banks relative to the size of GDP. It reflects the activity of financial intermediaries in channeling savings to investments and investors (Garcia & Liu, 1999; Gurley, John G.; Shaw, 1955). Thus, deeper financial institutions facilitate investments. Further, financial institutions continue to play a key role in infrastructure financing in emerging markets, where capital markets are less deep and have a low engagement in infrastructure investment.

Another commonly used proxy that was initially considered was the ratio of *total banking assets to GDP*. It has a comprehensive coverage i.e. it includes credit to governments in addition to private entities as well bank assets other than credit. However, we chose *private credit to GDP* over it because of better data availability. In addition, being closely correlated to total banking assets to GDP, literature suggested that it presented a close approximation for total banking assets (Cihak et al., 2012 pp.11).

It is noted here that a generic indicator reflecting the depth of the banking sector is only a loose approximation for an indicator looking specifically at the depth of 'green lending' in countries. However, usage of generic indicators, though less desirable, is a common practice; with the lack of sub-sector granularity in banking indicators in global policy indices well-acknowledged in recent stocktaking exercises (OECD, 2015).

Macroeconomic fundamentals: The influence of macroeconomic variables differs based on the type of market (developed vs. emerging), type of foreign flows (FDI vs. Foreign Portfolio Investments, FPI) and asset types but they provide an overall resilience to the vulnerable markets.

8. Inflation forecast

Among the assortment of macroeconomic variables such as inflation, GDP growth rate, exchange rate volatility, currency depreciation, interest rates etc.; inflation forecast was selected based on the client's experience as an institutional investor and from some literature evidence supporting its cruciality – in particular in emerging markets (IMF, 2014). Rate of inflation can increase the uncertainty of the return on investments over time and can be a risk if returns are not inflation-linked.

Our assessment now uses the IMF forecast for the average annual percentage change in Consumer Price Index (CPI) from 2017-2020 in the World Economic Outlook from October 2015 (IMF, 2015). While the ideal rate of inflation differs from country to country, we generally assume that a stable, lower inflation is preferred by long-term investors in our scoring.

As illustrated in *Table 4*, the three umbrella indicators and their underlying proxies were aggregated using equal weighting.

DATA SOURCES

Raw data was collected from the following databases:

Indicator 1.: Openness to FDI: OECD FDI restrictiveness index[19]

Indicator 2: Regulatory practices: World Bank Doing Business Index[20]

Indicators 3,4,5: Political stability, Regulatory quality and Rule of law: World Bank Worldwide Governance Indicators[21]

Indicators 6,7: Depth of capital markets and financial institutions: World Bank's The little data book on financial development[22]

Indicator 8: Inflation Forecast: IMF World Economic Outlook[23]

19 Ibid. p.14
20 Ibid. p.15
21 Ibid. p.16
22 http://data.worldbank.org/products/data-books/little-data-book-on-financial-development, (accessed January 5, 2016)
23 http://www.imf.org/external/pubs/ft/weo/2015/02/weodata/download.aspx, (accessed January 7, 2016)

Pillar 2 – Investment needs

Category 5: Future needs for investing in the electricity infrastructure

The investment needs pillar compares the G20 member states for their future needs for investments in the electricity infrastructure. The assessment reflects three facets of 'investment needs':

1. Absolute financial investments required per year in the mid-term future (between 2014-2035, billion USD_{2012} / year) for countries to develop an emission reduction path for the energy sector which is consistent with the international goal to limit the rise of global mean temperatures to 2 degrees Celsius in the longer term. This indicator reflects the availability of large investment destinations.

2. 2 degrees' compatible financial investments required per year in the mid-term future (between 2014-2035) per unit of electricity consumption (USD/ GWh/ year) which reflect where development needs dictate need for investing.

3. Investment needs that would arise in lieu of particular vulnerabilities of the electricity infrastructure to climate change

The following paragraphs describe the assessment approach taken for this pillar.

ASSESSMENT APPROACH

The indicators considered in our assessment reflect three facets of 'investment needs'. We chose an indicator based on 'absolute investment needs' and another based on 'investment needs per unit of electricity consumption'. The investment needs pillar highlights investment "needs" from an investor's and a policy marker's perspective – considering geographies which are the largest future markets on one hand (an investor's perspective); and on the other, geographies where investments are most needed due to current insufficiencies in electricity and energy infrastructure. The 'vulnerability indicator' was chosen for flagging the investment needs arising from the vulnerability of electricity infrastructure to future climate change impacts.

