HSBC Climate Change

HSBC Global Research

Global Climate Change
September 2010

Sizing the climate economy

We forecast the low-carbon energy market will triple to USD2.2trn by 2020

We believe that the global transition to low-carbon growth will intensify over the next decade – in spite of current regulatory headwinds. We have constructed four scenarios to model the growth potential for the low-carbon energy market, which comprises revenues for power, heat and fuels and related to energy efficiency in buildings, transport and industry. Our Conviction scenario produces a 2009-20e compound annual growth rate of c11% which results in the market nearly tripling to USD2.2trn per annum by 2020.

Over the coming decade, we believe three major shifts will take place. First, energy efficiency themes, notably low-carbon vehicles such as plug-in hybrid and full electric vehicles, will surpass low-carbon power as the major investment opportunity. Second, China's low-carbon market will overtake the USA (but not Europe). Third, the amount of upfront capital required will more than triple to USD1.5trn per year in 2020, a large but manageable sum in our view.

Our companion report, in which we introduce our *Climate Equity Opportunity list*, highlights those companies we believe are positioned to benefit from low-carbon growth.

By Nick Robins, Charanjit Singh, Robert Clover, Zoe Knight and James Magness

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HSBC's Climate Service

HSBC Global Research has developed a three-fold response to the investment challenge of climate change

- Equity: identifying stocks from our global coverage that offer climate investment opportunities
- Quantitative: providing solutions enabling investors to incorporate climate change into their investment decisions
- Macro: conducting in-depth research into the scientific, policy and market dimensions of climate change

Equity Research – the Climate Equity Opportunity list

Starting in March 2007 with the publication of *Green is the New Black*, HSBC Equity Research has been steadily expanding its coverage of stocks that derive material revenue streams from alternative energy solutions. HSBC has now identified around 90 stocks that have more than 20% of their revenues from the broader climate economy, notably energy efficiency, solar, water and wind. The bulk of the coverage is through the Clean Energy team, plus selected opportunities in Industrials.

Quantitative Research – the Climate Change Indices & Toolkit

In September 2007, HSBC's Quantitative Research team launched its family of Climate Change Indices offering investors with liquid exposure to leading companies providing solutions. The indices offer investors a variety of ways of responding to the investment challenge at global, thematic and regional levels. Quarterly research updates are produced in September, December, March and June.

Macro Research – the Climate Change Centre of Excellence

In October 2007, the Climate Change Centre of Excellence was established as a focal point within HSBC to identify the long-term commercial implications of the issue. Its research focuses on the Macro dimension, investigating the scientific foundations of climate change, geographical vulnerabilities, global policy frameworks and long-term market prospects.

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Summary

We estimate that by 2020 the world's low-carbon energy market will be almost three times larger than it is today. Our focus in this report is to show why this is the case, what the key opportunities are and where these are located. Using top-down macro estimates and bottom-up revenue modelling, we construct four distinctive scenarios of how policy and markets could evolve over the next 10 years. We recognise significant upside and downside risks to our forecasts, but even in our most bearish scenario, we expect the market to double by 2020.

The climate economy emerges

2010 has been a tough year for the global climate agenda. Policy pessimism after Copenhagen has been compounded by (largely unfounded) doubts over climate science along with governments backtracking on commitments in key countries. But looking through the fog of the carbon war, a new climate is starting to emerge, driven as much by resource scarcity and industrial innovation as by the raw realities of global warming. According to the US National Academy of Sciences, it is now a 'settled fact' that warming is taking place and that humans are largely responsible. This year's extreme weather events – fires in Russia and floods in Pakistan and China – have reminded everyone that climate change is a threat that should not be ignored. Beyond this, it is also self-evident that mounting pressures on energy, land and water resources require a step-change in economic behaviour, offering growth, employment and trade benefits for those countries that take a lead in climate business.

In this report, we examine the key investment opportunities which we believe are presented by the emergence of this 'climate economy'. We draw on the thematic framework developed by the HSBC Climate Change Index, and focus our attention on the potential for low-carbon energy production and consumption. For this report, we exclude from our analysis potential opportunities from reducing emissions in the agriculture, forestry and waste sectors, as well as those that flow from adapting to climate change, as these have fundamentally different investment drivers.

The size of the prize – our four scenarios for 2020

The low-carbon opportunity is defined by two complementary policy trends: first, taking carbon out of energy by curbing emissions from fossil fuels (notably coal, oil and gas) and creating incentives for using low-carbon sources of energy (notably renewables and nuclear); and second, taking energy out of economic growth by promoting energy efficiency in buildings, industry and transport. The challenge for investors, however, is the lack of certainty over both policy intentions and actual implementation. To map the range of potential outcomes over the next decade, we have constructed four distinctive scenarios.

- The Backlash scenario: This assumes that governments either renege on existing commitments and/or fail to implement these in practice.
- The Copenhagen scenario: This assumes implementation of the policies adopted in 2009 at the time of the Copenhagen climate summit.
- The Green Growth scenario: This assumes governments exceed their 2009 commitments over the next decade.
- The Conviction scenario: This projects what we believe is the most likely pathway to 2020 based on our current expectations. We believe that there will be diverging growth paths in the three key markets. In the EU, we expect renewable but not energy efficiency targets to be met; in the USA, we project limited growth in clean energy; and in China, we expect current targets for clean energy to be exceeded.

We have estimated both the baseline market in 2009 and also the markets that result from our scenario analysis. The results are set out in the table below, showing that our estimate of the annual market size grows from USD740bn in 2009 to USD1.5trn-2.7trn in 2020, with our Conviction scenario at USD2.2trn. From a macroeconomic perspective, this means that the low-carbon energy market moves from 1.3% of global GDP in 2009 to 2.1% of global GDP in 2020[1], representing an overall c11% CAGR for 2009-20e.

Low carbon growth: four roads to 2020 - estimated market size in USDbn

	2009e	2020e			
	Base	Backlash	Copenhagen	Green growth	Conviction
Low-carbon energy production	422	774	1,025	1,297	1,043
Energy efficiency and energy management	317	722	1,003	1,410	1,194
Total	**740**	**1,496**	**2,028**	**2,707**	**2,238**
CAGR (2009-2020e)		6.6%	9.6%	12.5%	10.6%

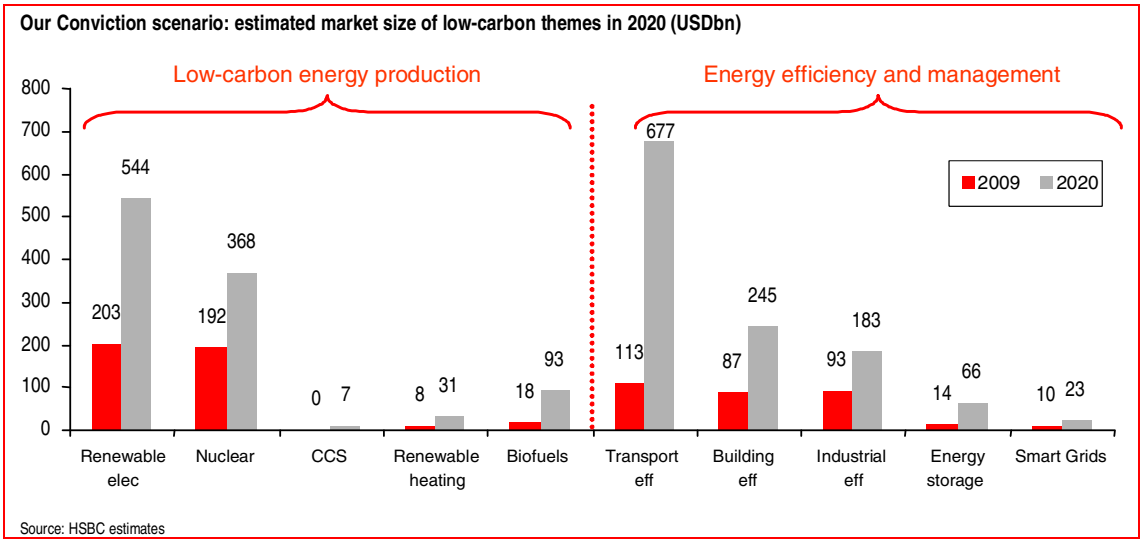
Source: HSBC estimates

Energy efficiency becomes the single largest opportunity by 2020

Market growth of c13% CAGR to USD1.2trn by 2020e

To date, the main feature of the low-carbon economy has been a changing energy supply mix. We believe this will change in the coming decade as governments implement policies to deliver 'negative cost' improvements in building and industrial efficiency, and transform the transport sector through a major shift to hybrid and electric vehicles (EV). Our estimate includes five key segments: transport efficiency (USD677bn, CAGR 18%), building efficiency (USD245bn, CAGR 10%), industrial efficiency (USD183bn, CAGR 6%), energy storage (including fuel cells) (USD66bn, CAGR 15%) and smart grid (USD23bn, CAGR 8%). The electric vehicle market stands out for attention – and we estimate it will grow more than twenty-fold by 2020 to reach USD473bn, with faster growth in the second half of the decade as prices fall, more products are launched and policies become more supportive.

[1] Global GDP in 2009 stood at USD58trn; we estimate that this will grow to USD109trn by 2020, which we have extrapolated using IMF forecasts for 2009-2015



Renewable power has largest growth in low-carbon energy supply

Low-carbon energy supply to grow at 8.6% CAGR to USD1trn by 2020

In contrast, we expect less rapid growth on the supply side. In terms of low-carbon power generation, we estimate that renewable power revenues grow at a CAGR of 9.4% to a market size of USD544bn; solar and wind revenues grow at CAGRs of 9% and 10%, respectively, to USD115bn and USD285bn. The nuclear market expands to USD368bn; we also forecast a capital investment market of USD7bn for Carbon Capture and Storage (CCS), but believe it is too early to forecast revenues from CCS generated electricity. Alongside this, we estimate that the market for bio-fuels will reach a 16% CAGR; we have not included corn ethanol or palm oil bio-diesel in our estimates due to the doubts over their potential as low-carbon solutions. Finally, we estimate a modest market for renewable heating of USD31bn in 2020.

Europe remains the largest market; China gains market share

Currently, the European Union (EU) accounts for 33% of the low-carbon market, followed by the USA (21%) and then China (17%). In our Conviction scenario, the EU retains its lead, but its share falls to 27%. The main riser is China, which climbs to a 24% market share, with a national CAGR of 14%; the US share falls back to 20%, and Japan falls from fourth to fifth behind India, which also grows at a CAGR of 14%.

A low-carbon economy will be a capital-intensive economy

The shift to a low-carbon economy invariably involves higher upfront capital costs, matched by lower operating costs; these investments will yield positive returns in terms of fuel savings, particularly in building, industry and transport sectors. We estimate annual capital investment in our Conviction scenario will grow from an annualised USD460bn in 2010 to USD1.5trn in 2020; in total, we estimate that cUSD10trn in cumulative capital investments will be required from 2010 to 2020. A continuation of the historical 60:40 split between debt and equity suggests a need for USD6trn in debt and fresh equity of USD2trn, assuming 50% of the equity from internal accruals. Importantly, we expect a third of investments will come from the household sector in the form of building efficiency improvements, decentralised renewables and low-carbon vehicles; new funding models are required to make this a reality.

Upside and downside risks to our estimates are significant

Our Conviction scenario is one that is easily recognisable from today's standpoint – a reflection of the limited ambition of most governments' policies for low-carbon growth. But there are clearly significant uncertainties affecting our estimates. Added to the normal risks of projecting any market a decade into the future, plotting the trajectory of low-carbon economic growth relies on a range of dynamic assumptions, notably around policy frameworks, technological innovation, infrastructure capacity, resource availability, scientific consensus and public opinion. In terms of our Conviction scenario, key downside risks include the withdrawal of key policy incentives, serious implementation delays, in particular for energy efficiency, and higher than expected technology costs. On the upside, a spike in fossil fuel prices, a global climate deal and faster breakthroughs in key technologies would provide additional momentum.

Beyond 2020

This report projects the future of low-carbon energy growth over the next decade. In many respects, we believe that this will accentuate trends that are already visible. It is in the following decade from 2020 to 2030 that we expect a step-change as carbon pricing becomes more prevalent, as long-lead-time assets such as nuclear and CCS potentially come on-stream and the deployment of breakthrough products such as electric vehicles becomes mainstream.

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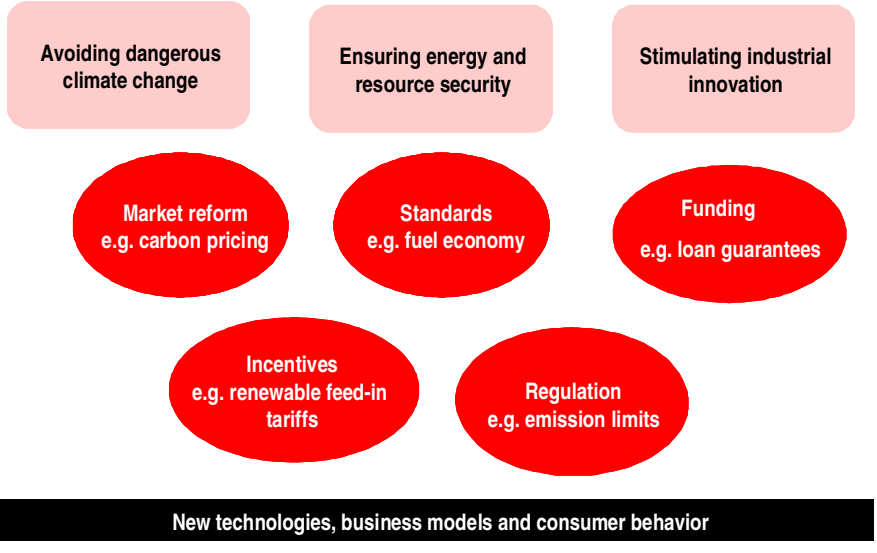
Driving low-carbon growth

- Governments are switching focus from just achieving climate security to stimulating low-carbon growth
- The mix of drivers differs across the world – with industrial policy foremost in Asia, climate change in Europe, and employment in the USA
- In this report, we focus on the low-carbon energy market; the overall 'climate economy' looks set to be considerably larger, stretching into natural resources and finance

Many reasons

Climate change is widely known as the world's "greatest market failure" in the words of Lord Stern, author of *The Economics of Climate Change*. But it is not just an environmental problem requiring traditional environmental policy solutions to the threats posed by rising greenhouse (GHG) emissions. First of all, the scale of the problem requires an "energy technology revolution" in the view of the International Energy Agency; traditional

Drivers of low-carbon growth: many reasons, many tools



Source: HSBC

Copenhagen Accord commitments

Countries	Climate commitment	Remarks
Annex I countries		
Australia	5% below 2000 levels by 2020	15% and 25% (from 2000 level) conditional on action by other developed and advanced developing countries
Canada	17% below 2005 in 2020	Lower than its earlier target of 20% below 2006 by 2020
Croatia	5% below 1990 levels by 2020	This is a temporary target and the target will be replaced in line with the EU mitigation effort upon the accession of Croatia to the EU
EU	20% below 1990 levels by 2020, rising to 30% with a global agreement	Countries including Cyprus, Italy, Malta and Poland have opposed moving to 30% unilaterally
Japan	25% below 1990 levels by 2020	Contingent on establishment of a fair and effective international framework
Kazakhstan	15% below 1992 levels by 2020	
New Zealand	10-20% below 1990 levels by 2020	Final number depends on the strength of international commitment
Norway	30-40% below 1990 levels by 2020	
Russia	15-25% below 1990 levels by 2020	
United States	17% below 2005 in 2020	Conditional on submissions by other Annex I and advanced non-Annex I countries, as well as agreement in Congress
Non-Annex I countries		
Brazil	36% to 39% below BAU in 2020	Brazil's commitment has been signed into law (National Climate Change Policy - PNMC)
Costa Rica	Long-term economy wide transformational effort to enable carbon-neutrality	Mitigation actions are conditional on financial assistance, technology transfer and capacity development
China	Cut emission intensity by 40% to 45% from 2005 to 2020	Domestically binding, but is being characterised by China as a "voluntary action"
India	Reduce emission intensity from 2005 to 2020 by 20% to 25%	Modelling from the Ministry of Environment & Forests indicates that CO2 intensity could fall 24% to 59% between 2005 and 2030 even in absence of new mitigation policies
Indonesia	Reduce 26% by 2020 below BAU	A 41% cut contingent on international support
Israel	20% below BAU by 2020	
Maldives	Carbon neutral by 2020	The Maldives' submission of its mitigation action is voluntary and unconditional
Marshall Islands	40% reduction of CO2 emissions below 1990 levels by 2020	Subject to the provision of adequate international support
Republic of Moldova	25% reduction from 1990 levels by 2020	To be achieved through implementation of global economic mechanisms
Singapore	7-11% below BAU by 2020	16% cut when a global agreement on climate change is reached
South Africa	Deviation below BAU by 34% by 2020 and by around 42% by 2025	The pledge is conditional on a "fair, ambitious, and effective" international agreement and on international finance, technology and capacity-building.
South Korea	30% below BAU by 2020, which is 4% below 2005	This is a unilateral commitment to reduce emissions

Source: UNFCCC

"end of pipe" pollution control will not be sufficient. But secondly, the need to tackle climate change is fusing with other key policy imperatives to stimulate the momentum for low-carbon economic growth.

As the chart above illustrates, avoiding dangerous climate change is clearly a major driver – particularly in environmentally conscious regions such as the European Union. But climate change remains for many a distant and uncertain threat – notwithstanding this year's record-breaking global temperatures and severe floods and droughts (see *Wheat's Up?,* 10 August 2010). The targets agreed by over 75 countries as part of the Copenhagen Accord were in many cases unprecedented, notably for emerging economies such as Brazil, China, India, Indonesia and South Africa. But these commitments not only remain uncertain, but are also insufficient, with estimates suggesting that they will most likely curb global average temperature increases over pre-industrial levels from a 4-5°C warming pre-Copenhagen to a 3-4°C range – a considerable distance from the aspiration of holding warming to just 2°C.

Achieving energy and resource security is for many countries a more powerful driver as energy demand rises and fossil fuel reserves are depleted. The high and volatile energy prices of 2008 have been a salutary warning for many countries of their growing

vulnerability, prompting efforts (so-far unrealised) to promote 'energy independence' in the USA, for example. Decarbonisation therefore does not just mean reducing emissions, but also reducing reliance on hydrocarbon sources of energy. Energy security is not always aligned with climate security – and can lead to investments in high carbon fuels such as coal and tar sands.

From a low-carbon perspective, energy efficiency and a switch to domestic sources of renewable energy are among the key strategies. According to the IEA's latest *Energy Technology Perspectives* report, a low-carbon economy could deliver USD112trn in fuel savings by 2050 for an upfront capital cost of just USD46trn[2]. Energy efficiency and key renewable technologies (such as wind) are also resilient to other resource threats such as rising water stress, which are posing increasing constraints on conventional thermal power generation.

Linked to energy security in the minds of a growing number of decision-makers is the way in which low-carbon strategies can stimulate industrial innovation. Here, South Korea is in the vanguard with its five-year 'green growth' strategy. This is allocating 2% of the country's GDP not just to reduce greenhouse gas emissions and improving energy security, but also to promote new engines of economic growth, with a target to increase Korea's share of clean tech exports from 2% to 8% of the world total by 2012. As part of this, some governments are also viewing low-carbon growth as a source of employment generation. The search for 'green jobs' was a critical factor in the allocations that a range of governments made to environmental infrastructure in their fiscal stimulus plans in 2008-2009. However, the rapid shift in economic policy from stimulus to austerity this year has dampened some of the enthusiasm for public-spending-fuelled green job creation (see *Carbon default – real or imagined?,* 21 June 2010).

