Global Climate Change Policy Tracker: An Investor's Assessment

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Investors deploy capital into markets that they are confident will earn them adequate risk adjusted returns. Climate change presents investors with what is potentially a new paradigm in world financial markets as countries and governments shift to a low-carbon economy. A key element in this process is the policy environment that, in effect, prices the externality of carbon emissions. This can be a carbon price in a long-term setting or find expression through mandates and policies at the industry or sector level where solutions are already deployed on the ground. Here we have gathered together about 270 climate policy emissions and mandates targets covering 109 countries, states and provinces, to assess their impact and investor risk profile.

We asked the Columbia Climate Center at the Earth Institute, Columbia University to model the impact on carbon emissions of each of the 270 climate policies we gathered, and then aggregate them at a country, regional and global level. This quantitative picture of what is currently being done or proposed provides a reference for policies to be discussed in the upcoming negotiations in Copenhagen. We believe that as a comprehensive exercise at both a policy and country level, this is the only publicly available study of its kind. **The findings show that from an expected Business-as-Usual 2020 emissions level of 59 gigatons of greenhouse gases[1], the maximum reduction that current policies (even including the American Clean Energy Security Act), could achieve still overshoots a pathway that might hold global warming to 2°C by 5 – 7 gigatons. This is equivalent to the annual emissions of the US economy. If global growth did not slow after 2014, as the International Energy Agency assumes it will, we believe this could add another 7 gigatons to the overshoot. In order to avoid catastrophic climate change, more government action is required to encourage capital formation.**

While emissions targets express an intention and carbon markets might deliver a price signal in the long-term, **governments must strengthen underlying mandates and incentives immediately if capital is to be deployed to cover the gap, creating more investment and jobs.**

What investors want is Transparency, Longevity and Certainty – "TLC" – in policy regimes to mobilize capital. As a starting point, **we have made what we believe is a unique aggregate risk rating of countries based on key mandates and supporting policy frameworks.** While actual capital flows do not follow our rating for every country over the past few years, we believe that investors will become increasingly concerned about regulatory risk and thus countries that deploy a transparent, long-lived, comprehensive and consistent set of policies will attract global capital. We find that the Major Economies Forum on Energy and Climate countries with a lower-risk rating include: Australia, Brazil, China, France, Germany and Japan.

A lower-risk rating relies on a comprehensive and integrated government plan, supported by strong incentives, among them feed-in tariffs. **We believe that appropriately-designed and budgeted feed-in tariffs have demonstrated their ability to deliver renewable energy at scale. Many major emitters such as the US do not have enough "TLC" in their policy frameworks.**

Importantly, recent studies have shown that energy efficiency can deliver significant emissions reductions. Since efficiency provides economic savings in the long-term, **it is essential that governments incentivize deployment of capital in this area.**

Against this background, our Carbon Counter continues to record the relentless increase in greenhouse gas concentrations in the world's atmosphere. We look forward to the day that with the driving force of investment, these slow dramatically.

[1] *Expressed as CO_2e*
[2] *"How the Energy Sector Can Deliver on a Climate Agreement in Copenhagen," © OECD/IEA, 2009.*

Executive Summary

DB Climate Change Advisors has collected information on approximately 270 climate change targets – both greenhouse gas (GHG) emissions targets and renewable, industry and sector mandates. From this database we have:

1. Analyzed each mandated target to assess its risk level and ability to deliver its goal;
2. Developed an investor risk assessment of country policy regimes by aggregating these individual mandates;
3. Modeled the impact of all the targets on emissions through 2020. The modeling was conducted by researchers at the Columbia Climate Center at Columbia University's Earth Institute.

We focus in this study on the Major Economies Forum (MEF) on Energy and Climate Change countries, which account for over 75% of global GHG emissions today. By 2020, on a Business-as-Usual (BAU) pathway the US, EU and China between them account for over half of global emissions.

Investor risk assessment

Our ratings look at a moderate, lower and higher risk assessment of mandated renewable, industry and sector targets from an investor's standpoint. We use a suite of criteria to define this rating, but we note that within a consistent and durable integrated policy framework incentives such as feed-in tariffs are a key driver of investability. We believe that in current markets, these mandates drive capital flows on the ground and we do not rate emission targets although they signal potential market size.

Among the MEF countries, China, Germany, France and Australia all have lower risk profiles for climate change investments. This is because they have strong incentives in place, along with a consistent approach, demonstrated through well-considered plans. All other countries in the MEF are moderate risk, with the exception of Italy, which has struggled to develop a coherent set of policies that would enable it to achieve its targets.

Notably, the US, UK and Canada are moderate risk as they rely on a more volatile market incentive approach and in the case of the US, have suffered from a stop-start approach in some areas, such as the production tax credit (PTC). However, when we correlate our ratings against actual capital flows over the past decade, these countries have been strong in absolute dollar terms. This reflects in the large size of their capital and energy markets overall, and in the US and Canada the existence of encouraging state level opportunities.

Impact of targets on emissions

The results for the world overall in the context of the forthcoming Copenhagen negotiations provide indeed a sobering picture. The Columbia Climate Center of the Earth Institute, Columbia University has derived a measure of the Business-as-Usual trajectory, which is based on the energy mix and policy regime as of 2007, and shows emissions rising from 47 Gt in 2007 to 59 Gt CO_2 equivalents in 2020. Even with the recent economic downturn and a projected slowdown from 2014 – 2020 in emerging market growth, there is still enough growth in Business-as-Usual (BAU) from 2007 – 2020 to leave a 13 to 15 gigaton (Gt) overshoot in emissions over and above the 44 to 46 Gt needed to hit the 450 ppm pathway chosen for this analysis, as outlined by the OECD World Environment Outlook, which scientists hope would limit temperature increases to 2^{o}C. Then the key question was: How far would current announced mandates and emissions targets reduce this excess? We found that even the maximum combination of the most aggressive current mandates and emissions targets, including some proposals such as the American Clean Energy Security Act (ACES), still leaves a 5 to 7[3] Gt emissions overshoot from a 450 ppm pathway by 2020. If growth does not slow down after 2014, as the IEA assumes and as we have used in our modeling, then this could add another 7 Gt to the task.

But all is not lost. The world can still get on the right pathway. The IEA has conducted a study of energy technology deployment needed to get from their reference scenario to the 450 ppm pathway in the energy sector. Their analysis indicates that up to 60% of the solution in 2020 can come from energy efficiency – both at power plants, and in end use[4].

[3] 5 Gt emissions overshoot based on 450 ppm pathway by OECD World Environmental Outlook; 7 Gt based on 450 ppm pathway by Project Catalyst.
[4] "How the Energy Sector Can Deliver on a Climate Agreement in Copenhagen," © OECD/IEA, 2009. "Unlocking Energy Efficiency in the US Economy," McKinsey & Co 2009.

Executive Summary

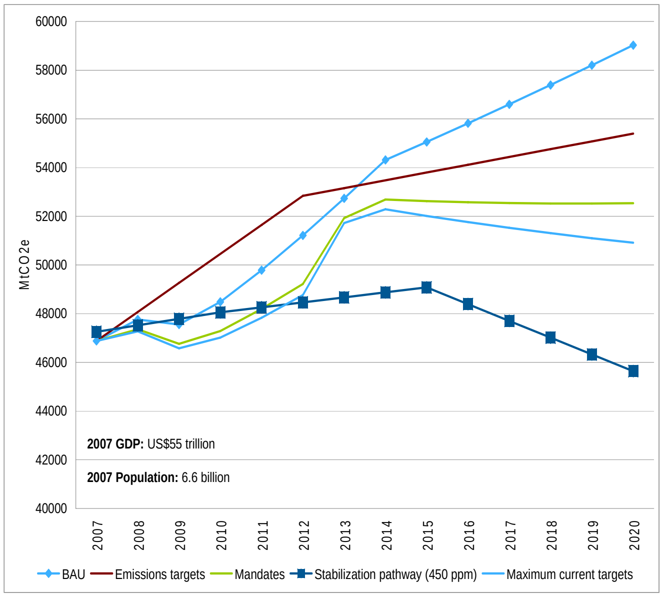
Adding this to action on land-use through avoided deforestation creates the possibility of getting close to the 450 ppm scenario. This represents an opportunity to invest to create jobs and growth, and not just a cost. However, it requires a strong deal at Copenhagen, but most importantly, strong follow-through at a sector and industry policy level to create Transparency, Longevity and Certainty.

Overall risk assessment and capital flows

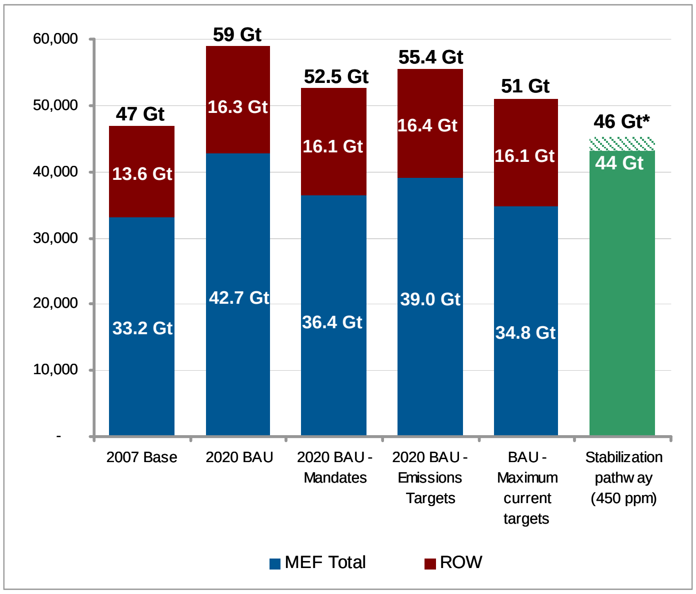
MEF Country	Overall Risk Assessment (1 = lower risk, 2 = moderate risk, 3 = higher risk)	Cap Inv 2000 - 2008 ($ m)	GDP 2008 (2008 $ bn)
Australia	1	5,427	800
Brazil	1	14,445	1,993
China	1	41,196	7,973
France	1	6,645	2,128
Germany	1	36,611	2,918
Japan	1	888	4,329
Canada	2	8,101	1,300
India	2	7,446	3,297
Indonesia	2	308	915
Mexico	2	135	1,563
Russia	2	113	2,266
South Africa	2	211	491
South Korea	2	1,916	1,335
United Kingdom	2	17,119	2,226
United States	2	52,120	14,260
Italy	3	6,421	1,823

Source: DBCCA analysis, 2009. Capital investment from New Energy Finance Industry Intelligence Database, 2009. Data only includes disclosed data, and may not fully encompass all deals. Data includes the following: (1) The figures include VC/PE for company deals, PE - Buy-out deals, but excludes PE for projects; (2) New build Asset Financing in clean energy (wind, biofuels, biomass, geothermal, mini-hydro, marine, & solar projects only). The figures exclude re-financing and project acquisition deals, bridge/construction type financing, and small scale projects; (3) Includes public market investment in clean energy. Private Investment in Public Equity (PIPE), and Over-the-Counter (OTC) deals are included. GDP data sourced from CIA World Factbook, 2009.

World emissions pathways



The 2020 estimated outcome[5]



Source: CCC, DBCCA analysis 2009.

[5] *See pages 23-24 for detailed analysis of MEF and ROW countries.*

** Range of 450 ppm pathways – 44 Gt source Project Catalyst estimates (http://www.project-catalyst.info/images/publications/comparability_memo.pdf); 46 Gt source OECD Environmental Outlook to 2030 (2008, p. 140) estimates.*

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Assessing Climate Change Policy Regimes

As investors, we are primarily interested in assessing policy regimes that encourage technology innovation, development, demonstration, deployment and diffusion in terms of their investability. In this light, we look for a number of clear ideas. To be effective, policies must:

- Be Transparent, Long-term and exhibit Certainty through consistent, secure and predictable, payment mechanisms ("TLC");
- Introduce incentives that decrease over time as technologies move towards market competitiveness;
- Eliminate non-economic barriers (grid access, administrative obstacles, lack of information, social acceptance);
- Provide fair and open access to distribution channels (e.g. transmission grid);
- Be enforceable.[1]

Policy regimes contain a variety of interrelated elements. They are generally developed with a goal – or target – in mind. In the case of climate change, these targets aim to reduce emissions, increase the penetration of renewables, boost efficiency, or transform an industry or sector. In this study, we divide these targets into two sets:

- **Emissions targets**, which aim to reduce greenhouse gas emissions by a specified level by a set year. These targets can be supported by carbon pricing, either through carbon taxes or cap-and-trade regimes;
- **Mandated renewable, industry and sector targets**, which require a minimum proportion of renewables in fuel pool or electric power mix, stipulate increased industrial efficiency, or mandate other actions, such as reduced deforestation or the phase-out of inefficient appliances. We have not at this time modeled detailed building efficiency codes.