For each country, the three indicator scores are aggregated with equal weighting to arrive at the final scores for investment needs *(Table 5)*. The identification of these indicators took an inductive approach; discussed in detail in the following paragraphs.

INDICATORS AND SCORING METHODS

TABLE 5: Composition of 'Investment needs' pillar

INDICATOR	MEASURED BY	WEIGHTING
Absolute investment needs	Absolute financial investments	**33.3%**
Relative investment needs	Financial investments per energy consumption	**33.3%**
Vulnerability indicator	The higher value between the percentage share of hydroelectric power and the percentage share of the sum of thermal and nuclear power in a country's generation mix	**33.3%**

24 It must be said in this context, though, that this is true in general when using these IEA statistics: there are assumptions on the needs of a country implicit in these numbers that will live on in our indicators.

1. Absolute investment needs

One way of describing the essentiality of investments in the power sector was by simply using the absolute level of investments for each country. We used the future investment needs data developed in the World Energy Investment Outlook (WEIO) by the IEA. WEIO's 450 scenario provides data for projected investment needs (in billion USD_{2012}) for the entire power generation section for the period of 2014-2035 *(see Table 6)*. The parent database also provides statistics for power generation from renewable sources only. We deemed the total investment needs in the assessment to be the more useful variable for our assessment, as the renewable investment needs already contain certain assumptions (from the scenarios used in the parent database) on how renewables should/could contribute to the development of the electricity sector in each country[24]. The relative difference between the two approaches was found only marginal.

In addition, **data downscaling** was done because the regions covered in IEA's WEIO 2015 do not (per se) match the G20 countries. To get country-level values, we assumed the electricity needs to be proportional to final electricity consumption. Thus, the final electricity share of each country in the wider region's population was used as a correction factor for those countries that were covered in the IEA analysis as part of a wider region.

These results are shown in *Figure 2*, both for the entire power sector as well as for the renewables sector only.

TABLE 6: Annual average investment needs for power generation sector for the 2014-2035 period in the IEA WEIO 2015 (450 scenario).

COUNTRY	BELONGS TO WEIO REGION	TOTAL INVESTMENT NEEDS (billion USD_{2012}/year) DOWNSCALED USING ELECTRICITY CONSUMPTION RATIO
Argentina	Latin America	5
Australia	OECD Asia/Pacific	7
Brazil	Brazil	25
Canada	OECD Americas	18
China	China	208
France	EU	19
Germany	EU	23
India	India	95
Indonesia	ASEAN	15
Italy	EU	13
Japan	Japan	36
South Korea	OECD Asia/Pacific	17
Mexico	OECD Americas	9
Russia	Russia	32
Saudi Arabia	Middle East	10
South Africa	Africa	14
Turkey	OECD Europe	9
United Kingdom	EU	14
United States	United States	141