[2] International Energy Agency, *2010 Energy Technology Perspectives*, Paris

Many tools

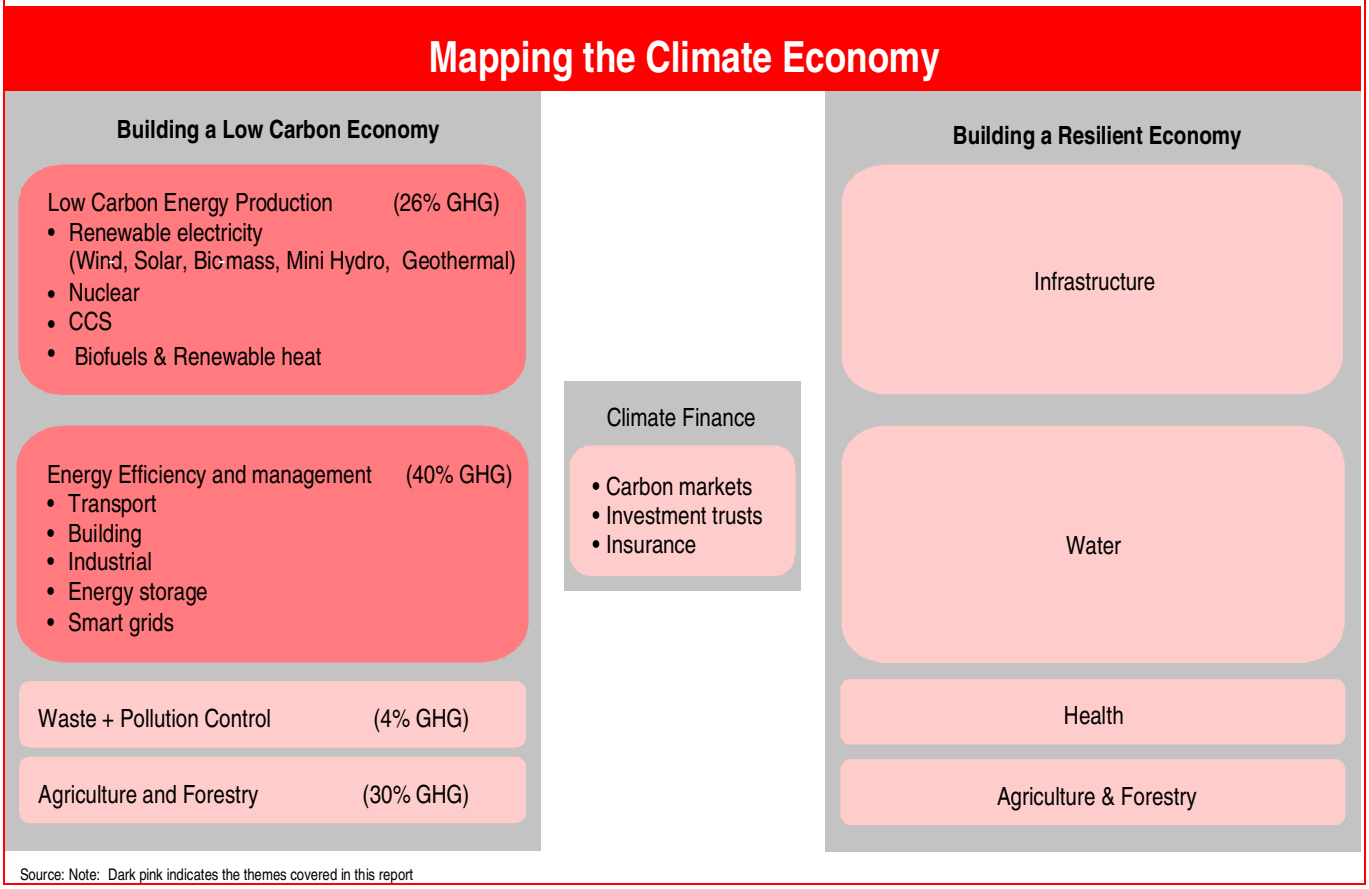
If the need to address climate change itself is only one driver of low-carbon economic growth, the tools that governments are using to engineer the shift are equally diverse.

The market itself cannot deliver low-carbon outcomes due to the economic, policy and institutional failures that fail to reward businesses and consumers for smart behaviour. Market reform is clearly an important element – spurred, for example, by pricing carbon, whether through taxation or emission trading schemes. The carbon market has grown from nothing in 2005 to some USD144bn in 2009, of which USD123bn is accounted for by the EU Emission Trading Scheme. But hopes that Copenhagen would set in train the creation of a truly global carbon market have been dashed for now – with the inability of the US Congress to agree cap and trade legislation during 2010, representing a major setback for the trading market and flows of private sector carbon finance to emerging markets.

The most effective tools to date for driving clean energy investments have been – and will remain – mandates and regulations, for example, those that require renewable electricity supply and raise end-use energy efficiency standards. And in the absence of a carbon price sufficiently high to drive technology substitution, old-fashioned regulation of carbon from industrial facilities and vehicles will be a major tool for change, offering a certainty that volatile carbon prices cannot.

Alongside this is a crucial role for public investment – and not just as a temporary stimulus. Many high carbon technologies are so entrenched that public research and development is crucial to drive down the technology costs of cleaner alternatives. A report prepared for the Major Economies Forum in December 2009 estimated that public R&D needs to increase between three- and six-fold by 2020, a tough call at a time of fiscal retrenchment in key

Mapping the climate economy



Source: Note: Dark pink indicates the themes covered in this report

industrialised economies[3]. Government support has also proved crucial in the deployment of clean technologies, for example, from loan and export guarantee programmes as well as credit facilities from state-owned banks from China through India to Spain and the USA. This support helps to improve projected rates of return, thereby making these investments viable and competitive with conventional technologies.

In the end, however, it will be private capital from corporations and consumers that will finance the climate economy – with governments setting the framework and providing capital at the margin.

[3] Major Economies Forum, *Technology Action Plan*, December 2009

The new climate economy

As a result, we see a new 'climate economy' emerging, illustrated in the chart above.

What's included in this report

In this report, we focus our attention on the most material aspects of this economy for investors today – the opportunities presented by low-carbon energy production and consumption. Taken together, energy supply and demand are responsible for about two-thirds of global GHGs – and we model the markets for low-carbon energy production as well as energy efficiency and energy management through to 2020.

Here, we draw on the methodological framework developed by our Quantitative Research team for the HSBC Climate Change Index. This has identified investable themes that are accessible to investors on global equity markets. The key investment themes

we have modelled in this report are: low-carbon energy production and energy efficiency and energy management.

Low-carbon energy production

The model includes both the capital investment required and resulting revenues from sales of low-carbon sources of electricity (notably renewables and nuclear), as well as renewable heat and fuels. We have also added carbon capture and storage (CCS) to our modelling exercise. Although it does not represent an investable theme at present – and therefore is not part of the HSBC Climate Change Index – significant policy backing could make it so by 2020.

Energy efficiency and energy management

This model includes the goods and services required to improve the use of energy in buildings, transport and industry, as well as for energy storage (including fuel cells). We have also separately modelled the market for 'smart grids'.

What's excluded from this report

As our map of the Climate Economy indicates, there are a number of other areas that could expand in the coming years. We have excluded the following as they do not help carbon abatement.

- Large Hydro: Hydro-electricity is currently the dominant form of renewable energy. However, it has a carbon footprint, and the UN Framework Convention on Climate Change (UNFCCC) has excluded large hydro from the Clean Development Mechanism.
- Biofuels: Different biofuel feedstocks and production processes have varying carbon footprints. As a result, we do not include biofuels based on corn ethanol or palm oil in our estimates for the low-carbon economy as there is insufficient carbon reduction benefit. Please see page 28 for further information.

We have also not estimated the market growth for a range of potential opportunities as they have fundamentally different investment drivers from the energy system. On the low-carbon side of the equation, this includes waste as well as other non-CO2 GHGs, along with options resulting from reducing emissions in agriculture and forestry:

We have also not modelled market growth for the goods and services needed to make infrastructure, water, health and food production resilient to the impacts of climate change. Currently, the regulatory framework is insufficiently developed to provide credible estimates: please see our report *Too Close for Comfort*, December 2009, for our assessment of climate vulnerability.

Finally, finance will be a major enabler of the climate economy. The HSBC Climate Change Index framework currently includes companies involved in carbon markets and investment trusts; we also believe that insurance could become an important financial solution in the years ahead. However, because of the regulatory uncertainty in this area, we have excluded estimates of climate-related finance from our models.

The scope of our analysis means that our market estimates cannot easily be compared with the revenues associated with the HSBC Climate Change Index for two main reasons: first, we have included a narrower selection of themes; and second, we are modelling full market revenues rather than those associated with companies listed on global equity markets. In 2009, the HSBC Quantitative Research team estimated 2008 global climate revenues generated by listed companies at USD530bn, and projected that these could grow to USD2trn by 2020 (see *Climate Change – September annual index review*, September 2009).

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Four roads to 2020

- We have constructed four scenarios based on differing assumptions about the delivery of climate and clean energy policy
- These scenarios a range for the low-carbon energy market in 2020 from USD1.5trn to USD2.7trn
- Our Conviction scenario yields an annual market size of USD2.2trn in 2020, with energy efficiency accounting for 53%, up from 43% of the total in 2009

Setting the range

To estimate what we believe is the likely size of the low-carbon energy market in 2020, we have constructed four distinct scenarios. Our estimates of market size include both capital investment in low-carbon infrastructure and equipment as well as sales of low-carbon 'commodities' (such as renewable electricity, fuel and heat).

We believe that a scenario approach is important given the high degree of uncertainty over both how ambitious the policies of governments around the world will be – as well as the actual implementation of agreed policies. The headline results are laid out in the table below. Amidst the multitude of policy factors, we believe that there are two critical determinants of future growth rates, one on the supply side and one on the demand side.

The factor on the supply side is the interaction between renewable energy deployment and levels of energy demand flowing from the introduction of tougher energy efficiency norms. Other things being equal, the greater the success in reducing the demand for electricity, the lower the resulting market for renewables. In addition, in some countries, such as the USA, energy efficiency offsets can be used to meet renewable energy targets. In essence, energy efficiency can cannibalise renewable power opportunities. The result is an estimated range for the renewable electricity market in 2020 from USD361bn in our 'bearish' Backlash scenario to USD679bn in our 'bullish' Green Growth scenario.

On the demand side, the most significant swing factor is the potential growth of the low-carbon

Four roads to 2020: estimated market size in different scenarios in 2020e (USDbn)

	Low-carbon energy	Energy efficiency		Total	CAGR (2009-2020e)
		Transport efficiency	Other efficiency themes		
Backlash scenario	774	312	411	1,496	6.6%
Copenhagen scenario	1,025	415	588	2,028	9.6%
Green growth scenario	1,297	731	679	2,707	12.5%
Conviction scenario	1,043	677	517	2,238	10.6%

Source: HSBC estimates

vehicle market. We believe that the continued tightening of fuel efficiency regulations will be joined in the coming decade by the accelerating deployment of hybrid, plug-in and full electric vehicles. With any fundamental technological change, the rate at which this takes place is dependent on a range of variables, not least policy incentives, infrastructure capacity and the speed of innovation (notably over vehicle batteries). In the case of transport efficiency, this results in a potential market size ranging from just USD312bn in the Backlash scenario to USD731bn in the Green Growth scenario, making it by far the biggest individual sub-theme.

Mapping the scenarios

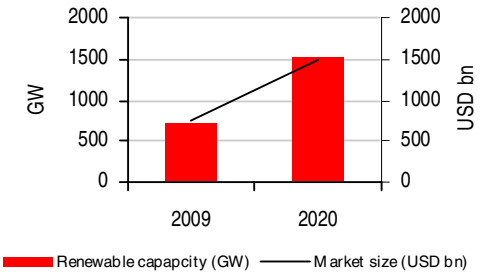
We have drawn up our four scenarios based on distinctive variations in low-carbon outcomes focusing in particular on the world's three largest markets: the EU, the USA and China.

Backlash: USD1.5trn by 2020

This scenario is driven by governments pulling back from existing commitments to low-carbon economic growth. Rising caution about the science of climate change acts in key countries to halt the passage of crucial new legislation. In the USA, for example, the status quo endures through the next decade and no federal cap and trade system is introduced. Modest improvements in renewable energy deployment are achieved, mostly in line with existing provisions at the state-level. But rising concerns about the size of the federal deficit constrain the government's ability to provide additional fiscal incentives, either for clean energy supply or improved energy efficiency.

In this scenario, the EU fails to meet its target to improve energy efficiency by 20% by 2020 due to the harsh realities of fragmented implementation. Progress is made on renewable energy, but the 20% target for primary energy supply is missed. In China, the great expectations of low-carbon economic growth at the beginning of the decade are ultimately unrealised. Energy efficiency lags its target and renewable deployment meets the current (low) target.

Backlash: low-carbon market size & renewable capacity



Source: HSBC estimates

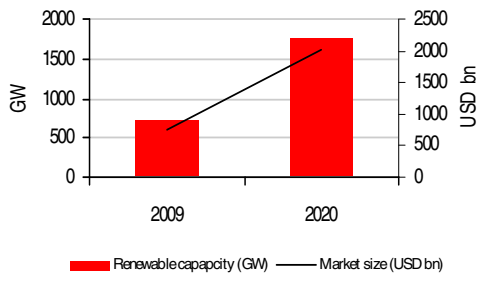
Overall, the absence of a global framework for climate change both cuts ambition at the national level and removes the financial incentives that current mechanisms such as the Clean Development Mechanism provide for enhanced action in emerging markets.

In this, our most 'bearish' scenario, the CAGR for the global market is 6.6% from 2009 through to 2020, producing a market worth USD1.5trn.

Copenhagen: USD2trn by 2020

Our Copenhagen scenario assumes that governments implement the commitments made in the run-up to the Copenhagen climate summit in 2009 – but introduce no additional efforts.

Copenhagen: low-carbon market size & renewable capacity



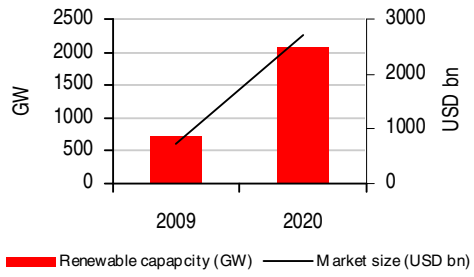
Source: HSBC estimates

For the EU, this would mean hitting its 20:20:20 target – a 20% reduction in GHGs, supplying 20% of primary energy from renewables and a 20% improvement in energy efficiency. In the USA, we assume the realisation of the Obama Administration's target to cut GHGs to 17% below 2005 levels is achieved through federal legislation as set out in the American Clean Energy and Security Act (Waxman-Markey) which was passed by the House of Representatives in June 2009. For the US market, the main driver of low energy carbon growth would be the existing stimulus measures and the introduction of a federal Renewable Portfolio Standard, with energy efficiency offsets. We believe that cap and trade would only become a significant driver of low-carbon opportunities in the USA in the decade after 2020. In this scenario, China would achieve its Copenhagen target of reducing carbon intensity by 40-45% reduction from 2005 levels and surpass its current targets for clean energy deployment. Other key countries also meet the targets made in 2009. We estimate that the global market is one-third larger than under the Backlash scenario at USD2trn.

Green Growth: USD2.7trn by 2020

The Green Growth scenario represents the 'best case' for the growth of the low-carbon energy economy through to 2020. It depicts how the global market could develop if governments move beyond existing commitments to the upper end of climate ambitions as viewed from today's standpoint. It therefore does not portray transformational breakthroughs. But it does assume full compliance with these upgraded targets.

Green Growth: low-carbon market size & renewable capacity



Source: HSBC estimates

In the case of the EU, this would mean moving to a 30% emission reduction target, delivered through a proportionate increase in both renewable electricity and energy efficiency. The European Commission's own analysis suggests that the enhanced target can be achieved by increasing energy efficiency and renewable energy generation, primarily through additional solar and wind power generators[4]. Turning to the USA, Green Growth would mean exceeding both the energy efficiency and renewable targets proposed in the Waxman Markey bill. As for China, we assume that it delivers carbon intensity improvements in excess of the current 40-45% target and achieves a massive 465GW in renewable energy capacity. In this scenario, the deployment of low-carbon electric and plug-in electric vehicles is particularly aggressive, with revenues almost two and a half times those in the Copenhagen scenario.

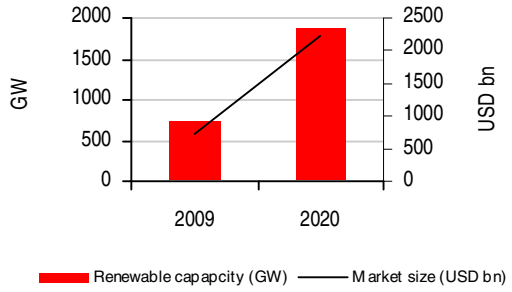
Overall, Green Growth results in a global low-carbon energy market of USD2.7trn. This is more than 30% larger than the Copenhagen scenario.

[4] European Commission, *Unlocking Europe's potential in clean innovation and growth - Analysis of options to move beyond 20%*, 2010

Conviction: USD2.2trn in 2020

Our Conviction case assumes that that none of these three scenarios will come to pass. We are generally more pessimistic than the Green Growth scenario, not as bearish as the Backlash scenario and believe that in certain countries and themes, the world will do better than suggested by the Copenhagen scenario.

Conviction scenario: low-carbon market size & renewable capacity



Source: HSBC estimates

In the USA, we believe that federal clean energy incentives will be introduced – but more akin to this year's Practical Energy and Climate Plan Act (Lugar) than last year's Waxman-Markey. In this scenario, we are not expecting an economy-wide cap and trade system to be introduced this decade; a utility-only cap is more plausible. In the EU, our Conviction assumption is that the Union will retain its 20% GHG target and, in spite of many doubters, will hit its renewable targets. But we believe that the EU will miss its energy efficiency improvement targets; recent EU documents suggest delivery in the range of 11-13%.[5] China, we believe, will surpass its current renewable capacity target by over 40%, while achieving efficiency goals in line with the Copenhagen scenario.

In the transport sector, our estimates for the market size of low-carbon emission vehicles are drawn from our Green Growth scenario. As a consequence, our Conviction scenario yields a total market size of USD2.2trn by 2020, a CAGR of 10.6%.

In the next section, we lay out the methodology we have deployed to reach these conclusions.

[5] See Communications from the EU Commission *Energy efficiency: delivering the 20% target* dated November 2008 and *Seven measure for 2 million new EU jobs* date October 2009.

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Our approach

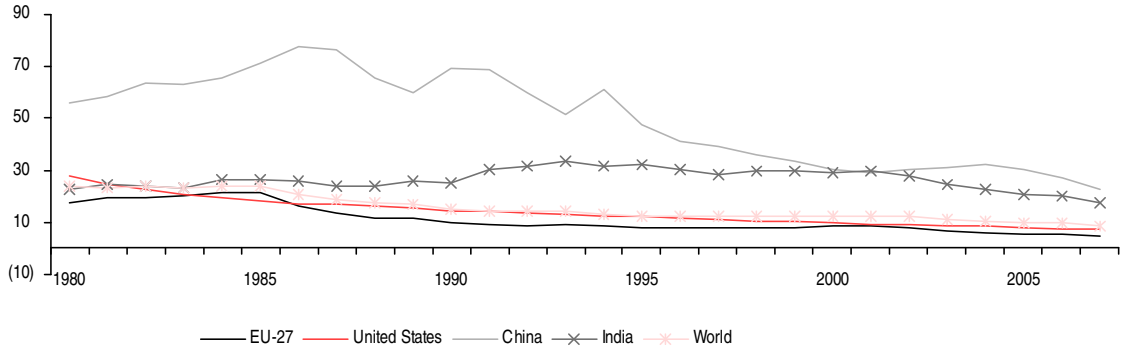
- We combine top-down models of the energy matrix with bottom-up projections of demand for energy saving products
- We model in detail the implications of clean energy policies for renewable energy production; other power sources such as nuclear and CCS are relatively inflexible over the next decade
- We draw on the analysis of the HSBC transport team to forecast low-carbon vehicle growth, and project growth rates for building and industrial efficiency

Efficiency up, carbon down

Delivering low-carbon economic growth involves two inter-related steps: first, taking of energy out of the economy (energy efficiency) and second, taking carbon out of energy production (carbon productivity).