Looking at these in terms of policy consistency, we have argued that mandates and incentives are key to (a) taking technologies down the cost curve when in development scale-up phase; (b) overcoming behavioral barriers in sectors such as energy efficiency (see Energy Efficiency section below); and furthermore that (c) carbon markets should become the long-term price signal as mandates phase-out. In terms of timeframe, our analysis goes to 2020, in which setting, mandates should be the driving force. From 2020 onwards, it should be hoped that carbon markets have been fully established globally and are mature enough to send a "TLC" price signal.

Underlying all of the targets are **incentives** that drive achievement. A great variety of incentive schemes are in place, ranging across feed-in tariffs, markets for tradable renewable energy certificates (RECs), reverse auctioning for renewable capacity, tax credits, loan guarantee schemes and government-backed funds. Still other policies, such as net metering and grid interconnection laws, are also key enablers for target achievement.

Obviously, the size of the investment market is also of interest to investors.

Therefore, in this study, we have:

- Estimated the potential emissions reductions of each mandated renewable, industry and sector target, which again provides an indication of market size, and then assessed them in terms of investor risk based on the incentives that underpin them and other factors discussed in *Exhibit 3*. We then aggregate them at a country level and have also put these in the context of recent clean tech capital flows.
- We have derived a Business-as-Usual scenario that assumes no new policies after 2007. We then present three alternate emission pathways, estimating the impacts on emissions of the policies compiled in this study. These scenarios are: (1) Aggregate emissions under proposed or enacted renewable, industry and sector mandates; (2) Aggregate emissions under emissions targets; and (3) A global estimate of the maximum reduction in emissions available assuming the greater of reductions from either mandates or emissions targets in each jurisdiction. We have not assessed actual emission targets from an investor perspective, although they are also an indicator of

[1] *This analysis was first elaborated in: Mark Dominik, Sabine Miltner, Virginia Sonntag-O'Brien, Eric Usher and Chris Taylor, "Financing clean energy and low-carbon technologies", in Lord Nicholas Stern et al., Meeting the Climate Challenge: Using Public Funds to Leverage Private Investment in Developing Countries, section 4, pp. 3-18.*

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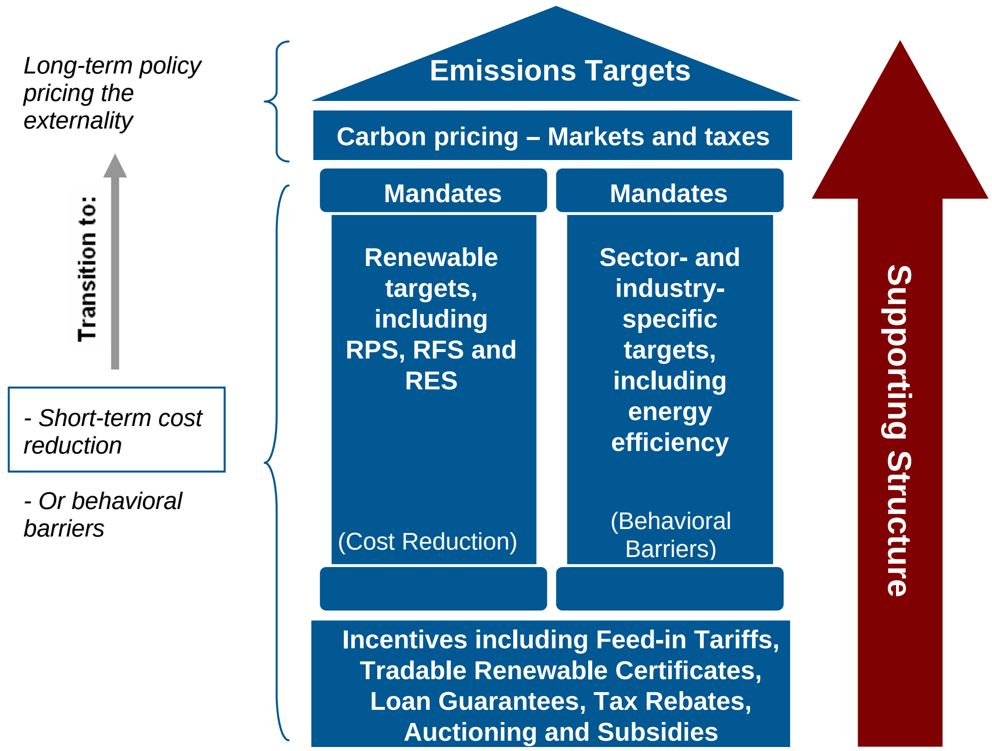
potential market size. Emissions targets represent something of an aspiration unless they are supported by a robust carbon market. Currently, only Europe has a carbon market, and it is still immature in many respects. In looking at the recent IEA scenarios for reaching a 450 ppm pathway, we have looked also at how much capital requires deploying in key sectors.

We have endeavored to be as comprehensive as possible in gathering targets (See Supplement: “Detailed Analysis of Targets by Region and Country”), but have sometimes been forced to abridge our search when there are multiple layers of subsidiary targets that underpin each other. Incentives are discussed in the context of the targets they underpin and support. We will continue to refine and develop this framework, and invite comments and feedback from investors, academics, policymakers, and civil society as we take this process forward. This is in effect a discussion or “Green Paper” in all senses of the word.

An idealized view of the current policy regime is one of enabling relationships that enhance the effectiveness of each individual target. *See exhibit 1.*

EX 1: Stylized current policy structure and relationships



Source: DBCCA analysis, 2009.

Energy efficiency

Energy efficiency measures featured prominently at a regional and country level across all the markets that we analyzed in our research and represent a very large and profitable investment opportunity which we expect to grow in size. From a modeling perspective, however, capturing efficiency measures posed a challenge for us. Not only were efficiency measures disparate by region and sector but the dataset we were using did not lend itself well to these targets, which are often set at city or regional levels, which we have not collected.

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Of course as analysts and investors, we believe the global trend of greater economy-wide energy efficiency measures will intensify going forward. Wide bodies of literature support this view, including work from McKinsey & Co that shows that investments in a wide range of efficiency measures are NPV-positive. And as we discuss a little later, the IEA believes that about $2 trillion could be spent globally between 2010-2020 on end-use and power plant efficiency measures to help the world achieve a 450 ppm stabilization target.

Since energy efficiency savings have such a compelling long run payoff, it has always been a question why such measures have not taken off more forcefully over the past thirty years. Much research has been done on the barriers to deployment such as the often significant upfront capital costs versus the lifecycle savings and the principal-agent problem between landlords and tenants of who pays and who has the right to benefit from efficiency energy savings. Policy has increasingly mandated efficiency action on appliances, lighting, and buildings—among many others—but has often fallen short in integrating efficiency across sectors and in setting tough enough standards.

While there are clearly significant energy efficiency initiatives happening now, we believe energy efficiency policy needs to be extended and deepened. A successful model is Japan, where its Top Runner program defines product-specific efficiency standards across a wide spectrum of product groups. The efficiency standards are dynamic and are set so that they exceed the most efficient products available on the market. Products that do not meet the standard by a targeted year are banned. Research has shown that this technology forcing strategy increases competitiveness while lowering energy use with no lifestyle impact. We believe a wider range of energy efficiency measures can and should be implemented broadly across sectors by more stringent mandates to deliver low marginal cost emission reductions.

Emissions targets – The high level regime

Within this study, we have included four main types of emissions targets from around the world:

- **Kyoto Protocol targets**, which were established in the Kyoto treaty, set limits on emissions from 38 developed countries[2], known in the treaty as Annex B parties to the Kyoto Protocol;
- **Supra-national emissions targets**, established specifically within the EU, where burden-sharing agreements allocate mitigation targets across geographies;
- **National emissions targets**, where countries establish targets independent of international agreements;
- **Sub-national emissions targets**, where regions, states or cities establish targets.

Emissions targets, where they exist, form the overall framework within which all other targets are inscribed, as the principal objective of climate policy is to prevent dangerous levels of global warming by limiting atmospheric stocks of greenhouse gases.

The principal distinction between the different types of emissions targets collected for this study is the level of government or international agreement that establishes it. Additionally, targets can be either mandatory or voluntary, with enforcement mechanisms varying by geography.

Some regions have multiple, overlapping emissions targets. In the case of European countries, targets can come from three, or even four, levels. France, for example, is bound by its signature to the Kyoto Protocol. As part of the EU, it is obliged to live up to its supra-national burden-sharing agreement. And Paris has established its own sub-national target. We have excluded city-level targets from this exercise – while we recognize the important contributions of cities in the fight against climate change, analyzing city-level regimes was beyond the scope of the current analysis.

Where targets overlap, generally, we assume that the most ambitious of them must be adhered to.

[2] *The United States, one of these 38 developed countries, never ratified the Kyoto Protocol.*

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Carbon pricing

In the document, we also indicate the type of carbon pricing mechanism in place for these emission targets: Cap-and-trade, a carbon tax, or no price. In the long run, economists agree the most efficient way to incentivize markets is to directly price the carbon externality and leave markets to sort out the long-term winners and losers.

Compliance with emissions targets is enabled through a variety of policies, of which carbon pricing can be a central compliance mechanism. This can be achieved either through establishing a carbon tax, or by instituting a cap-and-trade regime.

A number of geographies, including France, Ireland, and the Canadian province of British Columbia, have proposed carbon taxes. A carbon tax establishes a price for carbon, aiming to encourage a set amount of mitigation. While "guessing" the price of carbon to get to mitigation may be suboptimal, proponents of a carbon tax argue that its greater price stability reduces carbon price risk and encourages greater investment in alternative energy. Carbon taxes can also be effective for sectors where the transaction costs of cap-and-trade would make such a regime inefficient.

Proponents of cap-and-trade, which is the system used in the European Union's Emissions Trading Scheme (EU ETS) and that proposed under the American Clean Energy and Security Act in the US, argue that while the variability of carbon prices inherent in such a system reduces investor certainty, cap-and-trade allows mitigation to be achieved in the most efficient way possible. This is because cap-and-trade sets a policy-driven cap, motivated by scientific evidence, and market mechanisms then allow those regulated entities with the lowest cost of mitigation to reduce emissions, and to sell excess certificates to emitters with higher marginal costs of mitigation.

At Deutsche Bank, we believe that there are a number of lessons that have come out of early emissions trading regimes – both under the EU ETS and through the Kyoto Protocol mechanisms such as the Clean Development Mechanism (CDM) – that should be kept in mind when setting up future carbon markets. Firstly, on allowance auctioning, free allocations of carbon credits tend to create market distortions. Therefore, allowances should be auctioned to covered entities so that prices are determined on the basis of fundamental supply and demand. Secondly, on benchmarks, the reference levels used for setting the starting point for emissions abatement by entities covered under the system can quickly become irrelevant in light of rapid and dramatic changes in macroeconomic conditions. Thirdly, on short-term market intervention, periods of high volatility and low liquidity can discourage investments in clean technologies. Fourthly, on offsets, the provision of domestic and international offsets will encourage entities outside the trading system to undertake projects – and potentially programs of work – that reduce emissions. Lastly, on investment in clean technologies, the proceeds of allowance auctioning should be used by government to provide financial incentives that promote investments in renewable energy and other clean technologies integral to a low carbon economy. Interventions that reduce risk for clean technology projects, such as feed-in tariffs or loan guarantees, are particularly attractive.

There is great flexibility in allocating revenues in either regime. Most carbon tax proposals are presented as "tax neutral", meaning that other taxes will be reduced as carbon taxation is imposed. To date, revenues from the cap-and-trade regime in the EU have been limited, because a relatively low proportion of credits have been auctioned (as opposed to being given away for free). This is set to change in the third phase of the EU ETS, which begins in 2013.

In systems that auction more of their credits, there may be intense competition for hypothecation of the revenues generated. In the Waxman-Markey bill, for example, local electric distribution companies have successfully lobbied to receive 30% of the permits issued for free. This may potentially lead to an increase in profits for these companies.