25 Numbers normalized to the maximum across all countries and rescaled to 0 -100

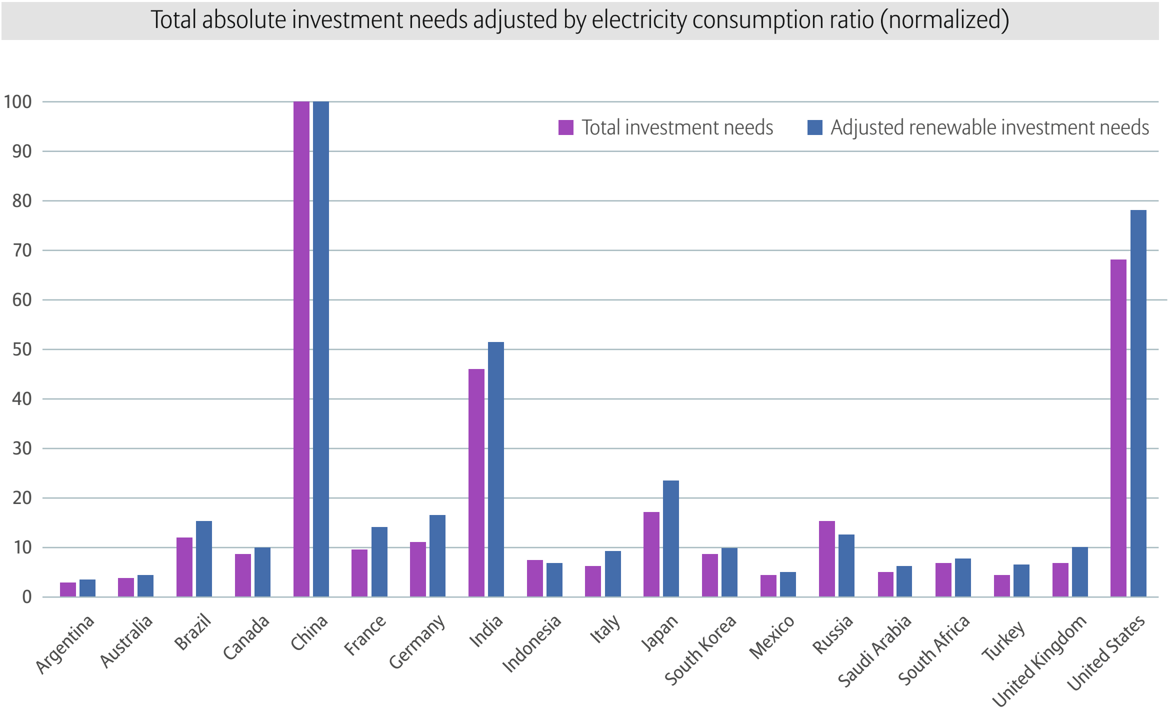


FIGURE 2: The total investment needs from 2014 to 2035 per country for the total power sector as well as only the renewable energy sector[25]

Clearly, these data are very skewed towards countries with either a high population (China, India), or high levels of electricity consumption (USA). This metric therefore does not tell us much beyond the obvious: the future investment needs are most in the biggest markets. While useful information for an investor, they present only a partial picture of the needed investments.

2. Relative Indicator

To supplement the absolute investment indicator, three relative indicators were tested:

- **Investment needs per capita:** Using a **per-capita approach** corrected the skewness attributed to high population in the absolute indicator. However, in doing so, it mixes up the effects of 'low absolute investment needs' with 'high population', creating a counter-intuitive ranking i.e. it would give roughly the same ranking to Germany as to India and Indonesia.

- **Investment needs per GDP:** Ranking by investment needs per unit GDP essentially measures *"how much of its own GDP would the country have to invest in its electricity sector to meet future needs"*. In this metric, India comes out distinctly on top, as displayed in *Figure 3*. One could see this metric as a proxy for the true "investment needs" of a country, in the sense that a higher value indicates that it would need to divert a higher portion of its GDP towards the electricity sector if left to its own devices.

26 Data on final consumption of electricity have been obtained from the 2015 IEA Energy Statistics and Balances Database for all countries.