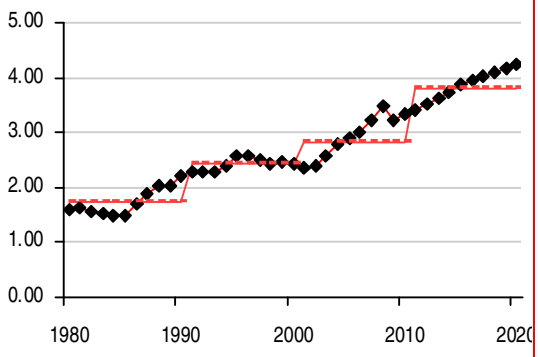
Historically, the global economy has tended to become more energy- and carbon-efficient as new technologies enter the system. Between 1980 and 2007, the global economy became 65% less energy intensive per unit of global income. Looking at electricity demand, we can see that in 1990 USD2.2bn in GDP was produced for every 1 billion kilowatt hours; by 2006, this had risen to USD3bn implying a CAGR of 2%. Between 2006 and 2020, we expect this will increase at a faster rate (CAGR 2.5%) to reach USD4.25bn per billion kilowatt hours.

Making the economy more energy efficient: global trends in energy intensity billion BTU per USD1,000 of GDP



Note: Current GDP in USD; Energy consumption in Quadrillion Btu
Source: IMF, EIA, HSBC

Improving electrical efficiency: (GDP in USDbn, electricity consumption in billion KwH)



Note: Red line indicates the average for the decades
Source: IMF, EIA

A similar trend can be observed for carbon dioxide, with average global intensity falling from 871 tonnes to 469 tonnes of CO2 for each million dollars (at purchasing power parity) between 1990 and 2007.

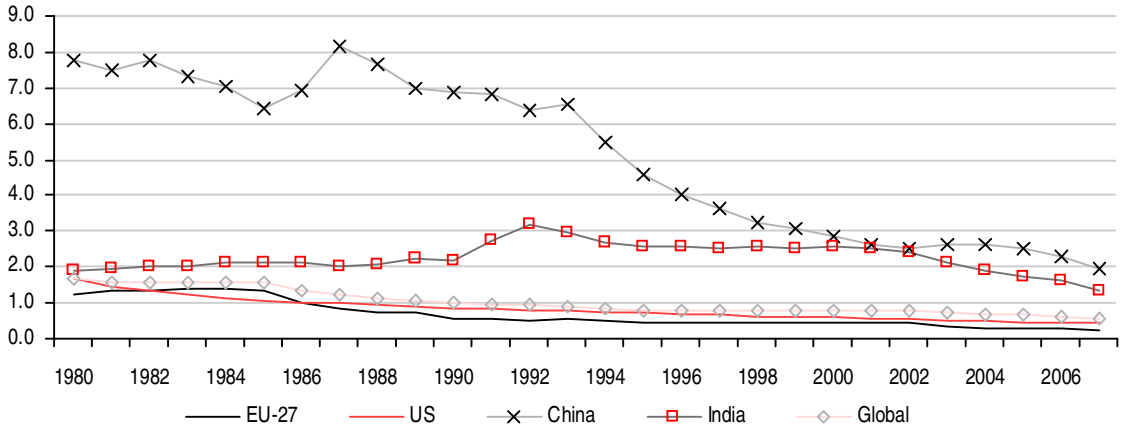
Good as these trends may seem on the surface they have been wholly insufficient to stop the rising trend in global GHGs, let alone to drive them down to safe levels. Global GHGs need to fall by between 50% and 85% by 2050, according to the Intergovernmental Panel on Climate Change to have a good chance of hitting the 2°C target agreed by world leaders in Copenhagen. Our analysis of the commitments made under the Copenhagen Accord suggest that a 'business as usual' pathway would take the world to around 56Gtonne of CO2e by 2020; current government pledges could reduce this to between 50Gtonne and 51Gtonne CO2e; to be on track for climate security, emissions need to be brought down to just 44GtonneCO2e. Essentially, Copenhagen got us half-way.

Modelling the supply side

In this report, we focus on what could be achieved given existing commitments – not what might happen if we got onto a truly low-carbon track. To do this, we have created two coupled models to derive market forecasts for our suite of climate investment themes.

First, on the supply side, we are interested in forecasting the market size for what we term low-carbon energy production – essentially clean power (renewables, nuclear and CCS) along with selected renewable fuels and heat; we do not model in detail the corresponding markets for high carbon power, notably coal, oil and gas. Electricity lies at the heart of a low-carbon energy system, and for this reason we have constructed a power model, which captures our views of how clean power targets (particularly the expansion of renewables, nuclear and CCS) intersect with

Taking carbon out of energy: global trends in emissions intensity (tonne of CO2 per USD1,000 of GDP)



Source: CDAIC, World Bank, HSBC

trends in energy consumption, both endogenous and enforced through efficiency programmes. Looking out over the next decade, our view is that the greatest variation lies in the prospects for renewable power, which remain subject to the largest degree of regulatory uncertainty; the range of alternative futures for nuclear power, by contrast, are more limited because of the long-lead times between planning and commencement of generation.

Using our in-depth power market models, we therefore focus our attention on flexing demand for renewable electricity using differing assumptions for the ambitions of government policy and policy implementation in our four scenarios. Based on our assumptions of policy ambition and implementation, we have modelled energy efficiency improvements for our four scenarios – set out in the table below. In addition, our forecasts factor any growth in electricity consumption from growth in electric vehicles.

Assumptions on energy efficiency improvement's under the four scenarios over 2010-2020e

	Backlash	Copenhagen	Green Growth	Conviction
China	10%	18%	28%	18%
EU	10%	20%	25%	10%
US	4%	8%	12%	10%

Source: HSBC estimates

Based on these efficiency assumptions, our four scenarios therefore have different electricity generation CAGRs, which are detailed in the table below.

CAGR of global electricity generation under four scenarios (2009e-20e)

Scenario	Electricity generation (CAGR)
Backlash	2.8%
Copenhagen	2.5%
Green growth	2.0%
Conviction	2.6%

Source: HSBC estimates

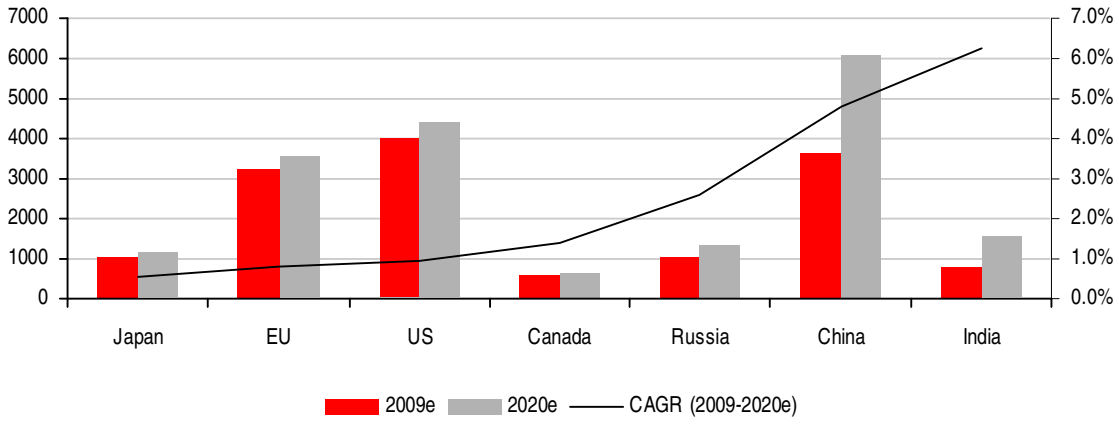
Our Conviction CAGR of 2.6% compares with an historical CAGR for global electricity consumption from 2000-2009 (inclusive) of 3.2%. The implications for total electricity demand in key economies are illustrated in the chart on the next page.

Modelling the demand side

On the demand side, we are interested in projecting the related growth in more energy efficient goods and services, whether in buildings, industry or transport, as well as in related energy storage and distribution activities. To do this, we have estimated the historical market size and growth of these businesses based on the revenues of major listed corporations around the world, 'stress-testing' our estimates with reference to other market surveys.

Looking at global trends in energy intensity between 2000 and 2007, we have identified an improvement CAGR of 3.9%, based on current GDP in USD and energy in BTUs; over the same period, we estimate that companies selling building and industrial efficiency products experienced average revenue growth of 5.4%. Based on our views on the relative improvement in overall energy intensity as well as specific electricity efficiency in key markets – consistent with our clean energy power model above – we have then amended our projections of future growth rates accordingly.

Estimated electricity generation (bn KWh) and generation CAGRs for 2009e-20e in the Conviction scenario



Source: HSBC estimates

Our trend analysis of key countries (EU, US and China) also provides a comparison against our assumptions for these individual countries over the forecast period.

- At least two draft communications from the European Commission point to Europe missing its 20% efficiency target[6], and only achieving efficiency improvements of 11-13%.We also believe the 20% target would be a challenge given that most of the energy efficiency measures are to be implemented at the consumer end and involve modifications to existing infrastructure. Our Conviction scenario assumption of around 1% pa electricity (and energy) efficiency improvement is close to the historical trend[7].
- Between 1997 and 2007, the USA improved its energy intensity by 2.1% pa, based on GDP in 2005 USD at market exchange rates, with energy in BTU. This is close to the EU's own track record of a 1.9% energy intensity improvement over the same period. For the next decade, we are assuming around 1% pa efficiency improvement for the USA, in line with other recent assessments.[8]
- Between 1997 and 2007, China improved energy intensity by 1.9% pa. Between 2009 and 2020, we assume a considerable improvement of 60%, rising to an improvement rate of 3% pa. This is based on our assessment of China's ability to meet its 40-45% carbon intensity reduction target. For China, we assume an electricity efficiency rate of 1.6% pa – some 60% higher than EU and the USA.

As a result of these assumptions, in our Conviction scenario, we estimate revenue CAGRs for the building efficiency and industrial efficiency segments of 10% and 6%, respectively, between 2009 and 2020. This results in a combined CAGR of 8.2%.

For the Backlash and Green Growth scenarios, our assumed growth rates for the industrial and building efficiency industry are 25% below and above the Conviction scenario, respectively,

6 Communication's from EU Commission 'Energy efficiency: delivering the 20% target' dated November 2008 and communication'7 measure for 2 million new EU jobs' in October 2009

7 http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/08/699&format=HTML

8 *Energy Efficiency in the American Clean Energy and Security Act of 2009: Impacts of Current Provisions and Opportunities to Enhance the Legislation*

implying combined CAGRs of 6.2% and 10.2%. For the Copenhagen scenario, we assume a growth rate of +12.5% above the Conviction scenario, implying a CAGR of +9.2%.

For our assumptions for transport efficiency – and in particular low-carbon emission vehicles – our starting point is the estimates from HSBC's Global Autos team. For low-carbon vehicles, our Green Growth scenario – which is also our Conviction scenario for this segment – assumes global sales of 8.65m electric vehicles (EV) and 9.23m plug-in hybrid electric vehicles (PHEV) in 2020. In addition, we assume that average prices for PHEV gasoline and diesel vehicles in 2020 will be 5-10% lower than average EV prices (USD27,500). Our Copenhagen scenario is drawn from the IEA's *Energy Technology Perspectives 2010*, which projected only 5m EV sales and 2.5m plug-in hybrid sales worldwide by 2020; the IEA's forecasts are based on existing policy support. Our Backlash scenario assumes a 20% shortfall from the Copenhagen scenario.

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Supplying low-carbon energy

- We estimate that the market for low-carbon energy supply will grow from USD422bn in 2009 to between USD774bn and USD1,297bn by 2020; our Conviction scenario is just over USD1trn
- We forecast sales of renewable power technologies and electricity will grow to USD544bn, with the next highest revenues coming from nuclear energy at USD368bn
- Our forecasts for renewable energy deployment by 2020 lie between those of the IEA and EREC

Powering the green economy

The low-carbon energy market consists of goods and services that supply power, heat and fuel with smaller carbon footprints than conventional fossil sources.

Our estimates of the market size comprise both forecasts of sales of technology along with revenues from low-carbon energy commodities such as bio-fuels and renewable electricity. Based on our four scenarios, we estimate that in 2020, the size of the low-carbon energy market could range between USD774bn in our Backlash scenario to USD1,297bn under Green Growth conditions. The widest variation in potential markets is for renewable electricity - from USD361bn to USD679bn in the four scenarios – highlighting the importance of regulatory uncertainty. In contrast, the potential range for nuclear power is just USD350bn-389bn. The main new entrant to the market is Carbon Capture and Storage, which grows from minimal revenues today to some USD4bn-11bn by 2020.

Key assumptions

Three sets of policies influence the size and growth rates of low-carbon energy supply, those related to climate and those related to clean energy and energy efficiency.

- Climate: Taking the EU as one bloc, 29 countries now have specific targets to reduce GHGs. We assume different carbon constraints in key regions. In the EU, for example, we assume a carbon price of

Low-carbon energy production: estimates for 2020 (USDbn)

	Backlash	Copenhagen	Green Growth	Conviction
Total market size	774	1,025	1,297	1,043
Capital investments	200	313	487	350
Electricity sales	538	588	656	611
Bio-fuel sales	36	124	155	83

Source: HSBC estimates

Renewable electricity and energy efficiency assumptions in the USA, the EU and China for 2020e

	US		EU		China	
	REN	EE	REN	EE	REN	EE
Backlash	10%	4%	20%	10%	7%	10%
Copenhagen	13%	8%	23%	20%	10 %	18%
Green growth	15%	12%	29%	25%	18%	28%
Conviction	13%	10%	23%	10%	13%	18%

Note: REN numbers do not include large hydro; For the US our REN numbers in Copenhagen scenario are based on Waxman Markey and our Conviction scenario is based on Lugar bill. We estimate that the percentage of renewable generation in 2009 was 4% for the US, 7% for the EU and 5% for China.
Source: HSBC estimates

EUR30/tonne of carbon; in the USA, we are not assuming that direct climate policies have much impact on opportunities for low-carbon power – although they will constrain coal and gas. For China, we believe that its economy-wide carbon intensity targets will be delivered primarily through clean energy and energy efficiency targets

- Clean Energy: Over 45 countries now have specific policies to promote renewable energy, with targets expressed both as a percentage of total energy or power, as well as in absolute terms such as installed capacity or volume of sales. Key countries such as China are expressing their renewable targets as part of a wider clean energy mandate. Where there are no renewable targets for a country, we extrapolate the levels of renewable energy from the emission reduction target.
- Energy Efficiency: Taking the EU as a single bloc, over 20 countries now have energy efficiency goals and policies in place. These range from economy-wide targets as in the EU and China to product specific objectives from automobiles through to appliances.

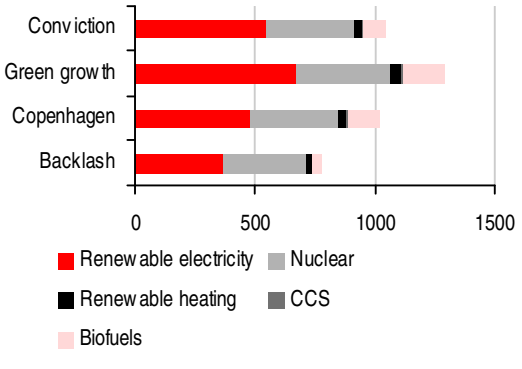
Bringing these three policy drivers together, we have estimated different penetration rates for renewable electricity and different success rates for energy efficiency in our three key markets of the USA, the EU and China: these are set out in the table above. This shows, for example, that we believe that the renewable electricity could range between 10% and 15% of power generation in the USA, between 20% and 29% in the EU and between 7% and 18% in China. Our model also includes assumptions for other countries such as Brazil, India and Japan.

Scenario results

In our Conviction scenario, the proportion of low-carbon power generation in the global mix (including renewable and nuclear technologies but excluding large hydro) increases from 18% in 2009 to 25% in 2020; this is largely the result of the renewables growing from c4% to c11% of the total. Overall, we expect total global electricity generation to increase by 33% by 2020e.

Based on this, we estimate an annual market size in 2020 of just over USD1.04trn – with renewable electricity at USD544bn, nuclear electricity at USD368bn and CCS at USD7bn; renewable heating is worth USD31bn and bio-fuels USD93bn. Our estimates include annual capital

Low-carbon energy production: estimated market size in 2020e (USDbn)



Source: HSBC estimates

investment of USD350bn (renewable electricity USD251bn, nuclear USD50bn, renewable and solar water heating USD31bn, CCS USD7bn and bio-fuel USD11bn), electricity sales of USD611bn from low-carbon electricity and bio-fuel sales of USD83bn.

Comparison of renewable capacity installations for 2020e (GW)

Technology	HSBC	IEA 450 scenario	EREC Energy revolution	EREC Advanced energy revolution	NEF peak case
Hydro	1,169	1,299	1,206	1,212	
Wind	754	559	878	1,140	570
Solar	302	137	440	664	262
Biomass	124	130	212	214	
Geothermal	21	20	49	69	
Nuclear	536	505			
Total	2,898	2,650	2,813	3,359	

Source: HSBC estimates; IEA World Energy Outllok2009; NEF - Global Futures Interim Report Summit 2009; European Renewable Energy Council & Greenpeace, Energy Revolution: A Sustainable World Energy Outlook, 2010

Renewable electricity: USD544bn in 2020

In our Conviction scenario, we estimate that an additional 1000GW of renewable capacity will come on stream between 2010 and 2020; this implies an average annual installation of c91GW, with an overall CAGR of 13%. We estimate that over 2010-20, c78% of the new capacity addition will be in wind and solar technologies. We forecast new capacity addition in these technologies at a CAGR of c5.5% and 16%, respectively. By 2020, we expect installed wind and solar capacity to reach around 750GW and 300GW respectively.

We have not included large-scale hydro-electric generation in our estimates due to concerns over its carbon intensity: please see page 58 for further details.

How do our forecasts compare with others?

Renewable electricity (REN) targets and proposals for 2020

Country	Targets/proposals
Brazil	Under stage II of PROINFA, Brazil is targeting a 10% share of electricity produced by biomass, small hydro and biomass by 2022.
China	Currently China is targeting 150GW wind, 20GW solar, 30GW biomass, 75GW Mini Hydro, 10 GW other renewable electricity, giving a total renewable capacity of 285 GW by 2020.
EU	The EU's target to meet 20% of primary energy demand from renewable sources implies 35% renewable electricity; this number includes large hydro. If the EU moved to a 30% emission reduction target, this could be delivered half through additional renewables and half from energy efficiency.
India	The 2008 National Action Plan on Climate Change (NAPCC) targets 5% renewable energy in 2009/2010 and increasing y-o-y by 1%.
Japan	We estimate that the target to reduce emissions by 25% from 1990 levels by 2020 implies 8% of electricity demand from renewable sources.
US	The Waxman–Markey bill proposes 20% electricity from REN, with an option to meet 8% of the requirement from energy efficiency measures. Current state targets amount work to 10%.

Source: HSBC estimates

We have compared our renewable energy forecasts with those provided by the IEA in its 450ppm scenario, two energy scenarios from European Renewable Energy Council (EREC) and Bloomberg New Energy Finance (NEF) in its Peak case. It is worth noting that the EREC scenarios assume the reduction of global GHGs to just 10 Gtonne a year by 2050 and the phase out of nuclear power; the Advanced scenario assumes a halving of the lifetime of coal-fired power from 40 to 20 years. For both wind and solar, our Conviction estimates are larger than those of the IEA and NEF, but less than EREC's two scenarios

Wind: USD285bn in 2020

In our Conviction scenario, we estimate that in 2020 the market size of the wind industry would be USD285bn. This includes capital investment of USD120bn and electricity sales of USD165bn. Our four scenarios provide a market size range of USD184bn-USD348bn.

For more details on our views on the wind sector, please see *Becalmed? Is it all over for the global wind markets?* August 2010.

We estimate that by 2020, total wind installations would reach around 750GW from an estimated 158GW at the end of 2009. This lies in a range of 535GW (Backlash scenario) to 862GW (Green growth scenario). We expect over 80% of the estimated 750GW would be in three key markets – the EU, the USA and China, with China in the lead.