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Mandated renewable, industry and sector targets (including Renewable Portfolio Standards & Renewable Fuel Standards)

A variety of renewable targets have been mandated. In effect, these mandates set demand side conditions – they determine the pattern of consumption of fuel or power at a consumer or utility level. They can be called “pull” policies. In order for these mandates to be effective, they need incentives of some kind to cause capital to flow until the underlying technologies are at commercial break-even. These incentives can be seen as a supply side response, or “push” policies. For an investor, it is the combined strength of these mandates and incentives that are currently driving investment opportunities. These are illustrated in *exhibit 2.*

EX 2: Supply-side (push) and demand-side (pull) policies support renewable targets

Supply-side (push) policies	Demand-side (pull) policies
Feed-in tariffs: A feed-in tariff is a premium price paid to an electricity generator to feed renewable energy onto the grid. Feed-in tariffs can work in a number of ways. They can be structured as long-term payments based on generation cost, or as a fixed premium on top of the spot market price for electricity. Most successful feed-in tariff regimes also require utilities to connect all eligible renewable energy generation, up to a specified limit per year, guaranteeing that renewable power producers will be able to feed their energy onto the grid. While feed-in tariffs have been criticized for their cost in some geographies, they have a track record of successfully scaling up renewable generating capacity. **Renewable certificates:** Called Renewable Energy Credits (RECs), Renewable Energy Certificates (RECs), Renewable Obligation Certificates (ROCs), or green certificates, some renewable mandates require electric power utilities to hold a specified number of certificates to prove compliance. Renewable generators receive RECs/ROCs for each MWh of renewable electricity they generate. They can then sell them on to utilities who need to prove compliance with the RPS by holding a specified number of RECs or ROCs. In most regimes, certificates must be handed over annually, with limited banking and borrowing. Sometimes, there are multiple classes of certificates in place, differentiated by technology. **Tax credits and exemptions:** Tax credits can be structured in a number of ways. Two of the most popular regimes have been used in the United States. These are the Production Tax Credit (PTC), where renewable power generators were granted a tax credit of $0.021/kWh for power generated in their first ten years of operation, and the Investment Tax Credit (ITC), where residential and commercial solar systems received a 30% investment tax credit. Other tax credits that have been used to encourage renewable deployment include sales tax and property tax exemptions. **Capital subsidies:** One of the major drawbacks of some types of tax credits is the need for tax equity financing. In the recent economic downturn, these markets have largely dried up, creating difficulties for project developers who relied on tax equity financing. The American Recovery and Reinvestment Act of 2009 allowed all projects eligible for the ITC to claim a cash grant of equivalent value instead.	**Renewable Portfolio Standards:** A Renewable Portfolio Standard (RPS) requires electric power utilities to source a specified proportion of their power from renewable sources. Robust regimes have mandatory, interim targets, accompanied by clear enforcement mechanisms with stiff penalties (also known as Alternative Compliance Payments) in place for non-compliance. Sometimes, the revenue raised through these penalties is hypothecated on renewable power, making the penalty more effective as a means of scaling up renewable power generating capacity. **Reverse auctioning/tendering:** China and some Canadian provinces have used reverse auctions, also known as tendering, to deploy a set quantity of renewables at least cost. Reverse auctions can be conducted by the government itself, or the government can require a utility to conduct a reverse auction for a specified amount of generating capacity. Reverse auctioning has a solid track record of rapidly delivering large quantities of renewables at low costs. New markets, such as California, are now discussing reverse auctioning as an efficient way of scaling up renewable power generating capacity.

Source: DBCCA analysis, 2009; Christina Hanley, "Government Intervention to Create Global Leadership and Competitive Advantages: How Has German Policy Shaped its Solar Technology Industry?", unpublished dissertation, London School of Economics, pp. 11-20; Grubb, Michael, "Technology Innovation and Climate Change Policy: An Overview of Issues and Options", 2004: www.econ.cam.ac.uk/faculty/grubb/publications/J38.pdf.

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These mandates, and their accompanying incentives, run across the policy orientation spectrum from market mechanisms to command and control. *See exhibit 3.*

EX 3: Policy orientation

Policy Orientation	**Command and control**				**Market Mechanisms**
Policy Tools	Centrally planned system built with reverse auctioning/ tendering	Technology-specific feed-in tariff	Technology-differentiated RPS with renewable certificates and penalties	General RPS with renewable certificates	Renewable tax credits or capital subsidies
Pros	Potential for rapid and orderly scale-up	Creates transparency and certainty, which incentivizes scale-up	Encourages specific technologies at potentially lowest cost	Encourages scale-up at lowest cost without “picking winners”	Encourages scale-up without “picking winners”
Cons	May lead to inefficient investment and “crowding out”	Government may set the price for renewables too high, which may lead to inefficiencies and budgetary issues	Lack of price certainty; may lead to investment in inefficient technologies	Lack of price certainty; may not scale up promising earlier-stage technologies	Lack of price certainty; may not lead to wide-scale deployment of renewables

Source: DBCCA analysis, 2009.

While general mandates that do not attempt to pick winners and rely on market pricing might seem to be most defensible, they do not adequately address all of the market failures at work in climate change, which include underinvestment in network expansion and technological innovation, as well as path-dependency on sub-optimal technologies that have benefited from high levels of historical investment.[3] To address these market failures, public policy interventions that reduce risk must be implemented. Indeed, we believe that Lord Stern’s view that feed-in tariffs “achieve larger deployment at lower costs” has a lot of merit. This is because under RPS regimes with tradable certificates, investors face a variety of risks, including electricity price volatility, renewable energy credit market volatility, and legislative and regulatory risks that raise the cost of capital required to finance renewable energy deployment. This increased cost of capital can make RPS regimes with tradable credits more expensive than feed-in tariff systems.[4] We also believe that reverse auctioning and tendering have shown early promise in China and Canada, and will be monitoring this further as other geographies experiment with these policies.

Ultimately, renewable mandates have limitations. Scaling up renewable power production beyond 20% may be difficult, and will rely on storage and the smart grid, due to issues of intermittency. If these issues are not addressed, as energy demand increases, so too will fossil fuel-based power production. While this is not an immediate-term concern for most geographies, it will be instructive to watch how Denmark – which is farther along in the development of renewables than many other countries – handles this issue as it attempts to scale further beyond 20% in the coming years.

[3] *Alex Bowen, Dmitri Zenghelis, and Mattia Romani, “Analytical framework: the case for public sector action”, in Lord Nicholas Stern et al., Meeting the Climate Challenge: Using Public Funds to Leverage Private Investment in Developing Countries, section 2, pp. 3-7*
[4] *Lord Nicholas Stern, The Economics of Climate Change, p. 366.*

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Sector and industry targets

The McKinsey & Co carbon mitigation cost curve presents over 10 Gt of cost-negative mitigation potential by 2030. Much of this potential comes from energy-efficiency opportunities that exist today, at low cost. These opportunities have not been deployed today due to a variety of challenges, including consumer preferences, non-rational economic decision-making and principal-agent problems.

Because pricing signals have been insufficient to unlock these opportunities, a variety of sector- and industry-specific targets have been established. These include

- Outright **bans**, or **plans to phase out** inefficient appliances or building materials, including policies around incandescent lightbulbs;
- **Automotive emissions caps**, including CAFÉ and EURO standards;

However, as previously discussed, we have not collected local building codes in detail in this study. While these often mandate minimum efficiency requirements, they are too localized and numerous to gather together in the first edition of this tracker in a robust way.

Regulatory regimes – An investor perspective

As investors, we are interested in the most robust regulatory regimes as these will deliver the most transparent and stable environment for investment and in effect be the least risky. The least risky regimes will also be most likely to deliver on the target that has been set, therefore achieving the climate goals that policymakers have set out. Note: The rating is not measuring the size of the ecological impact; i.e. this is not an environmental policy rating.

The starting point for us has been the targets described above. In this study, we have not rated emissions targets. But each mandated renewable, sector and industry target has been given a rating of “1”, “2” or “3:”

- **1** means that the regulatory regime is a lower risk for investors;
- **2** means that the regulatory regime is a moderate risk for investors;
- And **3** means that the regulatory regime is a high risk for investors.

Mandated target risk assessment – On-the-ground policies

We have developed a robust, qualitative assessment framework to rate each target, which is in turn fed into a quantitative risk rating score. Each target is assessed against 8 key criteria, which are then used collectively to develop a composite risk rating. As already discussed, incentives are particularly important. Given the importance of these, we use five sub-criteria to assess them.

While these evaluations are qualitative in nature, we have attempted to be as methodical as possible in our assessment. The rationale for ratings across the 8 key criteria we examine is set out in *exhibit 4.*

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EX 4: Investor policy framework assessment (mandated targets)

	Status		
	3: Higher Risk	2: Moderate Risk	1: Lower Risk
Incentives including: • **Feed-in Tariffs** • **RECs/ROCs** • **Loan guarantees** • **Tax rebates** • **Auctioning** • **Subsidies** • **Net metering** **(Rated against 5 sub-criteria)**	The timeframe of the policy is short-term or highly uncertain	The timeframe of the policy is medium-term and open to change	The timeframe of the policy is long-term and stable
	The enabling policy is poorly aligned with the overall target	The enabling policy is partially aligned with the overall target	The enabling policy is well aligned with the overall target
	Current market conditions substantially compromise policy effectiveness	Current market conditions may sometimes compromise policy effectiveness	The policy can be effective in the current market conditions
	Policy is extremely complex or bureaucratic, creating significant barriers to investment for all but local experts	Policy is somewhat complex or bureaucratic, creating some barriers to outside investment	Policy is accessible to outside investors
	The policy is unlikely to unlock private capital	The policy may unlock some private capital	The policy will unlock substantial private capital
Public Financing	Public financing is required but not available	Public financing is available but more may be required to achieve target	Adequate public financing is in place or is not needed
Enforcement	There are no penalties for non-compliance, or penalties are unlikely to be enforced	Penalties for non-compliance exist, but may be insufficient or sporadically enforced	Robust penalties are in place to ensure full compliance, and they are likely to be enforced
Monitoring	Monitoring mechanisms have not been identified, or are not robust	Monitoring is carried out, but may be infrequent or ad hoc	Robust monitoring is regularly carried out
Sovereign Credit Risk	Credit risk rating is non-investment grade, falling between CC and NR according to S&P or below Caa1 according to Moody's	Credit risk rating falls between BB and CCC according to S&P or between Ba1 and B3 according to Moody's	Credit risk rating is investment grade, falling between AAA and BBB according to S&P or between Aaa and Baa3 according to Moody's
Integrated Plan	No plan to achieve target is in place, or plan is unrealistic	Plan to achieve target is in place but lacks detail, or plan is in development	Detailed plan to achieve target is in place
Implementation Capacity	No team or committee has been assigned responsibility for implementation, or arrangements are unclear	A team or committee has been assigned responsibility for implementation, but it may be under-resourced or responsibilities may be poorly articulated	A well-resourced team or committee has been assigned responsibility for implementation
Historical Achievement	There is a history of falling short of targets	There is a history of meeting some targets	There is a history of meeting most targets
Overall risk assessment	**Determined by totaling up the individual ratings**		

Source: DBCCA analysis, 2009.

In the overall assessment, each of the criteria has been given equal weighting. This results in a composite score of between 8 and 24 points, with lower scores indicating a relatively lower-risk policy environment:

- For all targets with a **score of 12 points or less**, the composite score is **1 – lower risk;**
- for all targets with a **score of between 13 and 20**, the composite score is **2 – moderate risk;**
- and for all targets with a **score of 21 and above**, the composite score is **3 – higher risk**.

We have developed a view of the most attractive geographies for investment, based on the strength of the policy regime in place. Where multiple targets are rated in a single geography, we have weighted their ratings (based on the emissions impact) for the average rating for the region.

Assessing Climate Change Policy Regimes

We have also looked at the capital flows into clean technologies over the past 8 years, where data was available. *See exhibit 5.*

EX 5: Overall risk assessment and capital flows

MEF Country	Overall Risk Assessment (1 = lower risk, 2 = moderate risk, 3 = higher risk)	Cap Inv 2000 - 2008 ($ m)	GDP 2008 (2008 $ bn)
Australia	**1**	5,427	800
Brazil	**1**	14,445	1,993
China	**1**	41,196	7,973
France	**1**	6,645	2,128
Germany	**1**	36,611	2,918
Japan	**1**	888	4,329
Canada	**2**	8,101	1,300
India	**2**	7,446	3,297
Indonesia	**2**	308	915
Mexico	**2**	135	1,563
Russia	**2**	113	2,266
South Africa	**2**	211	491
South Korea	**2**	1,916	1,335
United Kingdom	**2**	17,119	2,226
United States	**2**	52,120	14,260
Italy	**3**	6,421	1,823

Source: DBCCA analysis, 2009.Capital investment from New Energy Finance database, 2009. Data only includes disclosed data, and may not fully encompass all deals. Data includes the following: (1) The figures include VC/PE for company deals, PE - Buy-out deals, but excludes PE for projects; (2) New build Asset Financing in clean energy (wind, biofuels, biomass, geothermal, mini-hydro, marine, & solar projects only). The figures exclude re-financing and project acquisition deals, bridge/construction type financing, and small scale projects; (3) Includes public market investment in clean energy. Private Investment in Public Equity (PIPE), and Over-the-Counter (OTC) deals are included. GDP data sourced from CIA World Factbook, 2009.