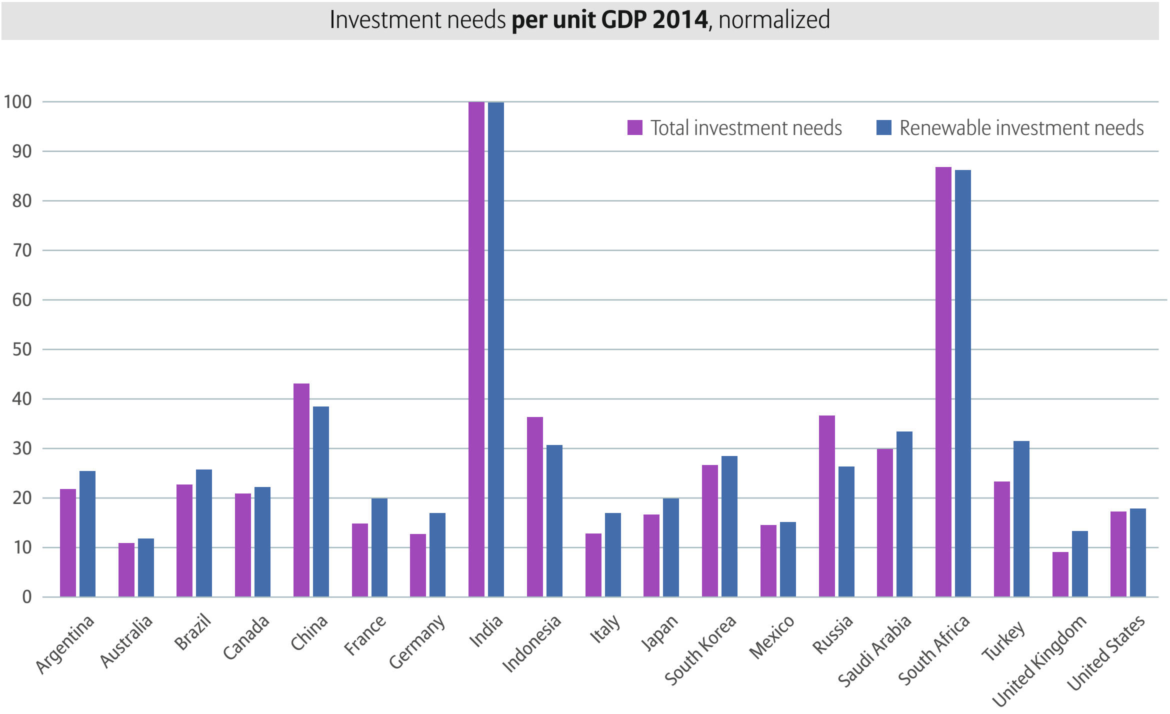


FIGURE 3: Investment needs in a) the power sector, and b) the renewable energy sector, per unit of GDP in 2014

- **Investment needs per unit final electricity consumption:** Another way of creating a ranking for investment needs is by dividing the **total investment needs by the total current consumption of electricity** for each country[26]. This, effectively, becomes a metric for *"how much investment is needed compared to how much is already being consumed"*, and thus is another way of ensuring that high-consumption societies do not skew this indicator upwards. A relatively high number means that a country is comparatively low on consumption but high on projected needs (typical for fast-growing developing economies). A relatively low number could mean that a country is not expected to need a lot of investments in infrastructure in its electricity (important: not energy) sector in the coming years according to the IEA, or that its electricity consumption is already very high.

  Results are given in *Figure 4* below. One can see that India comes out on top in this case, indicating that, in comparison, the amount of investments projected to be necessary is on the high side while the amount of electricity already being consumed is on the low side. Other countries ending up rather on the high side are Indonesia and South Africa, whereas China is now very much in the medium range.

Of the three options, the third one, i.e. a relative indicator considering investment needs per unit of electricity consumption, was considered most appropriate as it deprioritizes countries with already very extensive power consumption as compared to countries that do with much less and still need to provide large populations with electricity access to start with.

27 http://index.gain.org/, (accessed March 1, 2016)

Investment needs **per unit final electricity consumption 2013**, normalized

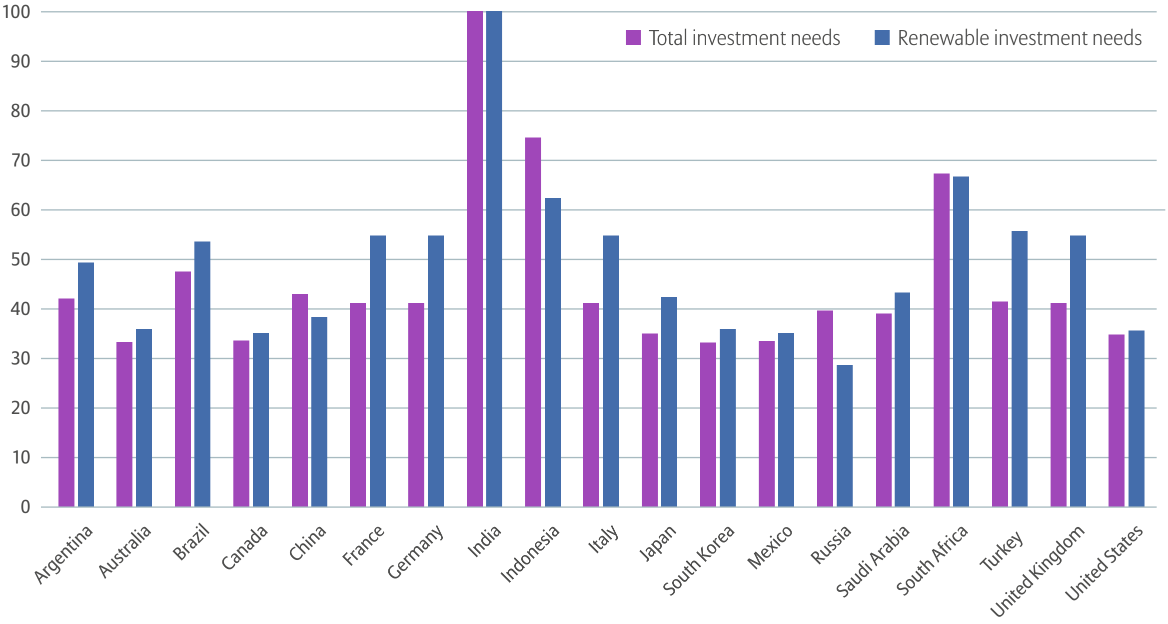


FIGURE 4: Investment needs in a) the power sector, and b) the renewable energy sector, per unit of final electricity consumption in 2013