In our Conviction scenario, we estimate new global wind installations to increase at a CAGR of c5.5% over 2009-20 against a forecast of around 12% over 2009-19, by BTM Consult. Our estimates imply an average annual installation rate of 54GW during the decade. For the USA and EU markets, we estimate an annual installation rate of c10GW and c15GW, respectively. We expect the growth rate of new installations in China – the largest wind market based on 2009 installations – to decline after three years of triple-digit growth (2006-09). Over 2009-20, we estimate new installations to realise a CAGR of c6%, reaching a cumulative installed capacity of c240GW by 2020.

Off-shore and on-shore wind

Of the total estimated 750GW of wind installations by 2020, we estimate total off-shore capacity at c68GW, with the remainder being on-shore, implying over 90% of the installed wind capacity in 2020 will be on-shore wind. Over 2009-2020, we estimate new off-shore installations to have a CAGR of 29%.

What do others say?

Our estimate of an installed base of global wind capacity at around 750GW by 2020 is higher than the 560GW in the IEA's 450ppm scenario and 570GW in the NEF Peak Case scenario. But we are lower than BTM Consult ApS estimate of 966GW by 2019 and the two EREC estimates of 878GW in its Energy Revolution scenario and 1140GW in its Advanced scenario[9].

Wind: estimated market size in 2020 (USDbn)

	Capital investment	Electricity sales	Market size
Backlash	65	119	184
Copenhagen	86	145	231
Green growth	160	188	348
Conviction	120	165	285

Source: HSBC estimates

Country	Wind targets and incentives
Brazil	Feed-in tariffs are about USD86.3- USD97.8/MWh for wind; USD44.9/MWh for bagasse; USD48.5/MWh from wood; and USD56/MWh for mini-hydro
China	CNY 510-610/MWh. Tariffs set on regional basis
France	Constant tariff of EUR83/MWh for the first 10 years of operation after which tariff depends on the output and location
Germany	Onshore tariff: EUR8.19cents/kWh for 5 years and EUR5.15 cents/kWh thereafter; Off-shore tariff: EUR9.10cents/kWh, with the basic tariff at EUR6.19cents/kWh for 20 years.
India	Generation based incentives of USD0.01 per KWh of electricity fed into the grid from wind projects
Italy	Italy market has forced down the pool plus REC price to EUR 130-160/MWh from EUR 180/MWh. One of the highest tariffs in Europe.
Spain	EUR65.34-78.18 /MWh
UK	Incentives: Onshore wind at 1 ROC/MWh; Offshore wind and biomass at 1.5 ROC/MWh; Wave, tidal, energy crops, solar at 2 ROC/MWh
US	PTC: Income tax credit of USD1.9cents/kWh for electricity produced from qualified wind facilities for the first 10 years

Source: HSBC

Solar: USD116bn in 2020

In our Conviction scenario, we estimate the 2020 market size of the solar industry at around USD116bn, with a CAGR of 9% 2009-20. This includes capital investment of USD81bn and electricity sales from solar portfolio of generation companies of USD35bn. This lies within a range of USD78bn to USD150bn.

[9] BTM, *International Wind Energy Development: World Market Update*, March 2010

Solar targets and incentives in selected countries

Country	Solar FIT targets
Australia	AUD0.44/kWh for <10kVA for single phase power; <30kVA for three phase power PV systems valid till 2028
China	Expected to soon issue a CNY1.15/KWh National Solar Tariff; cash grant of RMB20 to solar PV installations, preferably BIPV; Golden Sun: 50% subsidy of investment costs for more than 500MW of solar power capacity through 2011
France	EUR314-580/MWh
Germany	EUR319.4-430.1/MWh; Tariff cuts already made.
India	Up to INR12/kWh for >1MWp for PV system Up to INR10/kWh for >1MWp for STEG system
Italy	Italy's FIT has ranged between USD0.53 and USD0.72 in 2009, depending on the kind of installation and is applicable for 20 years.
Japan	Subsidy of JPY70,000 for 1kW for residential solar generation installation
South Korea	0.42 EUR/kWh guaranteed and constant for 15 years
Spain	0.34 EUR/kWh guaranteed for 25 years for <=20kW roof mounted PV systems (0.32 EUR/kWh for >20kW)
US	30% capital subsidy subject to max of USD2000 Accelerated depreciation up to 50% USD1.5/kWh (1993 dollars) renewable energy production incentive

Source: HSBC

Solar: estimated market size in 2020 under four scenarios (USDbn)

	Capital investment	Electricity sales	Market size
Backlash	54	25	78
Copenhagen	75	30	105
Green growth	122	39	161
Conviction	80	35	115

Source: HSBC estimates

We estimate total solar installations to reach 300GW by 2020, up from an estimated 24GW at the end of 2009. This lies within a range of 210GW to 350GW under our four scenarios. Of the total installed capacity, we expect over 80% of installations in three key markets – the EU, the USA and China. The other two key markets are Japan and India, where we estimate around 42GW (15% of total) installations.

New solar installation: CAGR of 16% 2009-20e

In our Conviction scenario, we estimate new solar installations to increase at a CAGR of 16% over 2009-20 and reach an annual installation rate of 40GW by 2020. For the US and EU, we estimate new installations to register a CAGR of 24% and 9%, respectively, while for China, we estimate new installations to grow at a CAGR of 37%. In other key markets, such as India, growth in solar installations will likely be back-ended, as the solar technology approaches grid parity. Refer to HSBC note *Global Solar Power*, 23 September 2009, for grid parity estimates across key markets.

Solar thermal: 5-15% of total capacity by 2020

In our Conviction scenario, we forecast solar thermal installations in a range of 20-45GW, which is c5-15% of our estimated total installed solar capacity by 2020. The key markets for solar thermal are likely to be the US, Spain, India, Italy, Greece, Australia and the Middle East.

What do others say?

Our Conviction estimate of 300GW of installed solar by 2020 is relatively aggressive when compared with NEF Peak scenario which estimates 262GW and IEA 450ppm scenario which projects 137GW by 2020. However, as compared with the two scenarios from EREC - 440GW in Energy Revolution and 664GW in the Advanced scenario – our numbers look conservative.

Biomass: USD71bn in 2020

In our Conviction scenario, we estimate new biomass electricity capacity addition at a CAGR of 10% over 2009-2020. This takes the total installed capacity of biomass generation to 124GW by 2020. As a result, the market size of biomass industry grows from USD25bn in 2009 to USD71bn in 2020. The 2020 market size includes capital investment of USD25bn and electricity sales of USD46bn. This lies within a range of USD46bn-91bn across our four scenarios.

Mini Hydro: USD49bn in 2020

For the small scale hydro industry, we estimate that market will grow in our Conviction scenario at a CAGR of 6% to reach a market size of USD49bn in 2020; this is up from USD27bn in 2009. This estimate includes capital investment of

USD14bn and electricity sales of USD35bn. Our four scenarios provide a market size range of USD37bn-55bn.

Geothermal: USD23bn in 2020

Finally, for electricity generated from geothermal sources, we estimate that capacity will increase from 9GW in 2009 to 26GW in 2020, taking the global geothermal market size to USD23bn in 2020 from USD6bn in 2009; this represents a CAGR of 13%. This includes capital investment of USD10bn and electricity sales of cUSD13bn. The United States accounts for about 30% of the global geothermal capacity addition. Our four scenarios provide a market size range of USD17bn-25bn.

Other Renewable electricity: Conviction scenario (USDbn)

	Capital investment	Electricity sales	Market size
Biomass	25	46	71
Mini Hydro	14	35	49
Geothermal	10	13	23

Source: HSBC estimates

Nuclear: USD368bn in 2020

In our Conviction scenario, we estimate that the 2020 market size of the nuclear industry will be USD368bn, implying a CAGR of 6%. This includes annual capital investment of USD50bn and annual electricity sales of USD318bn. Our four scenarios provide a market size range of USD350bn-389bn.

Nuclear: market size 2020 under four scenarios (USDbn)

	Capital investment	Electricity sales	Market size
Backlash	37	313	350
Copenhagen	50	318	368
Green growth	66	322	389
Conviction	50	318	368

Source: HSBC estimates

Our scenarios take into consideration the proposals for capacity additions in key countries. We estimate total nuclear installations will reach 525GW by 2020 from an estimated 375GW at end-2009. Of the estimated 150GW of new capacity, we expect 40% to be in China and 14% in India.

In the 2009 World Energy Outlook, the IEA states that 54 reactors with a total capacity of almost 49 GW are currently under construction; 40 of these units are in non-OECD countries. The IEA estimates that by 2020 the installed nuclear generation capacity will increase to 427GW in its Reference scenario (an increase of 56GW from 2007 levels). In its Blue Map scenario, the agency estimates installed nuclear capacity of 500GW by 2020; our estimates are slightly above this.

Nuclear energy targets and incentives in selected countries

Country	Nuclear energy targets
Canada	Build 9 new reactors by 2020
China	70 GWe of capacity is planned to go online by 2020, and 200GWe by 2030
France	In January 2006 the President announced that the Atomic Energy Commission was to embark upon designing a prototype Generation IV reactor to be operating in 2020
Germany	Phasing out of nuclear energy by 2020 policy was put on hold by the new government in 2009.
India	20GW nuclear power target by 2020. Aims for 25% of electricity from nuclear power by 2050.
Italy	25% of electricity from nuclear power by 2030
Japan	30-40% share or more for nuclear power in total generation by 2030.
Russia	FTP Program- 25-30% nuclear share in electricity supply by 2030, 45-50% in 2050
South Africa	Early in 2007 the Eskom board approved a plan to construct 20 GW of nuclear capacity, raising the nuclear share of power from 5% to more than 25% by 2025
South Korea	27 GWe capacity by 2020, and 35 GWe by 2030
Spain	Phasing out nuclear plants with the last reactor scheduled to close in 2034.
US	Federal loan guarantees for advanced nuclear reactors up to 80% of the project cost

Source: HSBC

CCS: USD7bn in 2020

Carbon capture and storage (CSS) is the only source of low-carbon power solely driven by climate change concerns. CCS has higher upfront capital expenses than other low-carbon power technologies, and its higher fuel consumption also adds to operating costs. As a result, considerable

policy intervention is required to spur deployment, including carbon pricing, carbon regulation as well as additional support for R&D and pilot projects.

At the Hokkaido summit in 2008, the G8 pledged to launch 20 CCS projects by 2010. At the end of April 2010, the IEA[10] estimates public funding commitments in the range of USD26.6-36.1bn and with the number of committed projects ranging from 19-43. A survey by the Global CCS Institute identified 80 currently active or planned large scale projects, most of which are in developed countries (Australia, Canada, the EU, Korea and the USA) with only seven projects in developing countries – four in China, two in the Middle East and one in Algeria. Of these 80 projects, only one – Gorgon in Australia – was proceeding to construction at that time.

The reliance of CCS on public funding has been one factor contributing to project delays to date. As a result, we have been conservative in our market projections. In our Conviction scenario, we estimate that by 2020 around USD30bn of public funds will be spent, along with an additional 50% contribution from the private sector. This takes the total CCS estimated investments during the decade to USD45bn. Our forecast is lower than the IEA's estimates of USD56bn investments over 2010-2020 which is made in the *World Energy Outlook 2009*. The IEA expects further investment of USD494bn during the following decade in its 450ppm scenario. To this investment market could be added the value of electricity generated from CCS facilities, but we have not included this in our estimates in this report.

CCS funding and project announcements from governments and international organisations

Country	Funding committed to date (USDbn)	Number of projects committed by 2020
Australia	2 to 6	3 to 5
Canada	3.5	up to 6
European Commission	4 to 6	6 to 12
Japan	0.1	1 to 2
Norway	1	1 to 2
South Korea	1	1 to 2
United Kingdom	11 to 14.5	4
United States	4	5 to 10
Total	**26.6 to 36.1**	**19 to 43**

Source: IEA

[10] http://www.iea.org/papers/2010/ccs_g8.pdf

Clean heat: USD31bn in 2020

Solar water heating

According to the IEA, global solar heating and cooling potential continues to grow, with China as the major market and a rapidly growing market in European countries.

We estimate the market size of the solar water heating industry based on the historical growth in capacity additions seen from 2000-08. China and the US have the dominant market share of the industry and so a closer look at their domestic markets helps in computing the average capital cost of solar heater.

In our Conviction scenario, we estimate global capacity additions to increase at a CAGR of 20% over 2009-2020 to reach an annual capacity addition of 215GWth in 2020. For comparison purposes, the 2000-08 CAGR was c16%. At a global average cost of capital of USD0.09m/MWth, this implies a market size of USD20.4bn in 2020. This is seven times our estimated market size in 2009. Given the large variation in capital costs across markets, we take a weighted average with a 70% weight to China and 30% to the USA. Under our four scenarios, we estimate a market size range of USD12bn-33bn in 2020.

Biomass heat

In a number of temperate regions, biomass offers a locally available source of fuel for heating purposes. In our estimates for the market size for biomass heat, we have limited our focus to the EU. In the EU, the market is being driven by the goal of increasing the overall share of renewables to 20% of primary energy by 2020. Our estimates are based on growth in the biomass industry's share of final heat generation in Europe from 57.5Mtoe in 2005 to 147.5Mtoe in 2020. This implies a capacity CAGR of 6.5% from 2005-20e.

For biomass heating in EU, we assume an additional heating capacity requirement of 17GW (over 2006 to 2020) to generate 90Mtoe of additional heat, based on estimates provided by AEBIOM[11] (European Biomass Association). Considering an average capital cost for a boiler at USD650/KW, we estimate a 2020 market size of USD11.1bn in our Conviction scenario, with a market range of USD10bn-13bn.

[11] http://www.eustafor.eu/userfiles/File/Kopetz.pdf

HSBC

Biofuels: USD93bn in 2020

Biofuels could play an important role in a low-carbon transport sector. However, the potential is constrained by competition for raw materials (particularly with the food industry) and also by the relative carbon footprints of different feedstocks and production processes.

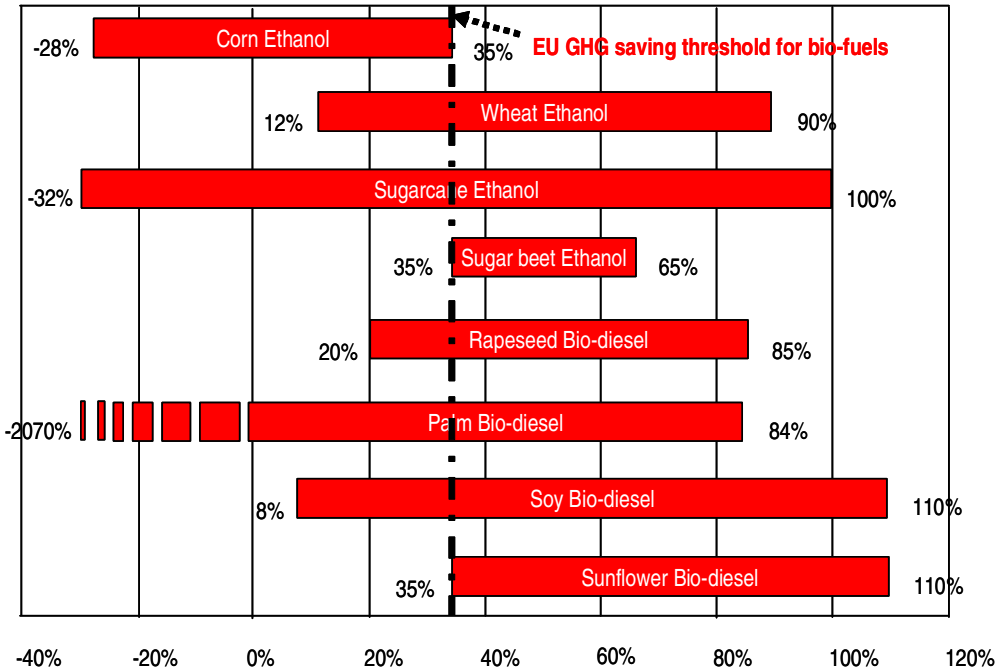
The chart below presents the latest assessments of the range of relative carbon benefits or costs of different feedstocks. We have taken the EU's target for biofuels to achieve a 35% improvement on fossil fuels as our baseline. The life-cycle based GHG saving chart shown above represents a synthesis of three main reviews in the biofuels sector: Scope (2009); FAO (2008) and Gallagher (2008). Both Scope and FAO show potentially high carbon costs associated with corn ethanol and palm bio-diesel; we have therefore excluded them from our estimates.

For sugar ethanol, FAO (2008) provides a GHG saving range of 68% to 89%; while SCOPE (2009) gives a range of 70% to 100%. The Gallagher Review (2008) provides a lower range of -32% with its upper range being 71%. However, the negative results were drawn largely from South African mills which use grid electricity generated from coal. We have therefore included sugar ethanol from other countries in our assessment.

Biofuel markets are driven by a combination of production targets (notably in the USA) and blending targets; in addition, in the EU, biofuels are part of the overall target for renewable energy. We analyse the biofuel-specific policies of key countries to estimate blending, which we then adjust to factor-in historical performance against targets, implementation issues and controversies surrounding the sector.

The highest blending target is 25% in Brazil, where it is already being implemented. In our four scenarios, we assume different achievement rates for these targets, taking into consideration historical performance against targets, implementation issues and the continuing controversies in the sector.

Life cycle analysis of GHG savings for different bio-fuel types (in %)



Source: SCOPE, 2009; FAO, 2008 and Gallagher Review, 2008

In our Conviction scenario, we estimate the 2020 market size of the biofuel industry will be around USD93bn. This includes capital investment of USD11bn and biofuel sales of USD83bn. This lies within a range of USD37bn-172bn in our four scenarios.

Biofuel policy framework in key countries

Australia	Current legislation implements zero excise on bio-ethanol and biodiesel until 1 July 2011 when it will rise to 7.6 cents per litre for ethanol and biodiesel each year until reaching 38.143cpl in 2015. In addition to the federal targets, states also have biofuel policies.
Brazil	Current legislation requires an ethanol content between 20% and 25%, with the executive branch having the flexibility to adjust within that band. As of 1 June 2007, the percentage of ethanol blended to gasoline is 25%. Brazil has also mandated 5% bio-diesel blending by January 2013. It is expected to raise the production of biodiesel in Brazil to 2.4 billion litres in 2010.
China	China has a E10 (10% ethanol blending) mandate for specific cities in the provinces of Hubei, Hebei, Shandong and Jiangsu.
EU	The renewable energy directive sets a mandatory 10 % minimum target to be achieved by all Member States for the share of biofuels in transport petrol and diesel consumption by 2020.
India	The government has set an indicative target of a minimum 20% ethanol-blended petrol and diesel across the country by 2017. In 2009, the Cabinet Committee on Economic Affairs (CCEA) made it mandatory for oil marketing companies (OMCs) to sell 5% blended petrol.
Indonesia	Through the Presidential Decree No. 10/2006, the government established a National Team for Biofuel Development. The team proposed several recommendations and has developed a road map for biofuel development. The plan sets a target of making biofuel account for 5% of the energy mix by 2025.
Japan	Japan has a target to replace 500,000 kl in crude oil equivalent of auto use of energy with biofuels in fiscal 2010/11.With respect to bio-diesel, the government decided that the blending ratio of Fatty Acid Methyl Ester (FAME) into light oil should be less than 5%, in order to ensure that the fuel meets safety and gas emissions standards for existing vehicles in the market.
US	The Energy Independence and Security Act of 2007 (H.R. 6), sets forth a phase-in for renewable fuel volumes beginning with 9 billion gallons in 2008 and ending at 36 billion gallons in 2022.

Source: HSBC

Biofuels: market size in 2020e under four scenarios (USDbn)

	Capital investment	Biofuel sales	Market size
Backlash	1	36	37
Copenhagen	14	124	138
Green growth	18	155	172
Conviction	11	83	93

Source: HSBC estimates

HSBC

Meeting demand for energy efficiency

- Energy efficiency is not only the cheapest and quickest way of cutting GHGs, but we believe it will also be the biggest opportunity in 2020
- Economic and regulatory drivers generate a 12% revenue CAGR and a market size of USD1.2trn in 2020 in our Conviction scenario
- Transport efficiency is, on our forecasts, the largest sub-theme within this market in 2020

The win-win-win solution

More efficient use of energy offers the potential to cut the costs of energy consumption, avoiding the need for unnecessary capital investment in generating capacity and eliminating GHGs with positive financial returns. Energy-efficiency investments can have short pay-back periods and negative net abatement costs, as the fuel-cost savings over the lifetime of the capital stock often outweigh the additional capital cost of the efficiency measure, even when future savings are discounted.