The data in exhibit 5 yields a number of interesting insights.

For lower risk countries:

- China, Germany[5], and France have all developed detailed climate change strategies, with generous and well-targeted incentives to achieve targets. This has stimulated high levels of investment in these lower-risk markets. For these countries, a mandated renewable target exists and is supported by either a feed-in tariff, a tendering process (often called reverse auctioning), or both. China is particularly notable within this group due to the large size of 2008 clean energy investment as a proportion of GDP.
- Brazil has attracted substantial capital flows based on a solid track record in renewables, and successful early implementation of its target to reduce deforestation. In 2008, it had the highest share of clean energy investment as a share of GDP among MEF countries.
- Australia has developed a robust set of incentives for deployment of renewables, making it a lower-risk investment environment.
- Japan has developed a set of targets that it is likely to achieve. In the longer-term, recent announcements for the new Japanese government are strengthening their commitment.

[5] *While the new German coalition is discussing accelerating the degression of feed-in tariffs, this is tied to declining cost for solar power. We believe that the investment climate in Germany remains strong.*

Assessing Climate Change Policy Regimes

For moderate risk countries:

- Some countries with deep capital markets, particularly the United States and United Kingdom, and to a lesser extent Canada, have attracted substantial capital, in spite of their moderately risky climate change policy environments. This risk is due, in part, to their reliance on tradable credits, which have been less successful at encouraging renewables to grow to scale. In parts of the US, the policy regime has also been characterized by a stop-and-start approach. Even California, long regarded as a climate leader, receives a 2 at a state level because of grid infrastructure challenges and the state's constrained budgetary situation. Recent announcements certainly continue to strengthen this policy framework in certain sectors.
- India has shown early promise in implementing its renewable targets, but they are still being rolled out across the country, leading to a moderate risk investment environment. South Korea is also beginning to step up efforts, but planning and monitoring remain challenging.
- Some countries have yet to become real players in climate change policy, including Russia, Mexico, South Africa, and Indonesia. However, they are working on this.

For higher risk countries:

- Despite substantial investment, Italy's climate change regime remains uncertain;

Risk ratings for all countries and US states can be found in our "Detailed Summary of Targets by Country and Region" and "Detailed Analysis of Targets by Country and Region" sections.

Analyzing the Impact of Emissions

Key Results for the World – A Sobering Baseline

In the lead-up to the 15th Conference of the Parties (COP) under the United Nations Framework Convention on Climate Change (UNFCCC), which will take place in Copenhagen later this year, it important to understand the emissions impacts of current and proposed targets. This is a complex process, and researchers at the Columbia Climate Center at Columbia University's Earth Institute took on the task of modeling each target, and then aggregating them at a country level. Emission impacts can be a signal of market size opportunities for an investor. The data are summarized by target in our "Detailed Summary of Targets by Country and Region" section, and are set out in the main body of the document alongside each target.

The methodology we used for the modeling is described in detail in a separate chapter. However, some key areas of focus include:

1. In calculating the BAU baseline, we assume that existing policies in 2007 continued thereafter. We then used IMF real GDP growth rates for economies to 2014 and IEA assumptions from 2015 to 2020. The IEA assumes a slowdown in emerging markets growth in particular (See "Energy Emissions Methodology" section), and this has a significant impact.
2. We then looked at the impact of the mandates on their own, as in many cases it is the mandates that at the very least that should be achieved. We show results for the Major Energy Forum countries (MEF) in this section; all countries are shown in the "Detailed Summary of Targets by Country and Region" section. Obviously the MEF countries dominate the emission numbers (of 47 Gt, now they are 33 Gt, of 59 Gt projected as BAU in 2020 they are 43 Gt).
3. We looked at the impact of the actual legislated or enacted emission targets, as well as some key proposed targets such as the American Clean Energy and Security Act (ACES) in the US.
4. We then derived for the world overall what we term the maximum potential emissions reduction, which aggregates for each country the larger of either the impact of mandates or an emissions target and sets this against what is required by a 450 ppm path (per OECD estimates[6]) to keep temperature increases under 2^{o}C.

Results:

- BAU – increases by nearly 12 Gt from 2007 to 2020, from 47 Gt to 59 Gt or 26%.
- Emissions targets on their own, if fully achieved, would reduce emissions by 4 Gt in 2020;
- Announced Mandates on their own, if fully achieved, would reduce emissions by 6 Gt in 2020; this is significant and points to how well on-the-ground policies can deliver.
- The aggregated strongest combination of mandates and emission targets at a country level would reduce emissions by 8 Gt from BAU.
- The 450 ppm pathway requires 13 Gt of reduction in 2020 from BAU to 46 Gt based on the OCED's World Environmental Outlook estimates. Project Catalyst estimates a 450 ppm level of 44 Gt in 2020.
- More than 80% of the 2 Gt of abatement that are set to be achieved by emissions targets with no underlying mandates comes from two countries: Indonesia and Mexico. Indonesia has announced a target to reduce emissions by 26% by 2020. Most of this will come from reduced deforestation. We note that Brazil has announced a sector target specifically for forestry, which we include in our mandates. Mexico has two emissions targets - a reduction of 8% below 2009 levels by 2012, and a reduction of 50% below 2002 levels by 2050. In our modeling exercise, we have assumed that Mexico implements a 15% reduction in emissions by 2020. The Mexican government has conducted significant analytical work as it recently put together a low carbon growth strategy. The leadership Mexico is showing in the space is encouraging, and we will continue to watch Mexico closely as it moves to legislate the priorities it has set out in its strategy.

See exhibit 6.

[6] OECD Environmental Outlook to 2030 (2008, p. 140)

Analyzing the Impact of Emissions

Therefore, there is a significant gap of around 5 Gt between what is required to achieve climate stabilization (450 ppm pathway) and if all existing maximum mandates and targets are achieved (maximum potential).

EX 6: Overall risk assessment and capital flows

Note: *Mandates and emissions targets cannot be combined as mandates would be supporting emissions targets. We take the largest of either when calculating the world maximum potential.*

MEF Country[1]	Base (Mt CO_2e)	No policy BAU Emissions (Mt CO_2e)		Impact of Mandated Targets (Mt CO_2e)		Impact of Emissions Targets (Mt CO_2e)		Investor Risk Assess-ment	GDP	Capital flows to clean energy	
	2007	2012	2020	2012	2020	2012	2020		2008 ($ bn)	2008 ($ m)	2000-08 ($ m)
Australia	520	550	570	0	-50	30[3]	-90	1	800	518	5,427
Brazil	2,350	2,430	2,560	-220	-440	0	0	1	1,993	7,602	14,445
Canada	770	780	840	-10	-160	-170	-210	2	1,300	1,373	8,101
China	8,130	11,230	15,140	-1,390	-2,290	0	0	1	7,973	16,727	41,196
France[2]	500	490	510	-40	-50	40[3]	0	1	2,128	1,794	6,645
Germany[2]	930	860	880	0	-160	80[3]	-160	1	2,918	4,606	36,611
India	1,970	2,440	3,140	0	-50	0	0	2	3,297	1,614	7,446
Indonesia	3,160	3,240	3,380	0	0	0	-880	2	915	16	308
Italy[2]	520	480	490	0	-50	-10	0	3	1,823	3,231	6,421
Japan	1,350	1,270	1,280	-10	-180	-160	-200	1	4,329	253	888
Korea	630	680	720	-30	-70	-680	-160	2	1,335	574	1,916
Mexico	740	770	890	-10	-10	-120	-320	2	1,563	-	135
Russia	1,970	1,950	2,160	0	-490	1,040[3]	0	2	2,266	13	113
South Africa	510	530	600	0	-10	0	0	2	491	169	211
UK[2]	610	590	600	-20	-100	40[3]	-120	2	2,226	3,937	17,119
United States	6,350	6,240	6,660	-20	-1,170	0	-1,360	2	14,260	15,241	52,120
Other EU[2]	2,240	2,190	2,280	-200	-1,020	360[3]	-170	N/A	5,815	28,113	48,943
Total	**33,240**	**36,720**	**42,700**	**-1,950**	**-6,290**	**460**[3]	**-3,670**	**N/A**	**55,432**	**85,781**	**248,045**

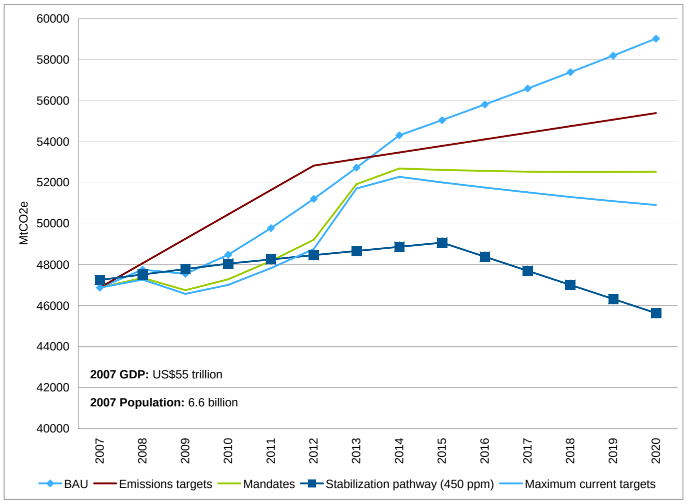
Notes: All figures rounded to nearest ten. [1] Includes the European Union as a region, [2] Abatement estimates for individual countries do not include EU-wide abatements. Therefore, there will be additional emission reductions for these countries associated with EU-27 mandates and targets above the assessments given here. The abatement estimated for the EU-27 as a region does include EU-wide and individual country policies. [3] "Hot Air" is included in the emission target.

Source: CCC, DBCCA analysis, 2009. GDP data sourced from CIA World Factbook, 2009. Capital investment from New Energy Finance Industry Intelligence Database, 2009. Data only includes disclosed data, and may not fully encompass all deals. The figures listed should be viewed as "baseline" figures, as there may have been transactions that NEF has not captured in their database. Data includes the following: (1) The figures include VC/PE for company deals, PE - Buy-out deals, but excludes PE for projects; (2) New build Asset Financing in clean energy (wind, biofuels, biomass, geothermal, mini-hydro, marine, & solar projects only). The figures exclude re-financing and project acquisition deals, bridge/construction type financing, and small scale projects; (3) Includes public market investment in clean energy. Private Investment in Public Equity (PIPE), and Over-the-Counter (OTC) deals are included.