3. Power sector vulnerability indicator

The vulnerability indicator pegs vulnerability of a country's power infrastructure to climate change impacts like flood and drought due to its reliance on hydro, and thermal or nuclear power resources, which together form a majority in the current generation mixes of most countries. The indicator looks at the proportion of hydro and sum of thermal and nuclear power in a country's total generation mix and favorably scores countries with a diversified electricity mix (by giving them a lower vulnerability score), while penalizing those with excessive reliance on either hydro or; thermal and nuclear (by giving them a higher vulnerability score). For instance, South Africa scored higher for the high share of thermal power in its electricity mix, while Brazil is scored higher for its high share of hydro; Germany scores lower due to comparatively diversified electricity mix.

While a detailed assessment of power sector vulnerability was initially planned, such a study could not be performed in the study timeframe; We regard it as a methodological upgradation for subsequent editions of the Monitor. It is also noted that some more robust methods of vulnerability assessment have been used elsewhere (such as the ND-GAIN Index[27]). While in comparison our indicator is simplistic, it is still relevant for the purpose to flag the potential investment needs arising from potential climate vulnerability.

Our rationale for using this indicator is discussed below:

- **Power infrastructure investments needs arising from performance-impeding climate change impacts:** Finance would be required for increasing the resilience of these power systems to performance-impeding climate impacts. Some reasonably documented impacts include reduction in the cooling efficiency for thermal and nuclear power stations, temporary shut-downs or production fluctuations

26 Data on final consumption of electricity have been obtained from the 2015 IEA Energy Statistics and Balances Database for all countries.

due changes in hydro potential in some regions (Mideksa & Kallbekken, 2010). A recent modelling study estimated the loss in usable capacity for 61–74% of the hydropower plants and 81–86% of the thermoelectric power plants worldwide for the period from 2040–2069 (van Vliet, Wiberg et. al, 2016). On one hand, regional modelling exercises predict both positive and negative changes in hydroelectric potential due to climate change (Kundzewicz, Z.W. et.al., 2007). But considering the heavy dependence of hydro power generation on natural climatic variability, an increased variability in climatic conditions such as changing precipitation and in-flow rates would scale up production uncertainties (Schaeffer et al., 2012). Similarly, for nuclear, climate impacts such as heat waves would increase the (surface) temperatures of water bodies, interfering with the legal limits for surface water temperature increase due to cooling-water discharge; thus decreasing plant efficiency in future periods of intense heat waves in future (IAEA, 2015).

- **Power infrastructure investments needs arising from physical damage inducing climate change impacts:** Additionally, investments will be required for climate-proofing these infrastructures to physical damages from extreme hydrological and meteorological events as well as sea-level rise risks to coastal power infrastructure. This is specifically so for thermal and nuclear power plants, which are built near water sources.

- **Overreliance on a single energy source:** Over and above the vulnerabilities, lack of a diversified electricity portfolio decreases the resilience of a country's energy infrastructure to climate change induced impacts, for example, due to resource scarcity and decrease in production efficiency and outputs. Climate change-induced high investment needs are assumed to be symptomatic of a less diverse, vulnerable power infrastructure.

DATA SOURCES

1. **Absolute and relative investment needs indicator:** We used the future investment needs data developed in the WEIO's 450-scenario. The data covers a time period of 2015-2035. The scenario provides investment data for 'an emission reduction path for the energy sector consistent with the international goal to limit the rise in the longer term the global mean temperatures to 2 degrees Celsius' (IEA, 2014). The investment needs are derived using IEA's World Energy Model, which uses assumptions on socio-economic variables (population, macroeconomic variables etc.) as well as technology specific assumptions such as on future capacity additions (e.g. year-to-year variation in peak demand, retirements per year, new renewable capacity due to policies in place); and nature of costs (e.g. capital, operation and maintenance, and efficiency costs; and world energy prices) (IEA, 2015d).

2. **Vulnerability indicator:** Data was collected from World Energy Statistics and Balances database by the International Energy Agency (IEA, 2015a). Shares of thermal and nuclear were for the year 2013 and are the latest available complete dataset for our sample in the IEA database. Keeping the fluctuations of water availability in mind, the share of hydroelectric power generation is calculated as a three-year average (2009-2013).

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