Continuing market, policy and institutional failures, however, prevent consumers and companies from seizing these opportunities. Carbon is still not priced in most markets; fossil fuel use, and energy consumption more broadly, is still subsidised in many parts of the world; high transaction costs can eat away at theoretical energy savings; and business models that profit from cutting energy have yet to expand beyond specialist niches. But decision-makers are now giving greater attention to this long-time 'Cinderella' of the energy matrix.

Overall, we estimate that the market in energy efficiency solutions could grow from around USD317bn in 2009 to between USD722bn and USD1.4trn, with a Conviction estimate of USD1.2trn. We have modelled market sizes across our four scenarios for five main market segments: transport, buildings, industry, energy storage and smart grids.

Energy efficiency: estimated market size in 2020e (USDbn)

	Backlash	Copen hagen	Green Growth	Conviction
Transport efficiency	**312**	**415**	**731**	**677**
Fuel efficiency	102	154	177	135
Low-carbon vehicles	151	189	473	473
Modal shift	59	73	81	69
Building efficiency	**194**	**275**	**308**	**245**
Building control	30	47	54	41
Efficient lighting	64	88	98	79
HVAC	37	51	57	46
Insulation	63	89	99	79
Industrial Efficiency	**154**	**200**	**217**	**183**
Fuel cells and energy storage	**48**	**85**	**110**	**66**
Energy storage	46	81	105	63
Fuel cells	2	4	5	3
Smart grid	**14**	**28**	**44**	**23**
Total energy efficiency	**722**	**1003**	**1410**	**1194**
CAGR (2009-20e)	**8%**	**11%**	**15%**	**13%**

Source: HSBC estimates

The energy efficient market has twin drivers of economics and regulation.

Energy efficiency targets by country

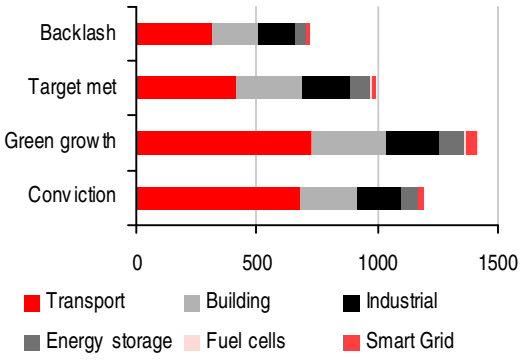
Countries	Energy efficiency target
Canada	Existing facilities reduce emission intensity by 18% from 2006 levels by 2010, and by a further 2% each year after that.
China	Reduce energy intensity (consumption per unit of GDP) by 20% by 2010 below 2005 levels and reduce emission intensity by 40-45% by from 2005 levels 2020.
EU	A target of improving energy efficiency by 20% compared to BAU by 2020. This implies around 1.5% of real energy savings per year up to 2020.
India	Reduce carbon intensity by 20-25% by 2020 from 2005 levels.
Indonesia	Decrease energy intensity by 1% per year until 2025 from 2005.
Japan	Each factory and workplace is required to achieve annually on c1% reduction or more in energy intensity.
South Africa	Energy efficiency improvement (energy demand reduction) of 12% by 2014 from BAU.
South Korea	Voluntarily energy efficiency improvement plan with industries and committing itself to achieve target

Source: Government websites, HSBC

We adopt both a top-down (regional assumptions) and bottom-up (company revenue streams) analysis to generate our model of the size of energy efficiency markets by 2020. Although we use different approaches to estimate the size of each segment, in most cases we assess the industry size by identifying the key listed players operating in the respective segments and forecasting their revenues for the target year of 2020. Our revenue forecast is based on an analysis of historical revenue trends and the key growth drivers over the next decade. Our list of companies is derived from a universe operating within the energy efficiency industry and contains only listed players. We adjust revenues to incorporate only the portion attributable to energy efficiency goods and services. Also, as our selected list of companies does not capture the complete market, we make adjustments to our current and 2020 market size forecast.

We assess the prospects for implementation of policy in our four scenarios below. A summary of the market size conclusions is given in the chart below.

Energy efficiency: market sizes under four scenarios (USDbn)



Source: HSBC estimates

Transport: USD677bn in 2020

In transport efficiency, we split the theme into three main categories.

- The fuel efficiency segment includes sales of engineered systems, automotive interiors, emission control products and components that optimise energy usage in automobiles. We have estimated a baseline for 2009 based on 25 global companies, and have then modelled growth rates based on our scenarios.
- The low-carbon vehicle industry includes hybrid-electric, plug-in electric and pure electric vehicles. Here, we build on the forecasts

Fuel efficiency targets in selected countries

Country	Transport energy efficiency targets
China	Standards are weight-based and to be implemented in two phases (the first in 2005/2006 and the second in 2008). The standards are classified into 16 weight classes, ranging from 38.0 mpg in 2005 (43.0 mpg in 2008) for the lightest vehicles and 19.0 mpg in 2005 (21.0 mpg in 2008) for heavier trucks
EU	Low-carbon Fuel Standard: CO2 emissions from new cars are limited to 120g CO2/km for 65% of new fleet in 2012; and 100% in 2015.
Japan	39.5 mpg fuel efficiency standard by 2015 to achieve 23.5% improvement in fuel efficiency by 2015 compared to 2004 levels.
South Africa	Will introduce a new tax on vehicles designed to cut CO2 emissions.
South Korea	Reach average fleet fuel efficiency of 40 mpg by 2015.
US	CAFÉ standards: increase fuel efficiency standards from current 25.5mpg (27.5mpg for LDV) to 35.5mpg in 2016 (39mpg for LDV).

Source: HSBC

developed by the HSBC Global Autos team to develop four scenarios for 2020.

- Our modal shift segment addresses the switch to lower carbon modes of transport; here, we focus in particular on the growth in electric and high-speed trains.

Fuel efficiency: USD135bn in 2020

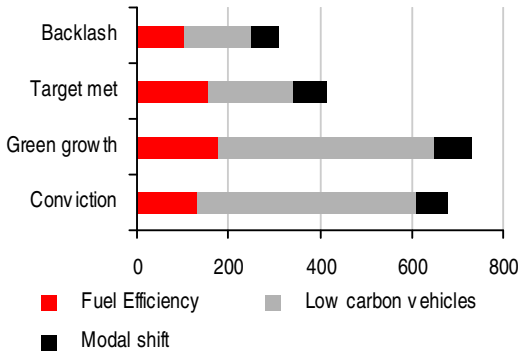
We have modelled our transport efficiency market using bottom up analysis of the revenues of companies involved in fuel efficiency. We apply growth rates derived from historic growth rates and our views on future policy implementation calculate potential market size across our four scenarios.

In our fuel efficiency analysis we include companies which supply efficient engineering systems, manufacturers of lighter and energy efficient component parts. Our base for analysis is the portion of the revenue stream that is attributable to energy efficiency goods and services in 2009.

Low-carbon vehicles: USD473bn in 2020

The low-carbon vehicle industry includes hybrids, plug-ins hybrids (PHEV) and pure electric vehicles (EV) (see Niels Fehre & Horst Schneider, *Hybrid and Electric Vehicles*, October 2009). An important advantage of EVs over conventional Internal Combustion Engines (ICE) is very high energy efficiency, low-cost motors and low running costs. Mass deployment of EVs powered by low-carbon electricity generation also offers the potential to reduce significantly GHGs from transport fuels, without substantially increasing power consumption: in our bullish Green Growth scenario, EVs consume around 0.75% of total electricity demand. Finally, EVs can contribute to resolving the load balancing challenges raised by an increasing proportion of intermittent renewable electricity in the power matrix. On the downside, high upfront costs, limitations in battery technology and embryonic charging infrastructure present major hurdles, which governments are trying to overcome through a range of policy support measures (see table below).

Transport Efficiency: estimated market size in 2020e (USDbn)



Source: HSBC estimates

Global targets and incentives for PHEV/EV

Country	Target	Cash Incentives			Registration Tax	Road Tax	Value Added Tax
		USD per EV	Budget allocation (USDbn)	Others/plans	Exemption (USD)	Exemption (USD)	Exemption (USD)
Africa							
South Africa	Plans to promote battery production and EV production	-	-	Green tax on normal cars from September 2010	No	No	No
Asia							
Australia	Still at early stages with plans to have first cars on road by 2012	-	-	-	No	No	No
China	2011: 0.5m annual production	879-8,800	1.5	-	No	Yes	No
India		15% discount in Delhi		Excise duty waived for EVs in 2010 Union Budget and on batteries	Yes	Yes	Yes
Japan	2020: 50% market share next gen vehicles	2,000	-	-	336	Yes	Yes
S. Korea	2012: 30,000	-	-	-	860	344	11
North America							
Canada	2018: 0.5m			Plans for new infrastructure for electric charging stations, and special lanes for slow moving electric cars	No	No	No
Mexico	-	-	-	Agreement with Japanese auto giant Nissan on recharging infrastructure for electric vehicles in 2011	No	No	No
US	2015: 1m PHEV stock	4,000	2.8	cUSD1.5bn in grants to batteries; cUSD500mn grants to produce electric drive components and cUSD400mn for test demonstrations	No	No	No
South America							
Brazil	-	-	-	Alternative fuel vehicles already extremely popular and government concentrating to promote EVs by developing charging infrastructure	-	-	-
Europe							
Denmark	2020: 0.2m	-	0.047	Plans to subsidise fleet lease of EVs	Yes	Yes	No
France	2020: 2m	6,984	0.542		Yes	No	No
Germany	2020: 1m	-		Plans under development to promote EV from 2012	NA	Yes	No
Israel	2012: 0.04 to 0.1m	-	-	70 to 100 recharge stations will open by 2011	Yes	No	No
Italy	-	4,888	-	Plans to subsidise electric two-wheelers along with charging stations	No	Yes	No
Spain	2014: 1m	8,155	0.332		Yes	No	No
UK	2020: 1.2m	8,073	0.386		No	Yes	No

Source: Government websites, Frost & Sullivan, HSBC

We believe that these initial incentives will drive sales of the first generation of PHEVs and EVs from 2011-12; we expect significant growth in EVs after 2015 as prices decline and more products are launched. In particular, we expect the price of batteries to fall from around USD1,000/kWh to around USD350/kWh in 2020.

The starting point for our Green Growth scenario – which is also our Conviction scenario in this case – are the estimates calculated by the HSBC Global Autos team This assumes global sales of 8.65m electric vehicles (EV) and 9.23m plug-in and hybrid electric vehicles (PHEV). In addition, we assume that average prices for PHEV gasoline and diesel vehicles in 2020 will be 5-10% lower than average EV prices (USD27,500). The estimated numbers of low-carbon vehicles take into consideration the technology and infrastructure development, as well as the financial incentives available for smaller and efficient cars, such as subsidies and tax incentives offered on the basis of engine size, efficiency and CO2 emissions.

Vehicle sales estimates ('000)		
Vehicle type	**2009e**	**2020e**
EVs	5	8,650
Plug-in hybrids	657	9,226
Total E's + PHEVs	**662**	**17,876**

Source: HSBC estimates

Vehicle price estimates (USD)		
	2009	**2020**
EVs	45,000	27,500
Plug-in Hybrid	38,700	25,500

Source: HSBC estimates

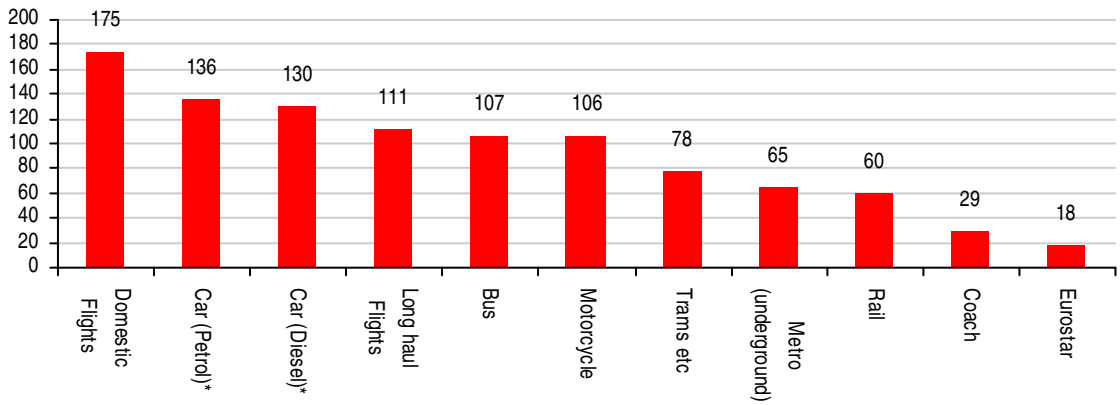
Our Copenhagen scenario suggests a market size that is 60% smaller, and is drawn from the IEA's *Energy Technology Perspectives 2010*, which projected only 5m EV sales and 2.5m plug-in hybrid sales worldwide by 2020; the IEA's forecasts are based on existing policy support. Our Backlash scenario assumes a 20% shortfall from the Copenhagen scenario.

Modal shift: USD69bn in 2020

The efficiency and carbon intensity of transport can be improved not just by switching to improved vehicles, but also by shifting between modes, notably away from aviation and automobiles to mass transit (such as trains, coaches, trams, buses). The chart below highlights the relative carbon performance of different passenger modes – with high-speed rail demonstrating the best performance. In our estimates, we focus on investments in electric rail and trams, especially the high-speed rail.

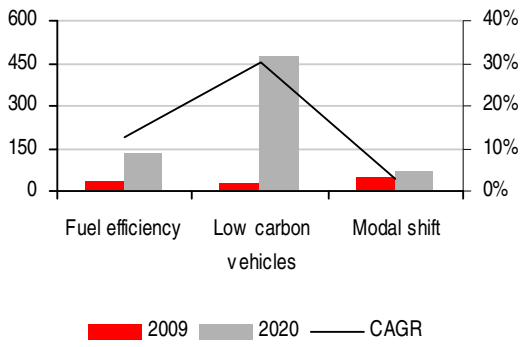
Within the public transport domain, there is increasing focus on switching from petrol/diesel locomotives to electrified versions. High-speed rail has also attracted major investment plans in many stimulus packages announced in 2009. China, France, Japan and Spain are among the countries that have built high-speed rail networks with trains operating at speeds of over 150 mph. Also, many countries have announced plans to build new tracks by 2020 for high speed transport. The growth rates are, nevertheless, lower than for other transport efficiency segments.

CO2 emission of different modes of transport (gCO2/passenger km)**



*Considering average car occupancy rate of 1.52 passengers per car for UK from EEA 2007; **Not life cycle emissions
Source: http://www.defra.gov.uk/environment/business/reporting/pdf/passenger-transport.pdf (2008)

Transport efficiency: market size in the Conviction scenario (USDbn)



Source: HSBC estimates

Overall, the market size in 2009 and 2020 of the three transport efficiency sub categories are highlighted in the figure below.

Selected investments in High speed /electric / metro rail and tramways over 2009-2020e (USDbn)

Country	Investment	Remarks
China	300	Plans to have 16000 miles of new track by 2020
France	30	EUR1bn (about USD1.4bn) to support a list of 57 tramway projects. EUR15bn to EUR20bn for Paris Metro to be completed by 2020.
India	17	Additional 14,000 km to be electrified to bring total to 33,000 by 2020, and additional 4,281 electrical locomotives by 2020
Russia	2	Spending nearly USD1.5bn to upgrade 401 miles of track between Moscow and downtown St. Petersburg and for buying electric trains
South Korea	7	Assuming all the investment is in high speed rail
Spain	122	Spain will have 10,000 kilometres (more than 6,200 miles) of high-speed track by 2020
UK	2	A GBP1bn plan to electrify the main rail route between London and Swansea has been announced by the government.
US	13	US has already secured USD8bn in funding in the stimulus bill and plans to pursue another USD5bn over the next 5 years

Source: HSBC estimates

Buildings: USD245bn in 2020

The building efficiency market is diverse – and often fragmented. It comprises: advanced insulation and glass materials; improved building materials that control the transfer of heat into and out of buildings; more efficient heating ventilation and air conditioning (HVAC); more efficient lighting such as light emitting diodes (LEDs), compact fluorescent lamps (CFLs); and smart systems that can control and manage power consumption in buildings.

A range of policy measures are driving growth in the building efficiency segment including:

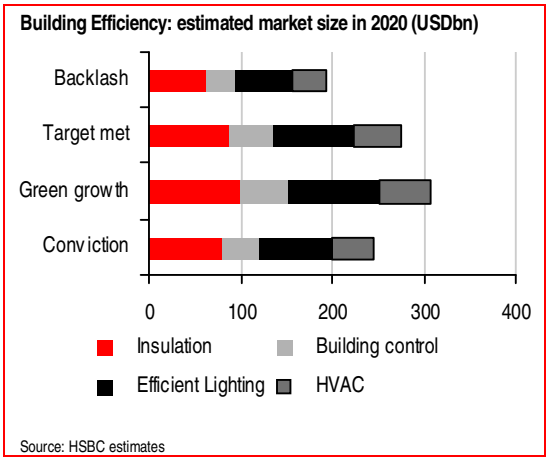
- demand-side management policies that require energy utilities to deliver energy savings;
- tightening regulations for new buildings. For example, zero carbon buildings are required in the UK by 2016
- market transformation strategies for key energy using appliances. For example, traditional incandescent light bulbs are being phased out in the EU and will cease to be produced by 2012.

Please refer to the chart on page 39 for further details.

Our estimates are based on an assessment of revenues of companies exposed to the insulation, building control, efficient lighting and Heating, Ventilation and Air Conditioning (HVAC) markets. Given that our selected list of companies only represents a proportion of the global market, we have adjusted the base year market size (2009) seeking information from sources such as Freedonia, World Resources Institute and others.

Based on our views of policy evolution and implementation, we have modified expected growth rates in the key sub-themes. We apply growth rates derived from taking into account our views on policy implementation and the growth of the industry to calculate potential market size according to our four scenarios. The chart below shows the breakdown of the market size according to theme and scenario.

Our Conviction scenario points to a USD245bn building efficiency market in 2020, within our scenario range of USD194bn to USD308bn. We believe that efficient lighting and insulation will be the largest sub-themes, each at USD79bn in 2020.

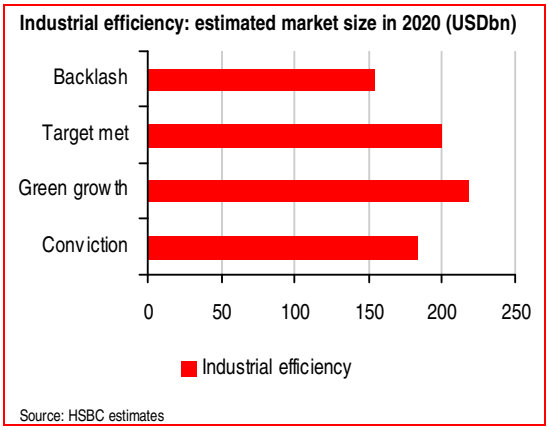


Industrial: USD183bn in 2020

The industrial efficiency segment comprises power and automation technologies, power transmission products, electric motor systems, power management solutions, and energy control and optimisation solutions.

Our analysis rests on a baseline assessment of the revenues of listed companies that provide goods and services relating to industrial efficiency. We look at the revenues directly attributable to efficiency. We have then applied growth rates derived from taking into account our views on policy implementation and the growth of the industry to calculate potential market size according to our four scenarios.