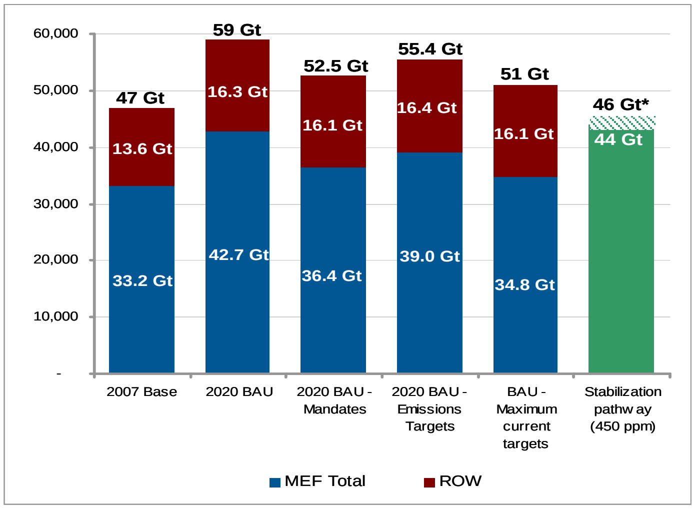
Analyzing the Impact of Emissions

EX 7: Emissions pathways

World

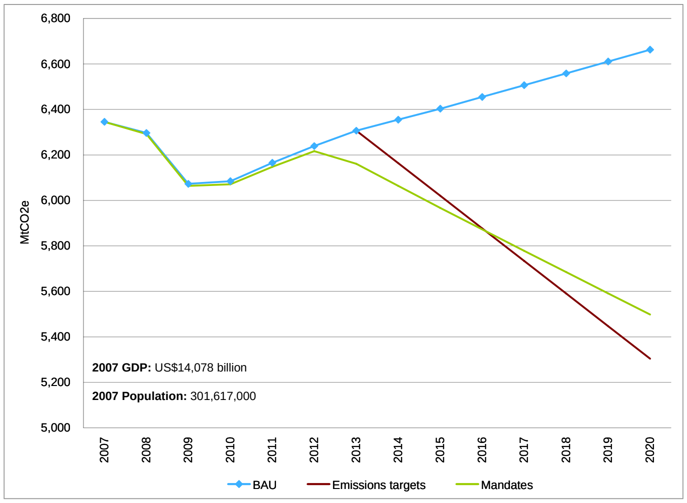


The 2020 estimated outcome



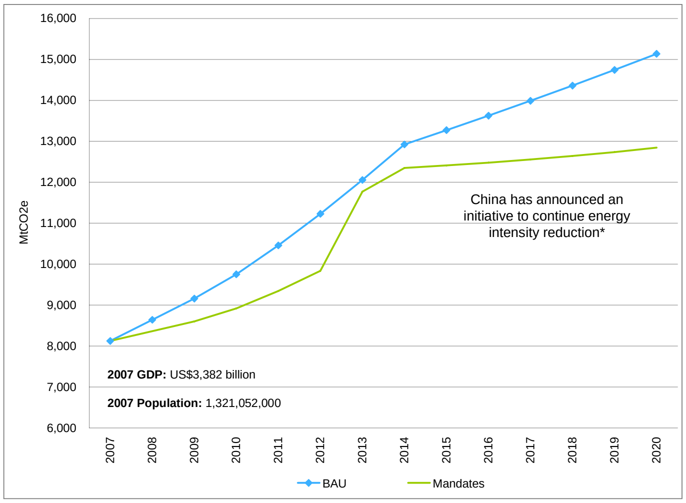
** Range of 450 ppm pathways – 44 Gt source Project Catalyst estimates; 46 Gt source OECD Environmental Outlook to 2030 (2008, p. 140) estimates.*

United States



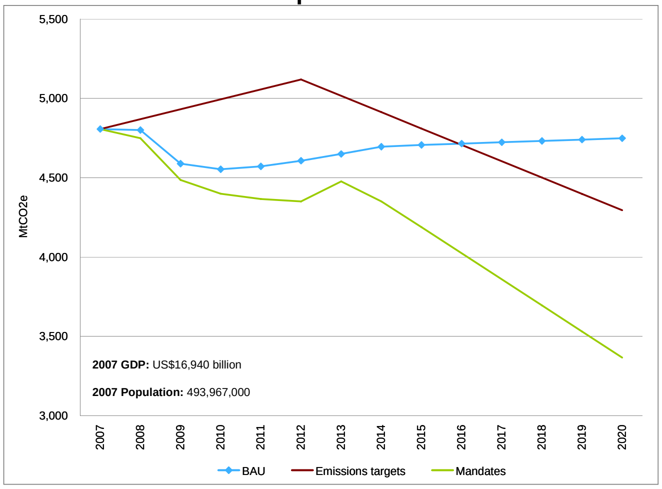
Note: Assumes the American Clean Energy and Security Act.

China



** See President Hu Jintao Speech at United Nations, September 2009.*

European Union



Note: In Europe, due to a 1990 starting base, many Eastern European countries generated excess carbon savings due to an economic recession and restructuring of the economy. This has been known as "hot air" and accounts for the worse outcome of emissions targets versus mandates, which subtract from BAU.

The recent economic recession has further relieved pressure on emissions targets. However, mandates reference off BAU in most cases, so they adjust down with BAU reductions.

Source: CCC, DBCCA analysis 2009.

Analyzing the Impact of Emissions

Key Results for the World – Increased Ambition Scenario

Therefore, as governments approach Copenhagen and consider their climate change efforts in the follow-up to the conference, there is a need to increase the ambition in order to reach an emissions peak by 2020. As concerned investors, we can only point out the need for a strong global deal where developed countries set ambitious hard targets and the developing world at least implements internationally accepted and validated low carbon growth plans within the context of their own development.

The United States is still debating its climate policy targets and carbon policy. We have modeled the American Clean Energy and Security (ACES) Act in our base case, as it has at least passed in the US House of Representatives. This bill aims to reduce emissions by 17% from 2005 levels by 2020. The Clean Energy Jobs and American Power Act (Kerry-Boxer) bill in the Senate would reduce emissions by 20% from 2005 levels by 2020.

The European Union has pledged to make emissions cuts of 30% below 1990 levels by 2020 within the context of a global deal. The EU's commitment comes on the back of substantial mandates.

China has demonstrated considerable leadership in addressing climate change through its 11th 5-Year Plan, which targets a 20% reduction in energy intensity of GDP between 2006 and 2010. At the UN General Assembly in September, 2009, President Hu Jintao underscored China's commitment to cut energy intensity of GDP "by a notable margin by 2020 from the 2005 level." We expect that in the 12th and 13th 5 Year Plan, China will continue to demonstrate the leadership it has in the 11th 5 Year Plan, and will continue to foster their national climate change investment environment – which earned our lowest risk rating in our policy assessment

IEA energy solutions for Copenhagen

When it comes to looking for a complete approach to limiting temperature increases to 2^{o}C at Copenhagen, the IEA's special early excerpt of the forthcoming World Energy Outlook 2009 frames the challenge appropriately. In October 2009, the IEA published "How the Energy Sector Can Deliver on a Climate Agreement in Copenhagen" dimensioning the energy sector pathways required to achieve a 450 ppm CO_2 equivalent trajectory (450 – Scenario) which is required to keep global average temperatures to 2^{o}C. The energy sector accounts for about two-thirds of emissions, the rest being mostly related to land use such as forestry and agriculture.

Of critical importance, the underlying assumptions informing the 450 - Scenario are dependent on the world agreeing to act in concert abiding by the principle of common but differentiated responsibilities that underpin the UNFCCC. Toward that end, the IEA 450 – Scenario assumes: 1) all OECD+ countries (includes non-OECD countries that are members of the EU) agree to a rigorous reduction in emissions with hard caps by 2020; robust carbon markets develop across the OECD+ power and industry sectors with no price caps; 2) international sectoral agreements, setting CO_2 intensity targets for new cars and airplanes, for the iron and steel and cement processes, are implemented by all countries as of 2013; 3) and energy efficiency mandates for buildings and appliances are instituted broadly.

From an investment perspective, we can then look at the IEA's expectations at a region or country level to see the modeled contribution toward the 450 – Scenario and the capital expenditures on a sector level that creates investment, jobs and growth. To be sure, achieving 450 ppm represents a large divergence from the IEA's "Reference Scenario" which reflects future energy trends based on policies enacted but not yet fully implemented by mid-2009 on a country by country basis.

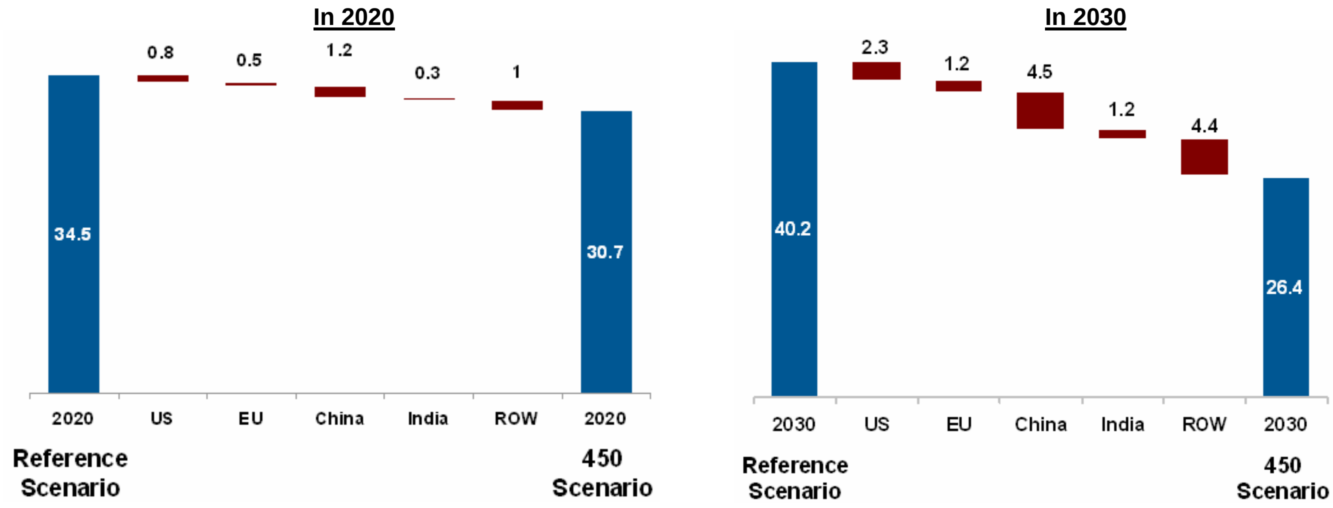
It is important to note that the IEA's 450 – Scenario is not a consensus document and does not necessarily reflect the views and policies of its member countries. The study – as the World Energy Outlook – was published under the authority of its

Analyzing the Impact of Emissions

Executive Director, Nobuo Tanaka. In this respect, the IEA's analysis is clearly targeted as a tool to stimulate international action at the upcoming climate negotiation meetings in December as it reflects what *could* happen with the right policy push.

For the purposes of looking at what countries and regions might therefore be able to contribute, the IEA shows how the key emitters would reduce emissions from its Reference Scenario in 2020, and for a longer term context in 2030, to achieve a 450 - Scenario. The IEA also indicates that where emissions reductions and investment take place may differ from who actually pays for the investment. In 2020 additional investment in non-OECD countries amounts to $200 billion and it is likely that a part of that will be co-financed by OECD countries (the precise amount will be of course a result of the negotiations). The IEA's Reference Scenario is its base case Business-as Usual model run, which assumes baseline capital stock turnover and market adoption based on today's technologies and policies. It is directionally similar to the DB Climate Change Advisors/Columbia BAU adjusted for current policy mandates.

EX 8: Domestic emission reductions by country and region to achieve the IEA's 450 – Scenario from the energy sector



Source: DBCCA analysis, 2009. How the Energy Sector Can Deliver on a Climate Agreement in Copenhagen: Special early excerpt of the World Energy Outlook 2009 for the Bangkok UNFCCC meeting; © OECD/IEA, 2009.

The additional incremental cumulative capital expenditures required for achieving the 450 – Scenario would result in $2,734 billion being spent between 2010 and 2020 and $9,361 billion between 2021 and 2030, according to the IEA. The value in the market sizing exercise that the IEA undertook from our perspective is that it represents an investment opportunity and points to the job creation and growth side of what is often thought of as a "cost."

EX 9: CO_2 abatement and capital expenditures in the IEA's 450 – Scenario

	Abatement Gigatons CO_2		Incremental Capex ($ 2008 bn)	
	2020E	**2030E**	**2010-2020E**	**2020-2030E**
Efficiency	2.5	7.9	$1,999	$5,586
Renewables	0.7	2.7	$527	$2,260
Biofuels	0.1	0.4	$27	$378
Nuclear	0.5	1.4	$125	$491
CCS	0.1	1.4	$56	$646
Total	**3.85**	**13.84**	**$2,734**	**$9,361**

Source: How the Energy Sector Can Deliver on a Climate Agreement in Copenhagen: Special early excerpt of the World Energy Outlook 2009 for the Bangkok UNFCCC meeting; © OECD/IEA, 2009.

Analyzing the Impact of Emissions

Achieving the 450 – Scenario would result in a substantial reduction in the energy intensity of the global economy, which in 2030 would produce half the CO_2 in the Reference Scenario for the same unit of GDP. In addition, per capita energy demand would decline substantially.

Land use: Agriculture and Forestry

With 30% of emissions relating to deforestation and agricultural practices, addressing this becomes crucial. Broad efforts to protect forests and encourage lower emission land use practices are very important. We note that Indonesia announced its intent to reduce its emissions by 2030 to 1.3 Gt from 2005 levels of 2.3 Gt if it receives international support. Actions to support early emission reductions from forestry are vital as well. McKinsey & Co estimates up to 7.8 Gt of potential abatement in the sector by 2030 with the bulk coming from avoided deforestation measures. The American Clean Energy and Security Act and the Clean Energy Jobs and American Power Act could be key enablers of reduced emissions from deforestation and degradation, as they propose forestry offsets for up to 20 years as a means for compliance for US covered emitters.