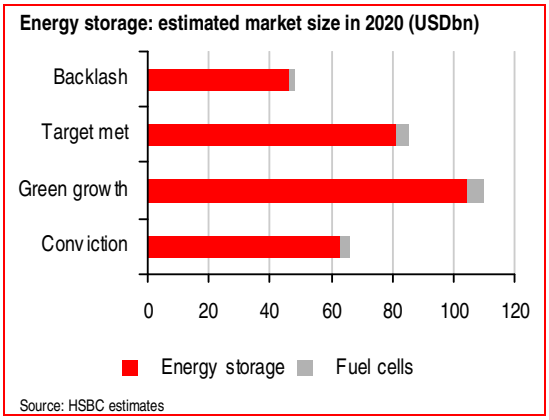
Our Conviction scenario estimates a market size of USD183bn, with a revenue CAGR of 6% from 2009-2020. This lies within a range of USD154bn-217bn for our four scenarios.



Energy storage: USD63bn in 2020

The energy storage and fuel cell segment provides a critical bridge between low-carbon power supply and efficient use. We believe the growth of renewable energy and low-carbon vehicles will drive the growth of energy storage and fuel cells. In its stimulus plan, for example, the US government earmarked USD2.4bn for electric vehicles and advanced batteries, with USD1.25bn for batteries. The EU has also launched its 'green cars initiative' to provide cost-based loans to car producers and suppliers to finance innovation.

Our estimates rest on a baseline assessment of revenues of companies operating in this segment and then projected out to 2020 taking into consideration the historical growth rates and our assumption of policy and technology. This results in a market size in our Conviction scenario of USD63bn, within a range of USD46bn-105bn.



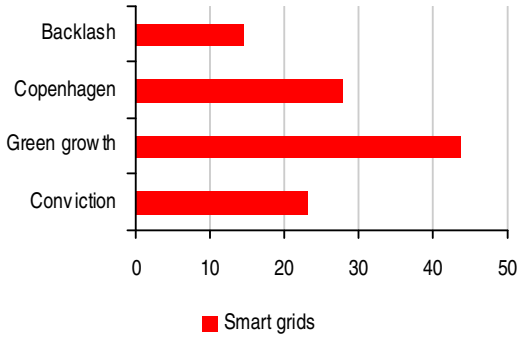
Smart grids: USD23bn in 2020

A low-carbon energy system requires considerable upgrading of the traditional transmission and grid infrastructure to cope with a greater proportion of intermittent and decentralised electricity generation and to enable building efficiency. Governments are introducing regulatory frameworks to accelerate the roll-out of smart grids and meters, often supported by stimulus spending.

We assume that market will peak around the middle of the decade, as investments in new transmission lines are made across countries/regions, such as the US, EU and China. A report from Pike Research quotes global smart-meter installations to reach 250 million units in 2015, up from 46 million in 2008[12].

The smart grid segment includes UHV transmission lines and the super grids, and also the smart metering at the consumer end. We have assessed a baseline market size of USD10bn based on a report from Pike Research[13]. We have then derived different growth rates under our four scenarios, producing a Conviction scenario market of USD23bn, with revenue CAGR of 8%. This lies in a range of USD14bn-44bn.

Smart grids: estimated market size in 2020e (USDbn)



Source: HSBC estimates

Selected smart grid investments 2010- 2020e (USDbn)

Country	Investment	Remarks/source
China	100	China's State Grid Corporation has announced a plan to build a 'Smart Grid' with more than RMB 4 trillion investment and the construction will start this year in three stages. This intelligent investment will reach at least 726 billion based on the planning period 2009 - 2020.
EU	80	EWEA and Greenpeace estimate EUR30-40bn investment in European Green Energy Supergrid. In addition EU countries will also have a smart metering programme. The UK alone estimates spending GBP8.6bn in replacing some 47m gas and electricity meters
South Korea	10	S Korea plans to spend KRW27.5trn (USD24bn) by 2030
USA	80	The USA allocated cUSD12bn for smart grids in its Stimulus package. We assume USD80bn of investments in smart grids and smart meters.
Total	**270**	

Note: Various countries all together have allocated cUSD18.5bn for smart grid investments in 2010
Source: HSBC estimates

[12] *http://www.environmentalleader.com/2009/11/02/global-smart-meter-installations-to-reach-250-million-units/*

[13] *Smart Grid Technologies (Networking and Communications, Energy Management, Grid Automation, and Advanced Metering Infrastructure)*

Building energy efficiency standards and incentives in key countries

Countries	Act/directives	Building energy efficiency target	Building codes	Appliances/lighting	Fiscal Incentives for Building EE
Australia	1. Energy Efficiency in Government Operations (EEGO) 2. Phase Out of Inefficient Light bulbs 3. BCA 2010: 6 Star NatHERS Rating for Buildings	New buildings and major refurbishments to achieve a 4.5 star rating under the National Australian Built Environment Rating System (NABERS Energy).	Revised and consistent Nationwide House Energy Rating Scheme (NatHERS). From 1 May 2010, 6 star NatHERS rating.	Phase-out of all incandescent bulbs by 2009 with full enforcement of new lighting standards by 2009-2010.	
China	1. 11th Five Year Plan (2006-2010) 2. Energy Conservation in Government 3. National Building Energy Standard	Reduce energy consumption from lighting and HVAC in public buildings by 50%. Save energy by 10% per unit construction area and per capita by 2010, relative to 2002. Requires a 50% reduction of building's energy consumption from 1980s.	20% of the total construction area must meet the national building energy efficiency standard.	From 2010 onwards plan is to phase out incandescent lighting, using a 'technology push/demand pull' strategy.	Construction enterprises that do not comply with the regulation may face penalties of CNY 200,000 to CNY 500,000.
EU	1. EU Energy Efficiency Standards 2. Directive on the Energy Performance of Buildings	Target of reducing energy consumption by 5% to 6% from 2009 by 2020 requires all new buildings be nearly zero energy buildings by 2020. By 2018, all public buildings shall be nearly zero energy buildings.		EU-level minimum efficiency standards for three product classes – domestic hot-water boilers, refrigerators and fluorescent lighting ballasts. Progressively phase out incandescent lamps between 2009 and 2012.	Member states to list incentives from technical assistance and subsidies to low-interest loans by mid-2011.
France	1. Decrees to Increase Energy Efficiency of Boilers. 2 .Energy Efficiency Requirements for Fluorescent Lighting Ballasts 3. Tax Credit for Energy-Saving and Renewable Energy Equipment 4. National Energy Efficiency Action Plan 5. Finance Law 2009: Sustainable energy provisions	Reduce energy consumption by approximately 20% in service-sector construction and 12% in residential construction within 5 years, and by more than a third by 2020.		Imposes minimal thermal efficiency standards for boilers in service. Imposes efficiency requirements of fluorescent lighting ballasts.	Tax credits for purchasing EE equipments. Tax credit is limited to EUR8,000 per person.
India	1. Energy Conservation Act 2. Energy Conservation Building Code		Mandates from 2010, minimum requirements for building envelope components, lighting, HVAC, electrical system, water heating and pumping systems.	Mandates appliances to meet energy performance standards and to display energy consumption labels.	
Japan	1. Financial or tax incentives for energy efficient houses and buildings 2. Law Concerning the Rational Use of Energy 3. Basic Program for Housing: Energy Efficiency Standards 4. Revised Energy Conservation Act (2008) 5. Eco-Points Scheme	40% of housing should have energy saving measures.	Owners of buildings larger than 2000 m^2 floor to prepare efficiency plans. Codes revised to strengthen measures to enhance energy efficiency.	Establishes the new Eco-Points Scheme to promote environmentally-friendly home appliance products.	Low interest loan programme for energy conservation renovation of buildings.
UK	1. Warm Front Scheme 2. Reduced VAT for EE materials 3. Decent Homes standard programme 4. Salix Project 5. Building Regulations Part L 6. Pay-As-You-Save (PAYS) pilots	20% improvement in the energy efficiency of new buildings, relative to 2002 regulations.	Establishes a minimum standard below which homes should not fall to ensure that all social housing is made "decent" by 2010.		Warm Front budget for 2008-2011 to GBP874m. Up to GBP2,700 worth of free central heating and energy efficiency measures. Reduced rate of VAT of 5% - the lowest VAT rate allowed under EU agreements. Spend-to-save programmes receiving DECC funding of GBP30m from 2008-11. PAYS designed for repayments to be less than energy bill savings.
US	1. Energy Policy Act (2005) 2. Energy Independence and Security Act (2007) 3. Energy Improvement and Extension Act 2008 4. Energy Efficiency and Conservation Block Grant (EECBG) Program	Mandates federal agencies to reduce building energy intensity every year from 2003 baseline by 2% per year beginning in 2006, reaching a 20% reduction by 2015. Mandates 30% energy reduction by 2015 for existing federal buildings, and carbon neutral by 2030 for new federal buildings.	Federal buildings must be designed to reduce 30% below the current ASHRAE standard. Department of HUD to update energy efficiency standards by applying the International Energy Conservation Code. Zero Net Energy Commercial Buildings Initiative to establish net zero new energy commercial buildings by 2030.	Agencies must have advanced metering capability by October 1, 2012. Phase out the use of incandescent light bulbs by 2014, and improve lighting efficiency by more than 70% by 2020; Updates Energy Policy and Conservation Act to set new appliance efficiency standards.	Energy Policy Act requires federal procurement of ENERGY STAR® designated products. Energy Efficiency and Conservation Block Grant (EECBG) Program with a budget of over USD2.7bn; Establishes an Office of High-Performance Green Buildings. Extends energy efficiency tax deductions for commercial buildings through 2013 and similar deductions for home improvements installed in 2009. Budget allocated cUSD2.7bn for EECBG.

Source: IEA Energy Efficiency Database, HSBC

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Regional insights

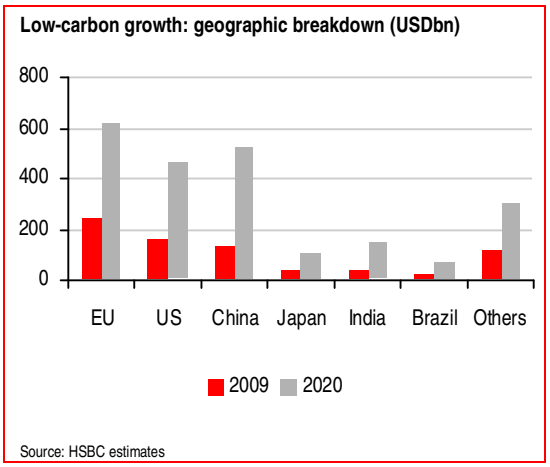
- Currently, the EU has the largest market share (33%) of the low-carbon energy market. It is followed by the USA (21%), China (17%), Japan (6%) and India (5%).
- In our Conviction scenario, the EU still leads the market in 2020, but its share falls to 27%; the USA and Japan also lose share
- China is the fastest growing market in our forecasts, taking its global share to 24%; India and Brazil rise to a combined 10%

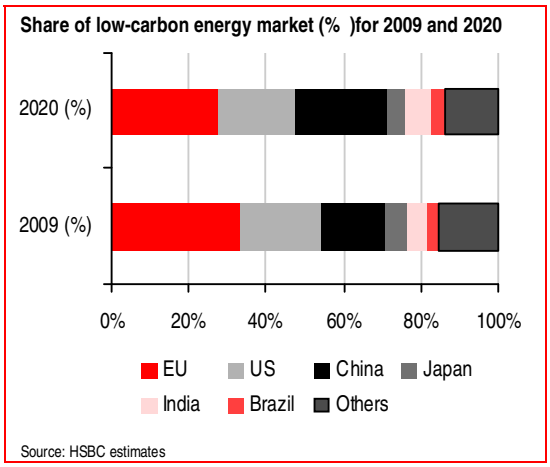
Sharing the spoils

The industrialised world has been the mainstay of the low-carbon economy over the past decade primarily due to a larger base of installed nuclear and renewable generation capacity and more focus on the installation of energy efficient technologies.

Over the next decade, we expect that this pattern will change markedly. We forecast that the share of the three largest industrialised markets (EU, USA and Japan) will fall from 60% in 2009 to 53% in 2020; by contrast, the share of the three leading major emerging markets (China, India and Brazil) will grow from 25% to 34%.

This reflects not just the wide differences in underlying growth rates across the globe – but also the diverging policy packages that governments are putting in place.





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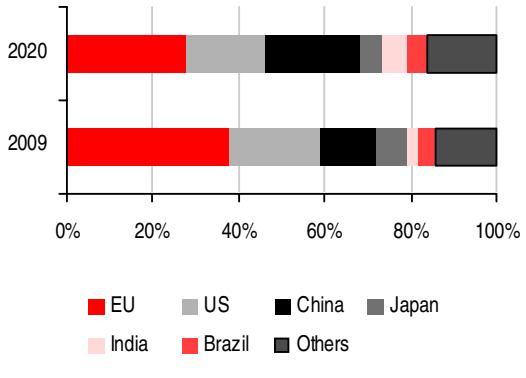
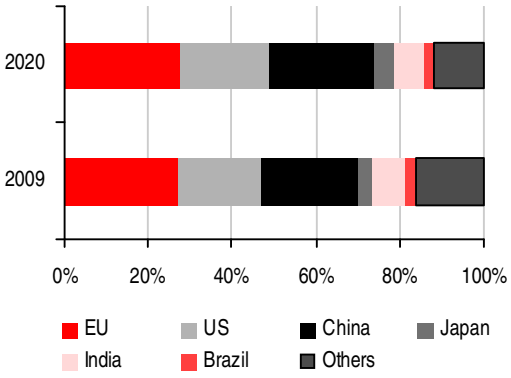
Low-carbon supply: geographical shares (2009 and 2020)



Source: HSBC estimates

Energy efficiency: geographical shares (2009 and 2020)



Source: HSBC estimates

Our estimates for the regional markets in low-carbon energy production are derived from our forecasts for the installed capacity of each segment – wind, solar, biomass, hydro, geothermal, nuclear and CCS, as well as renewable heat and fuels. One notable conclusion is that China's market share rises from 13% to 22% of the total, with the EU falling back from 38% to 27% and the US declining from 22% to 19%.

In the energy efficiency segment, we expect the EU to retain its predominant market share. Our 2009 estimate for geographical segmentation is: EU (27%), China (23%) and US (20%). For 2020, we estimate that all three countries are able to retain their position, with a marginal increase in market share – EU (28%), China (25%) and US (21%). These gains in market share are primarily driven by large investments in low-carbon vehicles, especially for the EU and the US, which have the largest share of investments followed by China. For building and industrial efficiency, we expect market growth to be higher in China.

For different energy efficiency sub-themes, we have used different approaches to identify the geographical exposure.

For the size of the market related to the building control sub theme, we have drawn on research by the World Resources Institute, which estimates that by 2020, the US and EU together will comprise around c63% of the global market.

For the other building efficiency sub themes, industrial efficiency theme and fuel efficiency sub theme, we have mainly relied on the breakdown of revenues by geographies of our selected companies. However, there are some key limitations to this analysis on the geographical segmentation. One is, we have to break down the entire revenue stream of the company rather than just revenues related to industrial efficiency or building efficiency, as the necessary data are not available. Also, our selected company list is weighted in favour of developed countries, because there fewer relevant companies in developing countries. We have therefore modified the geographical breakdown of 2009 revenues, based on observed trend of higher growth coming from developing economies, and also using our own subjective judgement.

The geographical breakdown for low-carbon vehicles (EVs and PHEVs), our biggest sub-theme, has been provided by our Global Autos sector analyst Niels Fehre. Using our pricing assumption, we have estimated the market size by geography.

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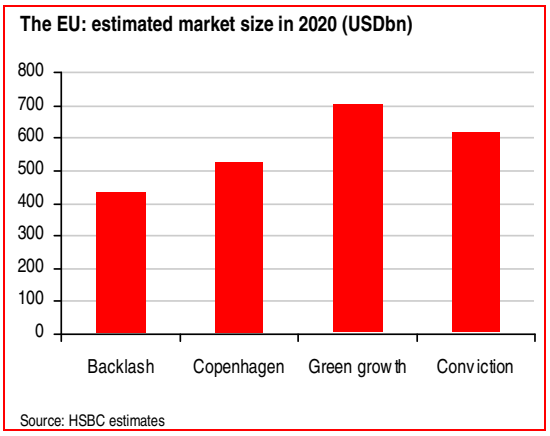
EU: low-carbon market leader

In our Conviction scenario, we estimate that the size of the EU's low-carbon energy and energy efficiency market at cUSD614bn, or 28% of the global total. Our four scenarios provide an estimated range of cUSD429-696bn for the EU low-carbon energy economy. Over 2009-2020e, we estimate market CAGR of c9%, below the global average because of the EU's large baseline.



Low-carbon energy production

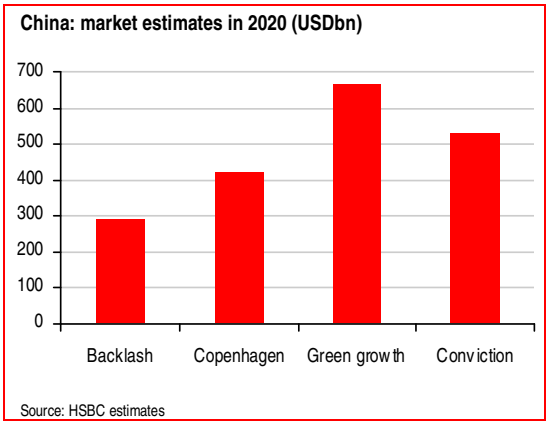
Our four scenarios provide a range for the low-carbon energy production market in the EU of USD240-310bn. In our Conviction case, we estimate a market size of USD284bn with wind, solar and nuclear contributing cUSD85bn, USD46bn and USD92bn, respectively. In our four scenarios, we estimate a range for renewable electricity generation capacity of 376-461GW by 2020, with a Conviction capacity of c440GW.

Energy efficiency

We estimate the energy efficiency market in EU could range from cUSD189bn-385bn in 2020. Our Conviction estimate is USD330bn, which includes building efficiency at USD59bn, industrial efficiency USD40bn, transport efficiency USD208bn (fuel efficiency- USD40bn, low-carbon vehicles – USD152bn and modal shift-USD16bn) and other sub-themes (USD24bn).

China: rapid rise

We estimate that China will be the fastest growing market over the next decade. Our four scenarios provide a market size range of USD289bn-664bn. In our Conviction scenario, China's market grows at a CAGR of 14% from 2009-20, reaching USD526bn in 2020. Low-carbon energy production comprises around 44% of this market (USD230bn) with the remaining 56% (USD298bn) being energy efficiency.



Low-carbon energy production

Our low-carbon energy production estimates for China vary from USD108bn to USD315bn. Our Conviction estimate is a 2020 annual market of USD230bn which includes USD95bn for wind, USD18bn for solar, USD46bn for other renewables and USD54bn for nuclear.

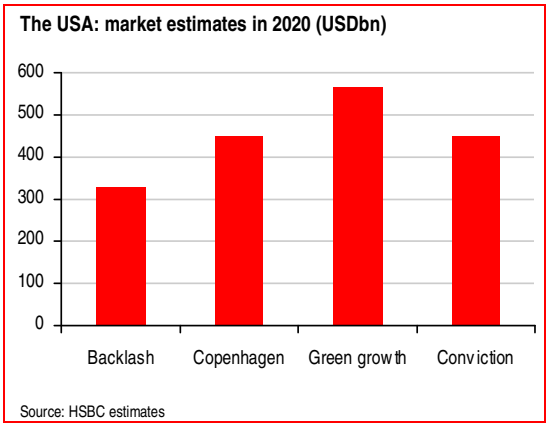
Under our four scenarios we estimate a renewable capacity generation in range by 2020 of 202-464GW, with a Conviction capacity of 391GW.

Energy efficiency

We estimate the energy efficiency market in China could range from USD181bn to USD350bn across our four scenarios in 2020. Our Conviction estimate is USD298bn, which includes building efficiency at USD58bn, industrial efficiency USD46bn, transport efficiency USD173bn (fuel efficiency-USD27bn, low-carbon vehicles USD119bn and modal shift USD28bn) and other sub-themes (USD20bn).

The USA: smaller share

We estimate that the US low-carbon energy market will grow by 10% CAGR over the coming decade; it therefore loses market share to emerging markets. In our Conviction scenario, we estimate a 2020 market size of USD451bn, split between USD255bn in energy efficiency themes and USD196bn in low-carbon energy production.



Low-carbon energy production

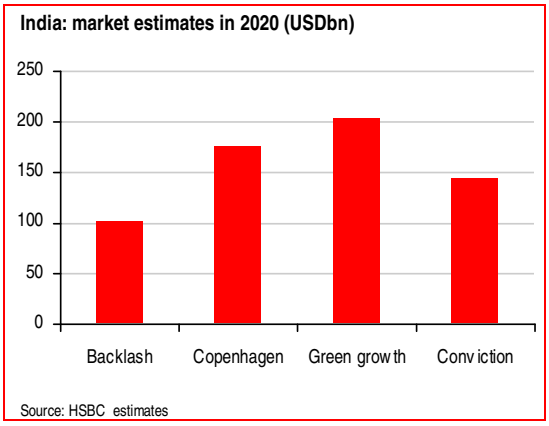
Our US estimates for low-carbon supply range from USD181-267bn, with our Conviction estimate at USD196bn. This includes USD51bn for wind and USD27bn of solar energy market. Our four scenarios give us a range for renewable capacity installations of 169-254GW by 2020, with a capacity of 226GW in our Conviction scenario.

Energy efficiency

We estimate that the US energy efficiency market could grow from USD147bn to USD302bn, in our four scenarios. Our Conviction scenario estimate is USD255bn, which includes building efficiency at USD54bn, industrial efficiency USD33bn, transport efficiency USD145bn (fuel efficiency USD31bn, low-carbon vehicles USD113bn and modal shift USD1bn) and other segments (USD23bn).

India: fourth place

India's projected growth is similar to that of China at 14% CAGR. As a result, our Conviction market size in 2020 is USD145bn, within a range of cUSD102bn-USD203bn. This takes India into fourth place in terms of global market share at 6.5%, ahead of Japan.



Low-carbon energy production

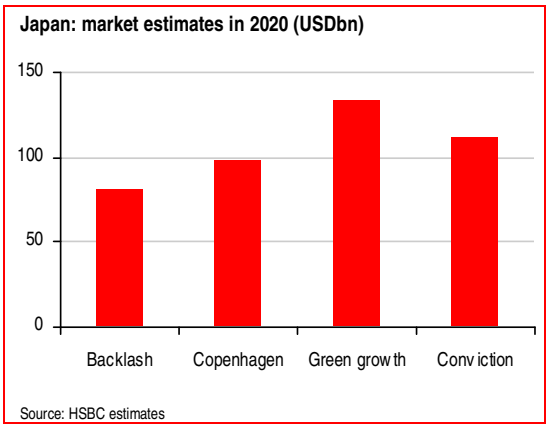
Our estimates for the low-carbon energy production in India range from USD41bn in the Backlash scenario to USD101bn in the Green Growth scenario. Our Conviction estimate is USD63bn, which includes USD15bn for wind, USD7bn for solar and USD14bn for other renewables technologies. We estimate a range of renewable capacity installations from 57GW to 128GW, with our Conviction capacity of 72GW.

Energy efficiency

We estimate the energy efficiency market in India to range from cUSD61bn-102bn, in our four scenarios. Our Conviction scenario estimate is USD82bn, which includes building efficiency at USD24bn, industrial efficiency USD26bn, transport efficiency USD25bn (fuel efficiency USD14bn, low-carbon vehicles USD9bn and modal shift USD2bn) and other sub-themes USD7bn.

Japan: slower growth

From fourth position in 2009, Japan slips to fifth position by 2020 in our Conviction scenario. With a below average 2009-20 CAGR of 9%, Japan's global share declines from 6% to 5%. Overall, we estimate the size of Japan's 2020 low-carbon energy market in a range of cUSD81bn-133bn, with a market size under our Conviction scenario of cUSD112bn.



Low-carbon energy production

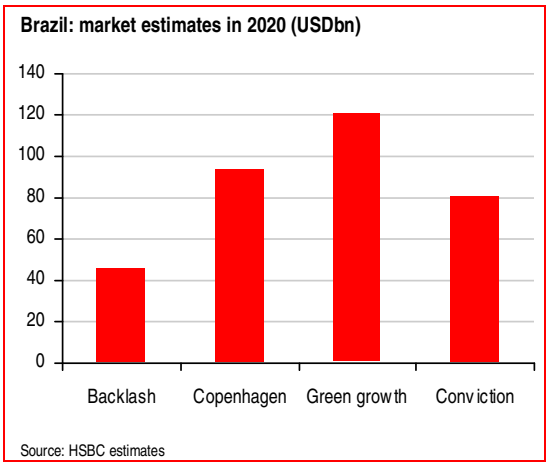
We estimate that Japan's low-carbon energy production market could grow to between USD49bn and USD65bn by 2020, with a Conviction scenario estimate atUSD53bn. This is dominated by a nuclear electricity market of USD34bn, followed by USD9bn for solar, USD3bn for wind and USD5bn for other renewables. Across our four scenarios, we estimate renewable capacity installations in a range of 32-53GW by 2020, with a Conviction scenario capacity of 43GW.

Energy efficiency

We estimate that energy efficiency market in Japan could range from cUSD32bn-68bn across our four scenarios. Our Conviction scenario estimate is USD59bn, which includes building efficiency at USD10bn, industrial efficiency USD7bn, transport efficiency USD38bn (fuel efficiency USD7bn, low-carbon vehicles USD30bn and modal shift USD1bn) and other segments USD3bn.

Brazil: biofuel leader

Across our four scenarios, we estimate that Brazil's low-carbon energy market could range from USD46bn-121bn in 2020, with a Conviction scenario estimate of USD80bn, implying a CAGR of 11%.



Low-carbon energy production

Our Conviction scenario estimate for low-carbon energy production is USD49bn in 2020, within a range of USD26bn-83bn. Biofuels is the largest segment, and at USD34bn is the world's largest market in 2020 (excluding corn ethanol and palm oil). Across our four scenarios, we estimate renewable capacity installations in a range of 20-33GW by 2020, with a Conviction scenario capacity of 26GW.

Energy efficiency

Our estimates for the energy efficiency market for Brazil range from USD20bn in the Backlash scenario to USD38bn in the Green Growth scenario. Our Conviction estimate is USD32bn which includes USD9bn for building efficiency, USD4bn for industrial efficiency, USD18bn for transport efficiency (fuel efficiency USD7bn, low-carbon vehicles USD9bn and modal shift USD1bn) and other segments are USD1bn.

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Capital requirements

- We estimate that building the low-carbon energy market will require total capital investments of around cUSD10trn between 2010 and 2020
- We expect annual low-carbon energy investments to rise from USD460bn in 2010 to USD1.5trn in 2020
- We expect that consumers will make a third of these capital investments in building efficiency, decentralised renewables and low-carbon vehicles

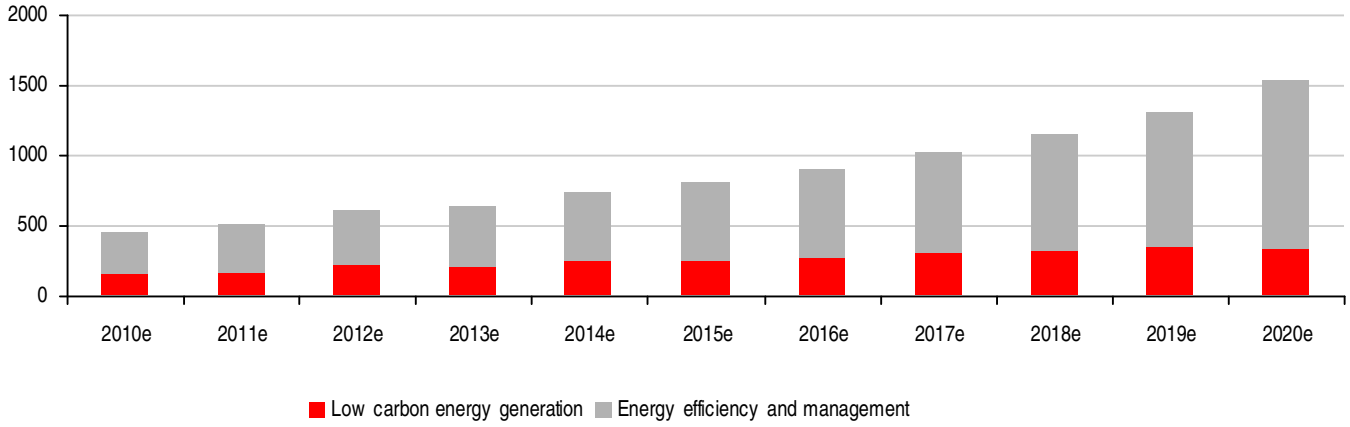
A capital-intensive economy

The shift to a low-carbon economy invariably involves higher upfront capital costs, matched by lower operating costs; these investments will yield positive returns in terms of fuel savings, particularly in building, industry and transport sectors.

We estimate that annual capital investment will rise from USD460bn in 2010 to USD1.5trn in 2020. In total, from 2010 to 2020, we estimate capital investments of USD9.73trn, with USD2.9trn on the energy supply side and USD6.9trn for energy efficient solutions.

On the basis of past trends, we assume these investments will be funded through a mix of debt and equity in a 60:40 ratio. This leads to a debt requirement of USD6trn and fresh equity of USD2trn, assuming that 50% of total equity comes from internal accrual.

Estimated capital investment in low-carbon energy 2010 to 2020e (USDbn)



Source: HSBC estimates

Consumers and corporations

A common misunderstanding is that the low-carbon energy market is the preserve of the corporate sector. This perception results from the supply-side bias of recent investments. However, with energy efficiency taking a larger slice of the market, particularly due to sales of low-carbon vehicles, along with the spread of decentralised energy generation, we expect a growing investment role from the household sector.

We estimate that households will account for around one-third of total capital investments, ranging from just 20% of investment in solar electricity generation equipment, through 50% of investment in building efficiency goods and services to 80% of capital investment in (purchases of) electric vehicles. A critical theme for the coming decade will be the design of new financial packages to make these investments simple and divided into affordable regular payments for households.

Is this affordable?

The tripling of capital investment by 2020 is a substantial shift, but one we think is affordable. Looking at the institutional investment market, in the depressed conditions of 2009, total debt and equity issuance in 2009 is estimated at just USD2.23trn, which includes USD1.49trn of debt and USD0.74trn of equity . But this contrasts with the total capitalisation of the global equity and bond markets of around USD127.5trn, accounted for by USD44.5trn in equity markets and USD83trn bond market.

Delivering this expansion in capital for climate investments will clearly lead to substantial new issuance of corporate equity and debt, as well as require new financing models to enable households to play their part.

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Risks

- Estimating the evolution of low-carbon-energy markets through to 2020 carries all the usual risks of long-term economic modelling, coupled with specific regulatory and technological challenges
- The main upside risks to our Conviction scenario are substantially higher fossil fuel prices, significantly more ambitious policies and technological breakthroughs reducing costs of alternative energy
- The key downside risks to our Conviction scenario are a major retreat from policy commitments in key countries, along with severe delays in implementation

How do we compare?

One way of assessing the risk in estimates is to make a comparison with other evaluations. We have identified three similar studies conducted recently, summarised in the table below. These provide a value range for a clean economy in 2020 at between USD2trn and USD2.3trn– compared with our Conviction estimate of USD2.2trn. One risk with such comparisons is that they often have different scope; another is, of course, a risk of estimates converging due to herd behaviour.

Key risks to our estimates

We have used scenarios as a way of illustrating the range of uncertainties in our estimates. Beyond these, we recognise the following upside and downside risks.

Key downside risks

- Withdrawal of existing regulatory incentives in key markets, perhaps as a result of economic recession and austerity
- Failure to introduce the required new legislation to drive the low-carbon economy: the risk is greatest in the USA

Estimates of 2020 market size

Agency/ report name	Date of publication	Coverage scope	Market size
HSBC Climate Change Index Annual Review	September 2009	Modelled growth rates of revenues of listed companies	USD2 trn
Clean Economy, Living Planet report by Roland Berger Consultants work for World Wide Fund (WWF)	November-2009	Clean energy technology comprising 2 segments: energy efficiency and renewable energy	USD2.2trn
Out of the Running? published by Centre for American Progress	March-2010	Clean energy technology comprising 2 segments: energy efficiency and renewable energy	USD2.3trn
Climate Competitiveness Index (CCI) produced by Accountability in partnership with UNEP	April-2010	Market for low-carbon products and services	USD2trn

Source: Reports quoted/listed in the table

- Inadequate implementation and enforcement of existing regulations for renewable energy and energy efficiency
- Erosion of public trust in the science of climate change
- Economic conditions diverting attention away from climate change and clean energy priorities
- Material decline in fossil fuel prices such as shale gas, undermining the economics of renewables and energy efficiency
- Low take-up of energy efficiency initiatives, particularly those which rely on large-scale involvement of consumers
- Absence of necessary infrastructure to support the roll-out of new technologies such as renewables and EVs
- Inability to agree a global climate agreement to succeed the Kyoto Protocol whose first phase ends in 2012

Key upside risks

- Resurgence of public concern on the back of strengthened science and incidence of extreme weather events
- Faster than expected decline in costs of key technologies, such as CCS, EV, solar and wind
- High and volatile rise in oil, gas and coal prices; we assume only inflationary increases in feedstock prices until 2020
- Serious commitment by governments to making low-carbon growth a feature of economic recovery plans
- A competitive 'race to the top' for low-carbon market share among key economies
- Development of new business models that overcome price and behavioural obstacles particularly in the consumer market
- Agreement of a strong international climate deal that builds confidence for additional action at the national level

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Appendix

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Background information

Key assumptions

The key parameters and variables on which we have made assumptions are as follows:

1 Growth in electricity consumption and demand

2 Renewable electricity and energy targets (absolute or relative)

3 Emission reduction targets

4 Repowering

5 Plant load factor (PLF) of various generation technologies

6 Capital cost of various electricity generation technologies

7 Average wholesale electricity prices

8 Oil, coal and gas prices

9 Carbon prices

10 Technology cost comparisons

This section gives a summary of the key assumptions for these parameters and variables.

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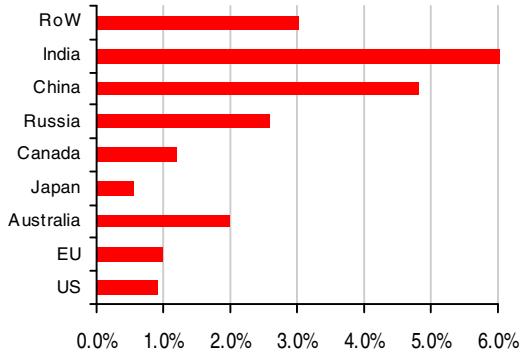
Electricity consumption

Our Conviction electricity growth rate assumptions over 2009-20e are summarised in the chart below. The rates take into consideration our energy efficiency estimates.

Conviction scenario: electricity consumption CAGR 2009e-20e



Source: HSBC estimates

Without energy efficiency measures, we expect electricity consumption growth rates to be considerably higher.

CAGR of electricity consumption over 2009e-20e (with and without any energy efficiency initiatives)

	CAGR
China	
BAU	5.6%
Conviction scenario (18% energy efficiency assumption)	4.8%
EU	
BAU	2.0%
Conviction scenario (10% energy efficiency target)	1.0%
US	
BAU	1.5%
Conviction scenario (10% energy efficiency)	0.9%

Source: HSBC estimates

The resulting electricity generation across the key countries is illustrated below.

Electricity generation across key economies and 2009e-20e CAGR for generation Conviction scenario (billion KWH)

	2009e	2020e	CAGR	GDP CAGR
US	3,992	4,418	0.9%	4.2%
China	3,638	6,109	4.8%	11.5%
EU	3,192	3,560	1.0%	2.9%
Japan	1,067	1,134	0.6%	3.4%
Russia	1,031	1,365	2.6%	16.4%
India	787	1,535	6.3%	10.0%
Canada	575	670	1.4%	6.7%
Brazil	482	686	3.3%	8.7%
RoW	4,554	6263	3.0%	7.8%
Total	**19,331**	**25,740**	**2.6%**	**5.9%**

Note: GDP CAGR is based on IMF estimates for the period 2009-2015
Source: HSBC estimates, http://www.imf.org/external/pubs/ft/weo/2010/01/weodata/index.aspx

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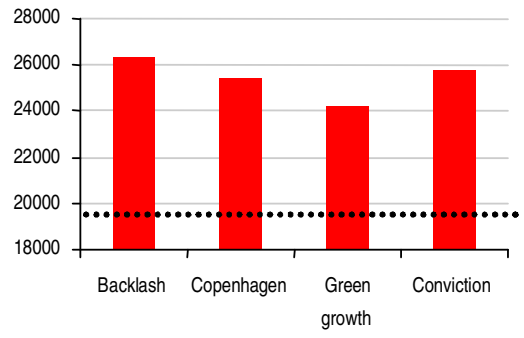
Electricity generation

Total generation under individual scenarios (billion KWH)

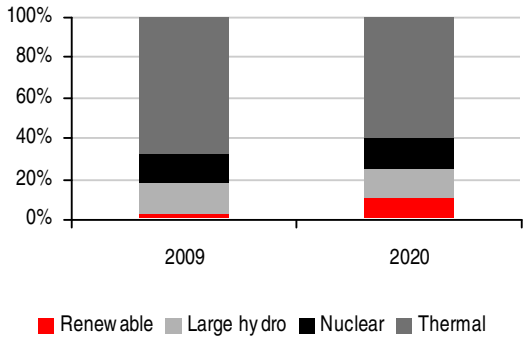


Note: Dotted line indicates our estimate generation for 2009
Source: HSBC estimates

Overall, we expect global thermal power generation to grow by around 18%. Between 2009 and 2020, we estimate that thermal generation in the developed world (US, EU, Canada, Japan, Russia and Australia) will decrease by c7% from the estimated 2009e levels (excluding Russia the decline is even larger at c12%). By contrast, we expect that it will increase by c40% in the developing countries (China, India and others), implying an increase of 18% at the global level. We do not expect old thermal generating stations in the developed world to be replaced with new coal based stations, especially as carbon capture and storage (CCS) is still not a commercially proven technology.

We expect the proportion of natural gas in the thermal generation mix will increase over the

Global generation mix (2009e-20e, %)

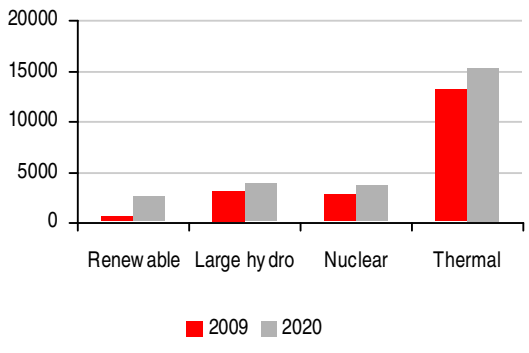


Source: HSBC estimates

coming years given the low-carbon content of gas compared to coal and oil and its increased supply. The finds of shale gas in North America and gas's lower cost of production due to developments in exploration technology are expected to result in lower gas prices and increased supply in the USA. This will lead to reduced LNG off take by the US companies, thereby improving the supply in other parts of the world and creating downward pressure on gas prices.