Detailed Analytical Results by Country

EX 10: Detailed results by MEF countries

Note: *Mandates and emissions targets cannot be combined as mandates would be supporting emissions targets. We take the largest of either when calculating the world maximum potential.*

MEF Country[1]	Base (Mt CO_2e)	No policy BAU Emissions (Mt CO_2e)		Impact of Mandated Targets (Mt CO_2e)		Impact of Emissions Targets (Mt CO_2e)		Investor Risk Assess-ment	GDP	Capital flows to clean energy	
	2007	2012	2020	2012	2020	2012	2020		2008 ($ bn)	2008 ($ m)	2000-08 ($ m)
Australia	520	550	570	0	-50	30[3]	-90	1	800	518	5,427
Brazil	2,350	2,430	2,560	-220	-440	0	0	1	1,993	7,602	14,445
Canada	770	780	840	-10	-160	-170	-210	2	1,300	1,373	8,101
China	8,130	11,230	15,140	-1,390	-2,290	0	0	1	7,973	16,727	41,196
France[2]	500	490	510	-40	-50	40[3]	0	1	2,128	1,794	6,645
Germany[2]	930	860	880	0	-160	80[3]	-160	1	2,918	4,606	36,611
India	1,970	2,440	3,140	0	-50	0	0	2	3,297	1,614	7,446
Indonesia	3,160	3,240	3,380	0	0	0	-880	2	915	16	308
Italy[2]	520	480	490	0	-50	-10	0	3	1,823	3,231	6,421
Japan	1,350	1,270	1,280	-10	-180	-160	-200	1	4,329	253	888
Korea	630	680	720	-30	-70	-680	-160	2	1,335	574	1,916
Mexico	740	770	890	-10	-10	-120	-320	2	1,563	-	135
Russia	1,970	1,950	2,160	0	-490	1,040[3]	0	2	2,266	13	113
South Africa	510	530	600	0	-10	0	0	2	491	169	211
UK[2]	610	590	600	-20	-100	40[3]	-120	2	2,226	3,937	17,119
United States	6,350	6,240	6,660	-20	-1,170	0	-1,360	2	14,260	15,241	52,120
Other EU[2]	2,240	2,190	2,280	-200	-1,020	360[3]	-170	N/A	5,815	28,113	48,943
Total	**33,240**	**36,720**	**42,700**	**-1,950**	**-6,290**	**460[3]**	**-3,670**	**N/A**	**55,432**	**85,781**	**248,045**

Notes: All figures rounded to nearest ten. [1] Includes the European Union as a region, [2] Abatement estimates for individual countries do not include EU-wide abatements. Therefore, there will be additional emission reductions for these countries associated with EU-27 mandates and targets above the assessments given here. The abatement estimated for the EU-27 as a region does include EU-wide and individual country policies. [3] "Hot Air" is included in the emission target.

Source: CCC, DBCCA analysis, 2009. GDP data sourced from CIA World Factbook, 2009. Capital investment from New Energy Finance Industry Intelligence Database, 2009. Data only includes disclosed data, and may not fully encompass all deals. The figures listed should be viewed as "baseline" figures, as there may have been transactions that NEF has not captured in their database. Data includes the following: (1) The figures include VC/PE for company deals, PE - Buy-out deals, but excludes PE for projects; (2) New build Asset Financing in clean energy (wind, biofuels, biomass, geothermal, mini-hydro, marine, & solar projects only). The figures exclude re-financing and project acquisition deals, bridge/construction type financing, and small scale projects; (3) Includes public market investment in clean energy. Private Investment in Public Equity (PIPE), and Over-the-Counter (OTC) deals are included.

Detailed Analytical Results by Country

EX 10a: Detailed results by other EU country

Note: *Mandates and emissions targets cannot be combined as mandates would be supporting emissions targets. We take the largest of either when calculating the world maximum potential.*

Other EU Country[1]	Base (Mt CO_2e)	No policy BAU Emissions (Mt CO_2e)		Impact of Mandated Targets (Mt CO_2e)		Impact of Emissions Targets (Mt CO_2e)		Investor Risk Assess-ment	GDP	Capital flows to clean energy	
	2007	2012	2020	2012	2020	2012	2020		2008 ($ bn)	2008 ($ m)	2000-08 ($ m)
Austria	80	76	77	-4	-6	-10	0	2	330	2	312
Belgium	134	128	130	-1	-31	-2	0	2	389	599	1,742
Bulgaria	68	68	79	0	-3	42[2]	0	2	94	860	1,095
Cyprus	7	7	8	0	-1	0	0	2	23	-	-
Czech Republic	144	141	147	-4	-9	29[2]	0	2	265	12	65
Denmark	61	58	60	-1	-10	-4	0	1	204	2,308	3,613
Estonia	23	19	20	0	-1	22[2]	0	2	27	89	361
Finland	73	68	70	-1	-10	1[2]	0	2	194	175	798
Greece	118	114	116	-7	-10	12[2]	0	3	343	73	1,240
Hungary	80	77	80	0	-8	35[2]	0	2	197	17	463
Ireland	61	54	54	0	-8	5[2]	0	2	188	232	2,398
Latvia	14	13	14	0	-1	14[2]	0	1	39	-	1
Lithuania	23	20	22	0	-1	26[2]	0	1	63	92	156
Luxembourg	11	10	10	0	-2	-2	0	2	39	-	-
Malta	2	2	2	0	0	0	0	3	10	-	-
Netherlands	232	218	221	0	-29	-15	0	2	672	587	1,391
Poland	377	406	430	0	-25	114[2]	0	2	668	1,018	1,299
Portugal	66	61	63	0	-8	9[2]	0	2	237	4,553	8,081
Romania	126	132	153	0	-9	122[2]	0	Not assessed	271	-	25
Slovakia	51	54	57	0	-5	15[2]	0	3	120	-	-
Slovenia	20	20	22	0	-2	-1	0	2	59	14	14
Spain	408	381	388	-25	-48	-65	0	2	1,403	18,402	43,258
Sweden	62	59	61	0	-11	14[2]	-19	1	344	604	1,113

Notes: [1] Abatement estimates for individual countries do not include EU-wide abatements. Therefore, there will be additional emission reductions for these countries associated with EU-27 mandates and targets above the assessments given here. The abatement estimated for the EU-27 as a region does include EU-wide and individual country policies. [2] "Hot Air" is included in the emission target.

Source: CCC, DBCCA analysis, 2009. GDP data sourced from CIA World Factbook, 2009. Capital investment from New Energy Finance Industry Intelligence Database, 2009. Data only includes disclosed data, and may not fully encompass all deals. The figures listed should be viewed as "baseline" figures, as there may have been transactions that NEF has not captured in their database. Data includes the following: (1) The figures include VC/PE for company deals, PE - Buy-out deals, but excludes PE for projects; (2) New build Asset Financing in clean energy (wind, biofuels, biomass, geothermal, mini-hydro, marine, & solar projects only). The figures exclude re-financing and project acquisition deals, bridge/construction type financing, and small scale projects; (3) Includes public market investment in clean energy. Private Investment in Public Equity (PIPE), and Over-the-Counter (OTC) deals are included.

Detailed Analytical Results by Country

EX 11: Detailed results by ROW countries

Note: *Mandates and emissions targets cannot be combined as mandates would be supporting emissions targets. We take the largest of either when calculating the world maximum potential.*

Legend: N/a = Not available; N/A = Not Applicable

ROW Country	Base (Mt CO_2e)	No policy BAU Emissions (Mt CO_2e)		Impact of Mandated Targets (Mt CO_2e)		Impact of Emissions Targets (Mt CO_2e)		Investor Risk Assess-ment	GDP	Capital flows to clean energy	
	2007	2012	2020	2012	2020	2012	2020		2008 ($ bn)	2008 ($ m)	2000-08 ($ m)
Abu Dhabi	N/a	N/a	N/a	N/a	N/a	N/a	N/a	1	184	50	50
Algeria	140	150	180	0	-1	0	0	2	233	-	95
Argentina	380	410	480	0	-4	0	0	2	574	-	31
Bangladesh	130	150	190	0	-1	0	0	2	224	-	-
Belarus	90	100	110	0	0	30*	0	N/A	114	-	-
Cape Verde	N/a	N/a	N/a	N/a	N/a	N/a	N/a	2	2	-	-
Costa Rica	20	20	20	0	0	0	-20	2	48	110	210
Croatia	30	30	30	0	0	0	0		82	28	129
Egypt	230	270	330	0	-4	0	0	1	444	-	91
Iceland	0	0	0	0	0	0	-1		13	-	483
Jamaica	10	10	10	0	-1	0	0	2	21	-	26
Jordan	20	30	30	0	0	0	-2	1	32	-	-
Libya	50	50	70	0	-2	0	0	3	89	-	-
Madagascar	N/a	N/a	N/a	N/a	N/a	N/a	N/a	3	20	-	-
Malaysia	880	890	950	-5	-6	0	0	1	384	-	53
Mali	N/a	N/a	N/a	N/a	N/a	N/a	N/a	3	15	-	-
Morocco	50	50	60	-4	-4	0	0	2	137	-	303
New Zealand	70	70	80	0	0	-20	0	1	117	17	532
Nicaragua	60	60	60	0	0	0	0	2	17	-	153
Nigeria	430	470	540	0	-1	0	0	2	335	-	-
Norway	50	50	50	0	0	-2	-20	N/A	275	1,584	3,375
Pakistan	280	300	360	0	0	0	0	3	427	122	150
Paraguay	20	20	30	-1	-2	0	0	2	29	-	-
Philippines	220	230	260	-20	-30	0	0	2	318	160	2,501
Rwanda	N/a	N/a	N/a	N/a	N/a	N/a	N/a	2	10	100	103
Senegal	20	30	30	0	0	0	0	2	22	-	-
Switzerland	40	40	40	0	-2	10*	1*	2	317	140	1,500
Taiwan	310	310	390	-20	-100	0	-80	1	712	244	1,316
Tunisia	30	30	40	-4	-5	0	0	2	82	-	-
Turkey	450	460	510	0	-30	0	0	2	903	349	549
Ukraine	490	470	530	0	0	470*	0	N/A	340	13	13
Uganda	N/a	N/a	N/a	N/a	N/a	N/a	N/a	2	39	35	35
Other Countries	9,140	9,770	10,970	0	0	0	0	N/A	N/A	N/A	N/A
Total ROW	**13,640**	**14,490**	**16,330**	**-50**	**-190**	**490***	**-120**	**N/A**	**6,559**	**2,952**	**11,698**

Notes: All figures rounded to nearest ten. * "Hot Air" is included in the emission target.

Source: CCC, DBCCA analysis, 2009. GDP data sourced from CIA World Factbook, 2009. Capital investment from New Energy Finance Industry Intelligence Database, 2009. Data only includes disclosed data, and may not fully encompass all deals. The figures listed should be viewed as "baseline" figures, as there may have been transactions that NEF has not captured in their database. Data includes the following: (1) The figures include VC/PE for company deals, PE - Buy-out deals, but excludes PE for projects; (2) New build Asset Financing in clean energy (wind, biofuels, biomass, geothermal, mini-hydro, marine, & solar projects only). The figures exclude re-financing and project acquisition deals, bridge/construction type financing, and small scale projects; (3) Includes public market investment in clean energy. Private Investment in Public Equity (PIPE), and Over-the-Counter (OTC) deals are included.

Investor Risk Assessments of States and Provinces

EX 12: Investor risk assessment by US state

US State	Final Rating (1 = Lower risk, 2 = Moderate risk, 3 = Higher risk)
Colorado	1
Florida	1
Hawaii	1
Illinois	1
Maine	1
Michigan	1
Minnesota	1
Nevada	1
New Hampshire	1
New Jersey	1
New Mexico	1
Oregon	1
Texas	1
Washington	1
Arizona	2
California	2
Delaware	2
Indiana	2
Kentucky	2
Maryland	2
Massachusetts	2
Missouri	2
Montana	2
New York	2
North Carolina	2
North Dakota	2
Ohio	2
Pennsylvania	2
Rhode Island	2
Vermont	2
Virginia	2
Wisconsin	2
Connecticut	3
South Dakota	3
Utah	3

Source: DBCCA analysis, 2009.

Investor Risk Assessments of States and Provinces

EX 13: Investor risk assessment by Canadian province

Canadian Province	Final Rating (Red = Higher risk, Yellow = Moderate risk, Green = Lower risk)
Alberta	1
British Columbia	1
Ontario	1
Quebec	1
Manitoba	2
Nova Scotia	2

Source: DBCCA analysis, 2009.

EX 14: Investor risk assessment by Australian state

Australia State	Final Rating (Red = Higher risk, Yellow = Moderate risk, Green = Lower risk)
New South Wales	1
South Australia	2

Source: DBCCA analysis, 2009.

Recently Announced Targets

EX 15: Recently announced targets by country

Country/State	Target Description	Modeled (Y/N)
Brazil	54 GW new grid capacity including 1.1 GW wind, 3.3 GW biomass and 3.9 GW small hydro (August, 2009)	N
China	Reduce energy intensity by a notable margin by 2020 (September, 2009)	N
India	20 GW solar by 2020 (August, 2009)	Y
Indonesia	26% reduction in emissions by 2020 (October, 2009)	Y
Mexico	8% emissions below 2009 levels by 2012 (August, 2009)	Y
Mexico	Increase renewable energy capacity from 3.3% in 2008 to 7.6% in 2012 (August, 2009)	N
New Zealand	10% below 1990 levels by 2020 and 50% below 1990 levels by 2050 (July/August, 2009)	N
Norway	40% reduction in emissions from 1990 levels by 2020 (October, 2009)	N
Russia	10% reduction in emissions below 1990 levels by 2020 and 50% by 2050 (July/August, 2009)	N
Scotland	42% cut in emissions by 2020 from 1990 levels, (August, 2009)	N
South Korea	4% reduction in emissions from 2005 levels by 2020.	Y
Switzerland	20% reduction in emissions by 2020 from 1990 levels (August, 2009)	Y
Ukraine	20% reduction in emissions by 2020 from 1990 levels (August, 2009)	N
United States	20% reduction in emissions by 2020 and 80% by 2050 from 2005 levels (Clean Energy Jobs and American Power Act, September, 2009)	N

Source: CCC, DBCCA analysis, 2009.

Energy Emissions Methodology

As the starting point for measuring the impact of the policies identified in this study, we have worked with researchers at the Columbia Climate Center Columbia University's Earth Institute to calculate a Business-as-Usual scenario based on projected growth in energy demand, beginning with 2007 data from the IEA (*Energy Balances* vol. 2009) and using the following key assumptions:

- Annual real GDP growth projections on a country-by-country basis for 2007-2014 (IMF World Economic Outlook, October 2009). Growth rates for 2015-2020 are not projected by the IMF, so for these years we use the average regional growth rates assumed by the IEA in its World Energy Outlook 2008. These growth rates are somewhat lower (2.7% worldwide) than those assumed by the IMF for the decade leading up to 2014 (3.4%).

- A global 1.5% annual decrease in energy intensity (measured as energy/RealGDP), which is equivalent to a 1.52% annual increase in energy productivity (RealGDP/energy). This reflects the autonomous efficiency improvement assumption that is common in many energy-forecasting models (Lackner and Sachs, 2006). We have modeled this assumption slightly differently than McKinsey & Co in its greenhouse gas mitigation cost curve, as they assume a 1.2% annual improvement in carbon productivity, or RealGDP/carbon (McKinsey & Co Version 2.0 GHG Mitigation Cost Curve, 2009 p. 24). Given that we are modeling energy demand, it seems more accurate to assume an improvement in energy – rather than carbon – productivity.

To illustrate this calculation, energy (measured as total primary energy supply) in France in 2020 is calculated as:

$(\text{Energy}_{\text{France},2007})*(1-.015)14*(1 + \text{GDPgrowth}_{\text{France},2008})* \ldots *(1+ \text{GDPgrowth}_{\text{France},2020})$

Next, we estimate the corresponding CO_2 emissions using:

- The country-specific fuel mix from 2007 (the most recent year available in the IEA Energy Balances), assuming constant proportions in future years; and

- Carbon emissions factors in terms of MtCO2/Mtoe for OECD and non-OECD countries in 2006 from the IEA (WEO 2008, pp. 508-509, 522-523). For OECD countries, these are: 3.86 coal, 2.53 crude oil, 2.32 gas. For non-OECD countries, these are: 3.80 coal, 2.57 crude oil, and 2.20 gas. The IEA Energy Balance data presents total primary energy supply estimates for petroleum products separate from estimates for crude oil. We assume that all petroleum products are produced from crude oil and thus share the same carbon emissions factor. We assume that biomass has a net zero impact on carbon emissions, which is an acknowledged oversimplification of a complicated issue.

It is important to note that we considered using the reference case for CO_2 emissions from the IEA's *World Energy Outlook 2008* as the "Business-as-Usual scenario" against which to measure the impact of potential emissions reductions. The IEA reference scenario includes the impacts of oil prices and a variety of other factors on emissions, providing a high level of complexity and robustness that we cannot replicate. However, it also includes the "effects of those government policies and measures that were enacted or adopted by mid-2008" (IEA WEO 2008, p. 59). Thus using it as a baseline for assessing the impacts of the policies in this study would result in a misestimate of the impact potential emission reductions.

This analysis is also different from the IEA's biannual *Energy Technology Perspectives* report, which analyzes the energy and emissions impact of many different future technology scenarios. For example, they estimate the emissions profile of a future where carbon capture and storage technology is widely deployed and nuclear energy is more prevalent than today. In contrast, our Business-as-Usual scenario is exactly that – Business-as-Usual. The relative energy mix in each country is exactly the same as it was in our base year of 2007.

Energy Emissions Methodology

CO_2e emissions

We have estimated projected emissions from non-CO_2 Kyoto greenhouse gases – CH_4, N20, HFCs, PFCs, and SF_6 – by using data assembled by the U.S. EPA (Global Anthropogenic non-CO_2 GHG Emissions, 1990-2020). This dataset, used by both McKinsey & Co and World Resources Institute (WRI), includes actual emissions for 1990, 1995, 2000, 2005 and projected emissions for 2010, 2015, 2020. We have assumed that intervening years are a simple linear interpolation of the surrounding years. We note two potential concerns with this dataset:

1. The EPA projections incorporate regional GDP growth rates estimated by the Energy Information Agency in 2001. These rates are obviously different from the October 2009 IMF country-specific growth rates we use to estimate CO_2 emissions from energy. We do not have enough information about the EPA model to re-parameterize their estimates based on more recent GDP growth projections.
2. The EPA data use the Global Warming Potential (GWP) conversion factors from the earlier IPCC reports. We have updated the CH_4 and N_2O projections of CO_2e emissions using the GWPs from the IPCC AR4. The EPA does not report disaggregated data for the other Kyoto gases, so these are still projected using the older GWPs.

Greenhouse gases regulated by the Montreal Protocol are included in the estimate provided by the Greenhouse Gas Counter we launched on June 18, 2009 near Penn Station in New York City. It is reasonable to include these gases in the stock of climate-forcing gases currently in the atmosphere - which is what the counter monitors - but since they are generally no longer emitted, we have not included them in our estimate of BAU greenhouse gas emissions. In addition, none of the other common inventories or projections (McKinsey & Co, WRI, etc.) include the Montreal gases in their CO_2e emissions datasets.

Land-use change and forestry emissions

The IPCC AR4 summarizes the range of estimates for Land Use, Land Use Change, and Forestry (LULUCF) (WG3, ch.9, table 9.2) and concludes that: “The picture emerging from Table 9.2 is complex because available estimates differ in the land-use types included and in the use of gross fluxes versus net carbon balance, among other variables. This makes it impossible to set a widely accepted baseline for the forestry sector globally. Thus, we had to rely on the baselines used in each regional study separately (Section 9.4.3.1), or used in each global study (Section 9.4.3.3). However, this approach creates large uncertainty in assessing the overall mitigation potential in the forest sector. Baseline CO_2 emissions from land-use change and forestry in 2030 are the same as or slightly lower than in 2000 (see Chapter 3, Figure 3.10).” This suggests that there is no definitive study and that existing studies have different methodologies and wildly different estimates. The range is 3 to 9 $GtCO_2$ per year worldwide between 1990-2005.

We have used data from Houghton, 2003, (whose estimates are included the IPCC table 9.2) and have assumed that the amount of deforestation in 2000 continues at the same level through 2020. The Houghton data are readily available, internally consistent (as opposed to using the IPCC range of estimates from various sources), and are used by McKinsey & Co and the World Resources Institute’s Climate Analysis and Information Tool.

Houghton’s 2003 dataset is available via the WRI website and represents emissions through 2000, allocated to individual countries. In the data documentation (http://cait.wri.org/downloads/DN-LUCF.pdf), Houghton states that “The errors associated with the regional estimates of carbon flux are substantial. The errors for individual countries are even larger because of the methods used to distribute the regional totals.” This is a strong warning about spurious precision in interpreting LULUCF estimates. Global emissions in 2000 are estimated at 7.6 $GtCO_2$. Houghton has a more recent dataset (2008) with somewhat lower estimates, but these data are not available by country and are thus less useful for this project.

Energy Emissions Methodology

Finally, current peat emissions from peat bogs rather than from peat combustion – which is included in the IEA's coal category – are estimated by Hoojier et al 2006 (and included by McKinsey & Co, assuming constant future emissions). We have not investigated peat datasets, since there are no policies aimed at peat emissions in the tracker. Given the overall level of uncertainty with regard to terrestrial emissions (and the relatively small contribution from peat, estimated at 2.0 $GtCO_2$ per year, relative to 3-9 $GtCO_2$ range of land-use and forestry emissions in the IPCC AR4), we have excluded peat emissions.

Cement process emissions

Cement emissions must be incorporated in a BAU scenario. The IEA dataset includes the energy emissions associated with the production of cement, but does not include the emissions produced by the cement calcination process.

Oak Ridge National Lab's Carbon Dioxide Information Analysis Center (CDIAC) provides estimates of emissions from the cement calcination process for every country through 2006 (Marland, G., T.A. Boden, and R.J. Andres, 2008). This dataset is included in the World Resources Institute's Climate Analysis and Information Tool dataset. In McKinsey & Co's work, the CDIAC data was used to build proprietary cement estimates assembled from a number of additional sources, including the World Business Council on Sustainable Development (WBCSD)'s Cement Sustainability Initiative, the IPCC, the IEA, and the European Cement Research Academy. The CDIAC dataset's advantage is that it is transparent and easy to disaggregate by country and year.

Using the CDIAC data, we assume that cement process emissions grow at the level of GDP growth in countries that remained below $15,000 in GDP-PPP in the IMF's forecast time period (2007-2014). In countries where GDP-PPP is projected to be above $15,000 through 2015, we assume a constant level of process emissions. Finally, in those countries that are projected to hover around $15,000 for most of the years between 2007-2014, we assume that process emissions grow at half the rate of GDP growth. These assumptions are obviously very simple, especially since they do not allow countries to move between the three groupings. In addition, we are also ignoring GDP-PPP growth after 2014. We think, however, that these assumptions allow us to estimate the approximate trend of cement process emissions (WWF-LaFarge Partnership, *Blueprint for a Climate-friendly Cement Industry*, 2008).

BAU sensitivity analysis

Our BAU projects 59.0 $GtCO_2e$ emissions in 2020, with the majority of emissions from energy use. In comparison, McKinsey & Co projects Business-as-Usual emissions of 61.2 Gt in 2020. We believe that the difference is probably due to slightly different assumptions regarding cement process emissions and other greenhouse gases. For energy emissions, McKinsey & Co's scenario incorporates the IEA WEO 2007, which projects emissions of 36.4 Gt in 2020, compared to our estimate of 37 Gt.

EX 16: BAU estimates ($GtCO_2e$)

	2007	2010	2015	2020
CO_2 Energy	28.3	29.2	34.4	37.0
Other GHG	9.6	10.0	10.9	11.8
LULUCF CO_2	7.6	7.6	7.6	7.6
Cement process CO_2	1.4	1.6	2.2	2.6
Total BAU estimate	**46.9**	**47.6**	**55.1**	**59.0**

Source: CCC analysis, 2009.

Our projection of global energy emissions is approximately a half Gt higher than that of the IEA WEO 2008 and approximately 2.5 Gt greater than the most recent WEO (which is available in limited form at the time of drafting this report).