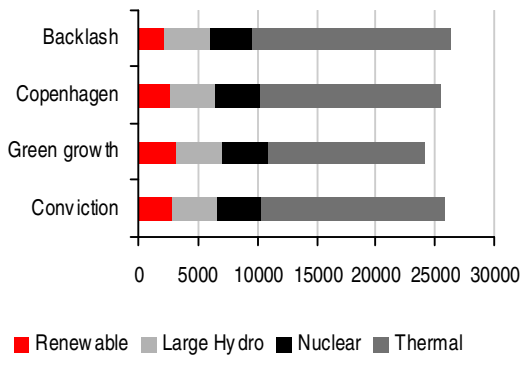
Given the US success story, the possibility of exploiting unconventional gas reserves in other parts of the world has increased. China, Australia, India and few other countries are also believed to hold large reserves of unconventional gas. The increased supply scenario, lower production costs and lower carbon content of gas, will result in

Electricity generation mix 2009 vs 20202 (billion KWh)

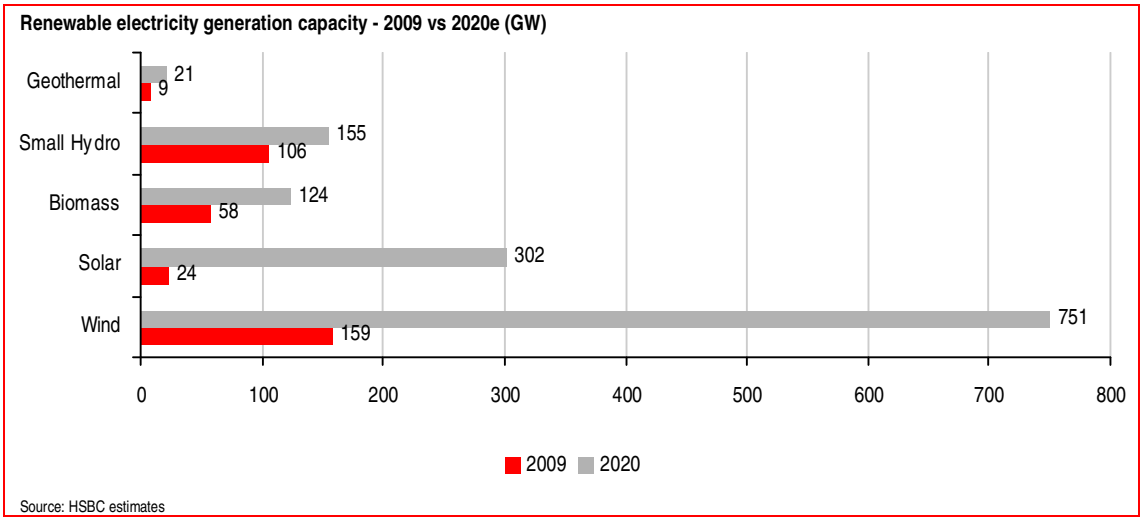


Source: HSBC estimates

Electricity generation based on generation type (2020, billion kWh) under the four scenarios



Source: HSBC estimates



natural gas being a larger proportion of the thermal mix especially in countries and regions such as the Middle East (with large natural gas reserves), China, and India, as well as the developed countries such as US and Europe, where gas is clearly the preferred option. This also changes the relative costs for addressing greenhouse gas (GHG) emissions as natural gas has a lower carbon footprint than other fossil fuels, about half that of coal.

Renewable electricity/energy targets

Some countries and regions have mandated or proposed renewable electricity targets, while others, such as the EU, have mandated renewable energy targets. A few countries, such as China, have proposed capacity addition targets for specific renewable generation and conventional technologies.

We discuss state level REN targets in US and European country targets below. We also analyse the deduced renewable electricity targets for the countries with emission reduction targets (but no renewable targets).While the Federal targets in the US are still being discussed, many states have announced their own renewable portfolio standards (RPS), which are voluntary, mandated or proposed. If we assume only the state RPS targets, we estimate c10% of electricity in 2020 will be supplied by renewable sources.

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US states with renewable portfolio standards (RPS)

State	% / MW	Target year	Remarks
Arizona	15	2025	
California	33	2020	
Colorado	30	2020	
Connecticut	27	2020	
Delaware	20	2020	
District of Columbia	20	2020	
Hawaii	40	2030	
Illinois	25	2025	
Iowa	1,000MW (wind)	2010	
Kansas	20	2020	
Maine	40	2017	
Maryland	20	2022	
Massachusetts	15	2020	
Michigan	10	2015	
Minnesota	25	2025	
Missouri	15	2021	
Montana	15	2015	
Nevada	25	2025	
New Hampshire	23.8	2025	
New Jersey	22.5	2021	
New Mexico	20	2020	
New York	29	2015	
North Carolina	12.5	2021	
North Dakota	10	2015	V
Ohio	25	2025	
Oklahoma	15	2015	V
Oregon	25	2025	
Pennsylvania	18	2021	
Rhode Island	16	2020	
South Dakota	10	2015	V
Texas	5880	2015	
Utah	20	2025	V
Vermont	20	2017	V
Virginia	15	2025	
Washington	15	2020	
West Virginia	25	2025	V
Wisconsin	10	2015	

Note: V – Voluntary
Source: www.dsireusa.org

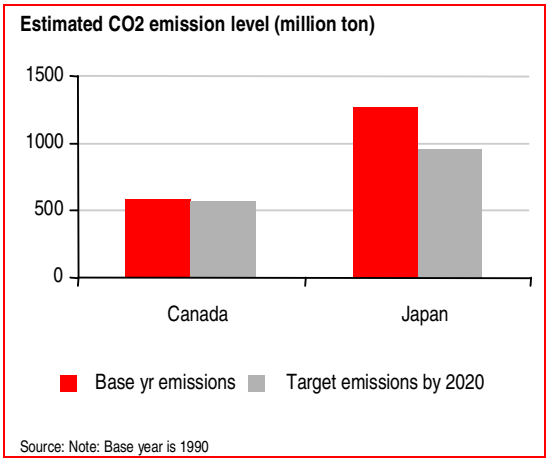
Assumptions for EU country targets

EU Country	REN energy mix in 2005	REN energy target for 2020	% increase required	REN electricity target for 2010	Assumed REN electricity target 2020	% increase required
Austria	23%	34%	11%	78%	80%	2%
Belgium	2%	13%	11%	6%	20%	14%
Bulgaria	9%	16%	7%	11%	25%	14%
Cyprus	3%	13%	10%	6%	20%	14%
Czech Republic	6%	13%	7%	8%	14%	6%
Denmark	17%	30%	13%	29%	50%	21%
Estonia	18%	25%	7%	5%	20%	15%
Finland	29%	38%	10%	32%	40%	9%
France	10%	23%	13%	21%	26%	5%
Germany	6%	18%	12%	13%	30%	18%
Greece	7%	18%	11%	20%	30%	10%
Hungary	4%	13%	9%	4%	20%	16%
Ireland	3%	16%	13%	13%	44%	31%
Italy	5%	17%	12%	25%	33%	8%
Latvia	35%	42%	7%	49%	49%	0%
Lithuania	15%	23%	8%	7%	20%	13%
Luxembourg	1%	11%	10%	6%	20%	14%
Malta	0%	10%	10%	5%	20%	15%
Netherlands	2%	14%	12%	9%	25%	16%
Poland	7%	15%	8%	8%	18.4%	11%
Portugal	21%	31%	11%	39%	60%	21%
Romania	18%	24%	6%	33%	38%	5%
Slovakia	7%	14%	7%	31%	34%	3%
Slovenia	16%	25%	9%	34%	40%	6%
Spain	9%	20%	11%	29%	42%	13%
Sweden	40%	49%	9%	60%	62%	2%
United Kingdom	1%	15%	14%	10%	30%	20%

Source: HSBC estimates

The EU has mandated a renewable energy target of 20% by 2020, which is further subdivided into targets for the member states. The European Commission required member states to submit their action plans by June 2010, with the energy targets being further subdivided into targets for electricity, transport and heating. In the absence of individual country renewable electricity targets which there are for renewable energy targets, we have made our own estimates targets primarily taking into consideration the difference in the current and proposed renewable energy targets and performance over the past few years. We have assumed that by 2020, 33% of electricity generated by EU27 will come from renewable sources.

For countries which have not mandated renewable energy targets but have mandated emission reduction targets, our estimates on growth in renewable generation are based on their emission targets. Here we look at two countries – Canada and Japan. Our estimates on their total emission based on their target reductions are summarised in the chart below.



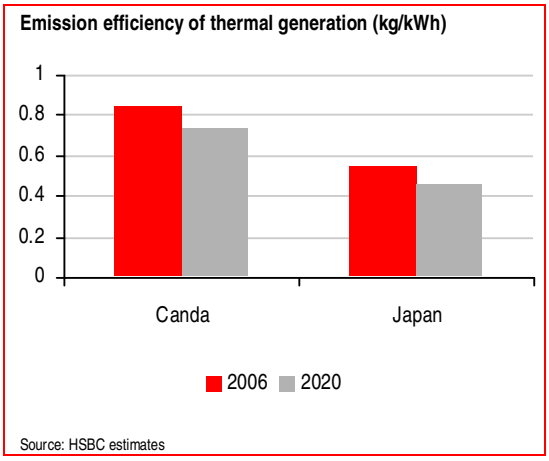
Source: Note: Base year is 1990

To calculate total permissible thermal generation at a given emission level, we assume a marginal improvement in generating stations' energy efficiency on a y-o-y basis. The emission factor is expected to improve over time due to technological advancement and fuel switch (from coal to gas and nuclear) (refer to the chart entitled Emission efficiency of thermal generation for our assumptions). We expect the remaining electricity to be sourced from large hydro, nuclear and renewable technologies.

Plant load factor (PLF)

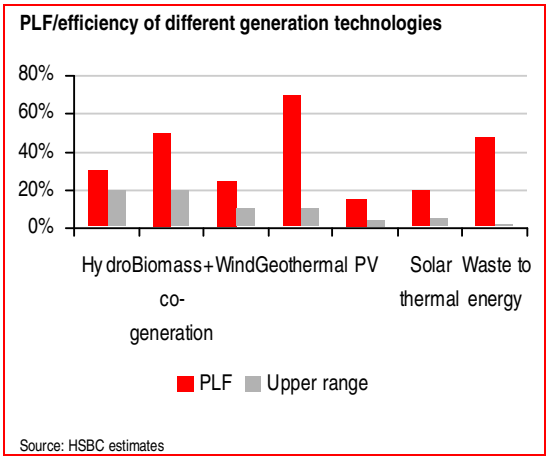
Our broad assumptions on the PLF of different technologies used to calculate electricity generation are given in the chart PLF/efficiency of different generation technologies. Wherever possible, we have used country-specific load factors based on historical performance.

After establishing the ratio of renewable electricity generation to total electricity demand, we assess the contribution of each renewable



Source: HSBC estimates

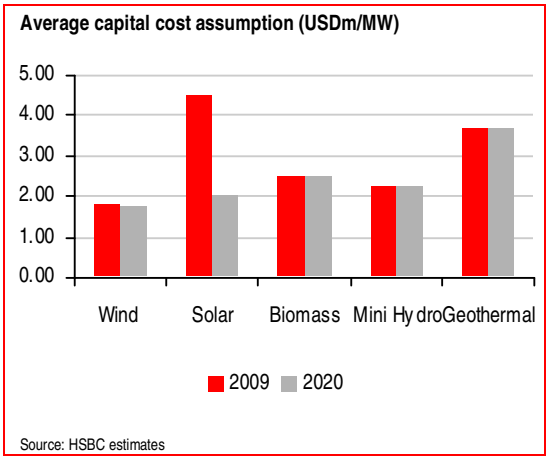
technology on the basis of parameters such as the natural abundance of power generation sources, country-specific policies and technological advancements in renewable energy sources. As a result, we are able to determine the scope and scale of each renewable technology.

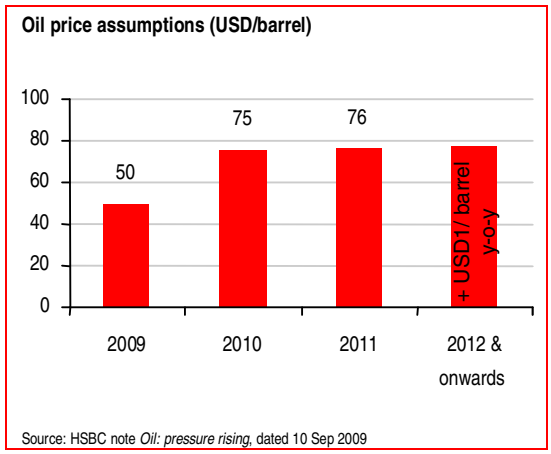


Source: HSBC estimates

Capital cost of generation

Given the significant variation in the cost of developing renewable technology platforms across countries, we have looked at a range of per unit cost for each technology and then used a median value to determine the average per unit cost for renewable technologies as a whole.





For solar energy, we assume the capital cost of a system to decline from USD4.5m/MW in 2009 to USD2/MW by 2016 and then remain constant over the remaining forecast period.

The weighted average capital cost estimates for wind energy, based on our estimates for on-shore and off-shore wind capacity and per unit capital cost of two technologies, are summarised in the table below. For per unit capital cost of on-shore and off-shore wind, we assume annual reduction rates of 2% and 5%, respectively, 2013-20.

Weighted average capital cost of wind (USDm/MW)

	2009e	2012e	2016e	2020e
On-shore	1.8	1.8	1.7	1.6
Off-shore	5.1	4.9	4.0	3.2
Weighted average capital cost	1.83	2.02	1.90	1.75

Source: HSBC estimates

For other more mature clean technologies, our estimates take into consideration the historic cost trends of electricity generation technologies where we project no significant changes in capital costs.

Oil, coal and gas prices

Over the forecast period, we use an oil price estimate provided by HSBC Oil & Gas team in its note *Oil: pressure rising*, dated 10 September 2009.

We believe coal prices will increase at a CAGR of 3% over 2009-20.

Gas prices are correlated to oil prices in most of the key markets, except in the US and the UK. Therefore, we expect gas prices to increase gradually with a rise in oil prices.

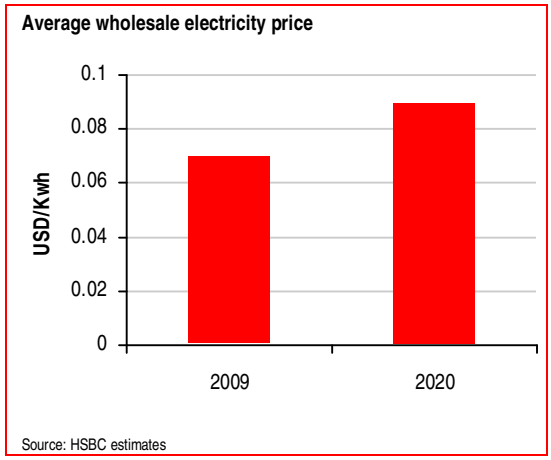
Coal and gas price estimates

	2009	2020 (conviction)	2020 (aggressive)
Coal (USD/ton)	75	105	150
Gas (USD/MMbtu)	8	11	15

Source: HSBC estimates

Average wholesale electricity price

We estimate the average world wholesale electricity price by using our y-o-y price estimate for select countries and states, which include Germany, Spain, Italy, California, New York and India. We have excluded China due to the lack of data. We raise our average wholesale electricity price estimate from USD0.07/kWh in 2009 to USD0.09/kWh in 2020. We use these prices to



estimate the revenue from electricity sales for various renewable technologies with exception of wind and solar. For wind and solar, we use a multiplication factor (over the average wholesale electricity prices) of 1.25 and 4, respectively, in 2009 and reduce this gradually to 1 by 2014.

Repowering

For renewable technologies with a project life of 20-25 years, we do not consider any significant capacity addition from repowering. For example, we expect wind to experience 4GW repowering by 2020, which we have factored into our analysis.

Technology cost comparison

Our analysis on the low-carbon energy framework is sensitive to the generation cost of conventional technologies (coal and gas) with key renewable technologies (wind and solar) in 2020. Our approach and methodology to work out the generation cost of various technologies along with key assumptions is summarised below.

Methodology

We have recalculated what we believe are the full capital and operating costs (including any fuels necessary) for both current key conventional technologies and renewables. These are the basic assumptions that underlie our analysis:

- We assume that full cost = capital cost + fuel cost + operating & maintenance costs + carbon cost
- Our energy price assumptions are summarised in the following tables
- Our capital cost assumptions are based on recently published information and our estimates of the cost of solar technologies in 2020 (refer to table below)
- We have assumed a plant load factor of 85% for most of the conventional technologies, while our load factor for solar and wind technologies vary across geographies, as summarised in the tables below
- We have made the following assumptions for plant efficiency: coal, 39%; CCGT, 55%; and IGCC, 40%
- Carbon parameters: We estimate the CO_2 produced by coal-fired power generation at 800Kg/MWh and CO_2 in CCGT power generation at 400Kg/MWh and price assumptions are summarised in the tables below

The table below shows the estimated cost of wind and solar generation in 2020.

Estimated cost of wind and solar generation (EUR/MWh; 2020e)

Market	Specification	Wind-off-shore	Wind – on-shore	Solar
	Capital cost (EURm/MW)	4,000	1,200	1,400
EU and Asia	PLF	35%	25%	20%
EU and Asia	Generation cost	169	76	100
US	PLF	40%	35%	20%
US	Generation cost	149	55	100

Source: HSBC estimates

We draw nine scenarios with three sets of coal and gas prices and three carbon price assumptions. For the USA, we consider our Conviction scenario based on coal and gas price assumptions of USD100/tonne and USD10/mmbtu, with a carbon price assumption of USD20/tonne. For the EU market, we consider our conviction scenario based on coal and gas price assumptions of USD110/tonne and USD12.5/mmbtu, with a carbon price assumption of USD40/tonne. The results of our scenario analysis are summarised in the following tables.

Generation cost with coal price of USD100/tonne and gas price of USD 10/mmbtu and assumed carbon price

Carbon price	USD/ton	20	30	42
Coal	EUR/MWH	54	60	67
Gas	EUR/MWH	62	64	68

Source: HSBC estimates

Generation cost with coal price of USD110/tonne and gas price of USD12.5/mmbtu and assumed carbon price

Carbon price	USD/ton	20	30	42
Coal	EUR/MWH	57	63	70
Gas	EUR/MWH	73	75	79

Source: HSBC estimates

Generation cost at a coal price of USD150/tonne, gas price of USD15/mmbtu and an assumed carbon price

Carbon price	USD/ton	20	30	42
Coal	EUR/MWH	67	73	80
Gas	EUR/MWH	84	86	90

Source: HSBC estimates

We believe coal is unlikely to be the preferred choice in the developed world (given the focus on cutting emissions). We therefore compare the cost of gas generation to wind and solar. In our Conviction scenario, we expect onshore wind to be fully competitive with gas generation across the key markets of the EU and the USA.

For other key energy markets, primarily developing countries including China, India and South Korea, we believe generation cost of renewable technologies, such as wind and solar, will be higher than coal and gas. However, these countries have fixed their renewable generation capacity targets (for select technologies) in absolute terms and we do not see carbon price as the key influencing factor for these countries.

Tropical hydro: high GHG emissions

A review by Éric Duchemin and colleagues[15] for the tropical hydro reservoirs find the average GHG emissions for each range from 200 to 3,000 grams per kilowatt-hour. The top of the range is more than three times higher than the emissions from modern coal-generated electricity. Other studies (Fearnside 1995, 2000 and 2005) for tropical dams especially in Brazil have reported far higher emissions (see table below). Thus it seems that large hydro in tropical countries is not "climate friendly". A study[16] by Brazil's National Institute for Research estimates in 1990 the greenhouse effect of emissions from the Curuá-Una dam in Pará, Brazil, was more than three-and-a-half times what would have been produced by generating the same amount of electricity from oil. This is because large amounts of carbon tied up in trees and other plants are released when the reservoir is initially flooded and the plants rot.

Tropical Hydro – a significant source of GHG emissions

Regions	Hydro installations	Emissions (gCO2eq./KWh)	Source
Canada	Churchill Falls	<90	P. Raphals (2001)
	Complexe la Grande	<75	P. Raphals (2001)
Switzerland	Wohlensee	119	Del Sontro, T. et al. (2008)
Boreal/ temperate		10-200	Eric Duchemin, 2002
Brazil	Balbina	30,250	P.M. Fearnside (1995)
Brazil	Curua-Una	5700	P.M. Fearnside (2005)
Brazil	Tucurui	3280	P.M. Fearnside (2000)
French Guiana	Petit-Saut	455	Alain Tremblay et al. 2007[14]
Tropical		200-3000	Eric Duchemin, 2002
	Non-Hydro installation		
	Coal (modern plant)	790-1,200	
	Biomass Energy	17-120	
	Wind power	7-40	

Source: Compiled by HSBC

[14] Alain Tremblay et al. 2007 http://www.un.org/esa/sustdev/sdissues/energy/op/hydro_tremblaypaper.pdf

[15] Éric Duchemin et al. (2002) "Hydroelectric reservoirs as an anthropogenic source of greenhouse gases," World Resource Review

[16] Source: http://www.newscientist.com/article/dn7046

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Disclosure appendix

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