Energy Emissions Methodology

We believe this difference has at least two explanations. First, we have used the IEA WEO 2008 growth rates, as the WEO 2009 growth rates are not yet public. As a result, we may be assuming higher growth for 2015-2020. Second, the IEA reference scenario includes the impact of announced (but not necessarily fully implemented) energy policies. Their estimate of the impact of these policies would naturally lower the reference scenario. In addition, the IEA also incorporates projections of energy prices and fuel-switching, as well as other behavioral complexities. These projections are rich in detail but somewhat opaque; the direction of their impact is therefore unclear.

Our global energy projections are comparable to the U.S. Energy Information Agency's high growth scenario (*International Energy Outlook*, 2009). On a country level, our estimates are close to those of the IEA and the EIA for the United States, the European Union, Russia, Japan, and India, but they are somewhat higher than the IEA and EIA projections for China.

EX 17: BAU energy emissions ($GtCO_2e$) sensitivity analysis

	1990	2006	2007	2015	2020
World					
Earth Institute (1990 from WRI)	20.5		28.3	34.4	37.0
EIA reference case 2009	21.5	29.0		33.1	35.4
EIA high growth 2009	21.5	29.0		33.9	37.0
IEA WEO 2008	20.9	27.9		34.0	36.4
IEA WEO 2009 (limited pre-release)	20.9		28.8		34.5
United States					
Earth Institute (1990 from WRI)	4.9		5.7	5.6	5.8
EIA reference case 2009	5.0	5.9		5.9	6.0
EIA high growth 2009	5.0	5.9		6.1	6.2
IEA WEO 2008	4.8	5.7		5.8	5.8
IEA WEO 2009 (limited pre-release)	4.8		5.7		5.5
Japan					
Earth Institute (1990 from WRI)	1.1		1.2	1.1	1.1
EIA reference case 2009	1.1	1.2		1.2	1.2
EIA high growth 2009	1.1	1.2		1.2	1.3
IEA WEO 2008	1.1	1.2		1.2	1.2
IEA WEO 2009 (limited pre-release)	1.1		1.2		1.0
European Union					
Earth Institute (1990 from WRI)	4.1		3.8	3.7	3.7
IEA WEO 2008	4.0	3.9		4.0	3.9
IEA WEO 2009 (limited pre-release)	4.0		3.9		3.6
Russia					
Earth Institute (1990 from WRI)	2.2		1.5	1.6	1.7
EIA reference case 2009	2.4	1.7		1.9	1.9
EIA high growth 2009	2.4	1.7		1.9	2.0
IEA WEO 2008	2.2	1.6		1.9	1.9
IEA WEO 2009 (limited pre-release)	2.2		1.6		1.7
China					
Earth Institute (1990 from WRI)	2.2		5.9	10.2	11.7
EIA reference case 2009	2.3	6.0		8.2	9.4
EIA high growth 2009	2.3	6.0		8.4	9.9
IEA WEO 2008	2.2	5.6		8.8	10.0
IEA WEO 2009 (limited pre-release)	2.2		6.1		9.6
India					
Earth Institute (1990 from WRI)	0.6		1.4	2.0	2.3
EIA reference case 2009	0.6	1.3		1.6	1.8
EIA high growth 2009	0.6	1.3		1.6	1.9
IEA WEO 2008	0.6	1.3		1.8	2.2
IEA WEO 2009 (limited pre-release)	0.6		1.3		2.2

Sources: IEA World Energy Outlook 2008; IEA World Energy Outlook 2009 data from How the Energy Sector Can Deliver on a Climate Agreement in Copenhagen (IEA, October 2009); EIA International Energy Outlook 2009; World Resources Institute, Climate Analysis Indicator Tool, online at www.wri.org. CCC analysis, 2009.

Energy Emissions Methodology

450 ppm CO_2e stabilization scenario

For reference, we show a CO_2e emissions stabilization pathway to reach 450 ppm of CO_2e. This pathway is from the *OECD Environmental Outlook to 2030* (2008, p. 140) and was generated using the Netherlands Environmental Assessment Agency's FAIR model. The values for 2005, 2010, 2015 and 2020 are 46.7, 48.1, 49.1, and 45.6 Gt CO_2e, respectively. These values fall within the range of stabilization scenarios developed in recent years as reported in the IPCC AR-4 WG-3 report.

Estimates of target impact

There are two general categories of targets. Emissions policies represent a fixed reduction in emissions from a baseline, expressed either as emission reduction goal (such as the Kyoto reductions, or Brazil's target to reduce emissions from deforestation), a tax, or a cap-and-trade system. Mandates refer to policies that specify how emissions will be reduced – for example, by increasing the percentage of renewables in a country's electricity supply.

We have estimated the impacts of policies for two target years: 2012 and 2020. To model the impact of emissions policies, we have calculated the difference between the baseline year (such as 1990 for most of the Kyoto targets) and the target year (such as 2012 for the Kyoto targets). For baselines not in our dataset (e.g., a 10% reduction from 2000), we used World Resources Institute data (as our dataset closely follows their methodology). In many cases, targets are specified for a period beyond 2020, such as a 60-80 percent reduction by 2050. For these targets, we estimated the reduction by 2020 following the "20% by 2020" convention in most cases.

To represent the emissions pathways graphically we assumed that the abatement corresponding to the targets was applied linearly between 2007 and 2012 or between 2012 and 2020. We also took into account the nature of the target. Progress is thus portrayed for emission targets as a straight line for 2007-2012 or 2012-2020 for 2012 and 2020 targets respectively. The abatement corresponding to mandate targets was applied evenly to the Business-as-Usual (BAU) emissions throughout the time period corresponding to the target year.

There are many different types of renewable mandates, so modeling these targets requires various assumptions for each target. For RPS-fuel targets, we calculated the impact of additional biomass fuel above the existing level of biomass consumed by a country's road sector. We assumed that biofuel displaced a country's use of petroleum. For RPS-energy targets, we calculated the impact of additional renewables from the baseline level of renewables in the country's total primary energy supply. For RPS-electricity targets, we calculated the impact of additional renewable from the baseline level of renewables in the country's electricity consumption data. For energy and electricity targets, we assumed displacement of coal whenever possible. In countries with relatively low levels of coal, we assumed displacement of the predominant fossil fuel. In countries with moderate coal use and aggressive RPS targets, we assumed displacement of both coal and gas. These displacement assumptions are summarized below.

EX 18: Displacement assumptions by country

Fuel displaced	
Coal	Algeria, Australia, Belgium, Bulgaria, China, Canada, Czech Republic, Denmark, Estonia, EU-wide targets, Finland, Germany, Greece, Hungary, Ireland, Japan, Malaysia, Mexico, Morocco, New Zealand, Poland, Portugal, Romania, Russia, Slovak Republic, Slovenia, Spain, South Africa, South Korea, Sweden, Taiwan, Turkey, United States.
Coal/gas	Austria, Brazil, France, the Philippines, United Kingdom.
Gas	Algeria, Argentina, Bangladesh, Italy, Latvia, Libya, Lithuania, Luxembourg, Netherlands, Nigeria, Switzerland.
Petroleum	Cyprus, Egypt, Jamaica, Jordan, Malta, Senegal.

Source: CCC analysis, 2009.

Glossary of Terms

Annex I Parties: The 40 countries plus the European Economic Community listed in Annex I of the United Nations Framework Convention on Climate Change (UNFCCC) that agreed to try to limit their GHG emissions.

Annex A: A list in the Kyoto Protocol of the six greenhouse gases and the sources of emissions covered under the Kyoto Protocol.

Annex B: A list in the Kyoto Protocol of the 38 countries plus the European Community that agreed to emissions targets. The list is nearly identical to the Annex I Parties except that it does not include Belarus or Turkey.

Baselines: The baseline estimates of population, GDP, energy use and hence resultant greenhouse gas emissions without climate policies, determine how big a reduction is required, and also what the impact of climate change without policy will be. Targets for reducing GHG emissions are often defined in relation to a base year. In the Kyoto Protocol, 1990 is the base year for most countries for the major GHGs.

Cap-and-Trade: A cap-and-trade system sets an aggregate limit on the amount of greenhouse gases that may be emitted annually by certain capped sources. Subject to the overall limit, capped sources may buy and sell the right to emit greenhouse gases.

Carbon Taxes: A surcharge on the carbon content of oil, coal, and gas that discourages the use of fossil fuels and aims to reduce carbon dioxide emissions.

Electricity Generation: The generation or use of electric power by a device over a period of time, expressed in kilowatt hours (kWh), megawatt hours (MWh), or gigawatt hours (GWh).

Energy: The capacity for doing work as measured by the capability of doing work (potential energy) or the conversion of this capability to motion (kinetic energy). Energy has several forms, some of which are easily convertible and can be changed to another form useful for work. Electrical energy is usually measured in kilowatt hours, while heat energy is usually measured in British thermal units (Btu).

Energy Consumption: The use of energy as a source of heat or power or as a raw material input to a manufacturing process or service.

Energy Demand: The requirement for energy as an input to provide products and/or services.

Energy Efficiency: Refers to programs that are aimed at reducing the energy used by specific end-use devices and systems, typically without affecting the services provided. These programs reduce overall electricity consumption, often without explicit consideration for the timing of program-induced savings. Such savings are generally achieved by substituting technologically more advanced equipment to produce the same level of end-use services (e.g. lighting, heating, motor drive) with less electricity.

Energy Intensity: Economy-wide energy intensity measures units of energy to units of gross domestic product (GDP). Energy intensity can also be measured at the sector level using sector-specific data. For example, energy intensity in the commercial sector is measured by the ratio of energy consumption measured in millions of Btu to square feet of commercial floor space.

European Union Emissions Trade Scheme (EU ETS): The EU ETS commenced operation in January 2005 as the largest multi-country, multi-sector Greenhouse Gas Emission Trading System in the world.

Green Certificates: An official record proving that a specified amount of green electricity has been generated. The certificates can be traded separately from the energy produced.

Gross Electricity Generation: The total amount of electric energy produced by generating units and measured at the generating terminal in kilowatt hours (kWh) or megawatt hours (MWh)

Hot Air: A situation in which emissions (of a country, sector, company or facility) are well below a target due to the target being above emissions that materialized under the normal course of events (i.e. without deliberate emission reduction efforts). If a recession occurs and fuel use declines, emissions may be well below targets since targets are generally set in relation to emission projections. If emission trading is allowed, an emitter could sell the difference between actual emissions and emissions targets. Such emissions are considered “hot air” because they do not represent reductions from what would have occurred in the normal course of events.

Hypothecation: Hypothecation is the pledging of securities or other assets to secure a loan.

Incentives: Regulations that use the economic behavior of firms and households to attain desired environmental goals. Incentive-based programs involve taxes on emissions or tradable emission permits.

Intergovernmental Panel on Climate Change (IPCC): The IPCC was established in 1988 by the World Meteorological Organization and the UN Environment Programme. The IPCC is responsible for providing the scientific and technical foundation for the United Nations Framework Convention on Climate Change (UNFCCC).

Kyoto Mechanisms: The Kyoto Protocol creates three market-based mechanisms that have the potential to help countries reduce the cost of meeting their emissions reduction targets. These mechanisms are Joint Implementation, the Clean Development Mechanisms, and Emissions Trading.

Kyoto Protocol: An international climate agreement adopted in December, 1997. The Protocol sets binding emission targets for developed countries that would reduce their emissions on average 5.2% below 1990 levels by 2012.

Glossary of Terms

Mandates: Mandates specify quantities of new generating capacity to be built

Non-Annex 1 Parties: Countries that have ratified or acceded to the UNFCCC that are listed in Annex I of the UNFCCC.

Non-Annex B Parties: Countries that are not listed in Annex B of the Kyoto Protocol

Primary Energy: Energy in the form that it is first accounted for in a statistical energy balance, before any transformation to secondary or tertiary forms of energy. For example, coal can be converted to synthetic gas, which can be converted to electricity; in this example, coal is primary energy, synthetic gas is secondary energy, and electricity is tertiary energy.

Renewable Energy Certificate (REC): Renewable energy certificates (RECs), also known as green certificates, green tags, or tradable renewable certificates, represent the environmental attributes of the power produced from renewable energy projects and are sold separate from the physical electricity production connected to the grid. Customers can buy green certificates whether or not they have access to green power through their local utility or a competitive electricity marketer. And they can purchase green certificates without having to switch electricity suppliers.

Renewable Portfolio Standard (RPS): Requirement of a certain percentage of a utility's power plant capacity or generation to come from renewable or alternative energy sources by a given date.

Subsidy: Form of financial assistance paid to a particular sector.

United Nations Framework Convention on Climate Change (UNFCCC): A treaty signed at the 1992 Earth Summit in Rio de Janeiro that calls for the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."

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