

INTERNATIONAL ENERGY AGENCY
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A stylized world map is visible in the background of the central section, rendered in dark red and black silhouettes against a lighter red and orange gradient. The map shows the outlines of continents and major landmasses.

**THE IMPACT OF THE FINANCIAL
AND ECONOMIC CRISIS
ON GLOBAL ENERGY INVESTMENT**



Note to Readers

This report was prepared for the G8 Energy Ministerial in Rome on 24-25 May 2009 by the Office of the Chief Economist (OCE) of the International Energy Agency (IEA) in co-operation with other offices of the Agency. The study was directed by Dr. Fatih Birol, Chief Economist of the IEA. The work could not have been completed without the extensive data provided by many government bodies, international organisations, energy companies and financial institutions worldwide.

The 2009 edition of the World Energy Outlook (WEO), to be released on 10 November, will include an update of this analysis and additional insights into the implications of the financial and economic crisis on energy security, climate change and energy poverty over the medium and longer-term.



EXECUTIVE SUMMARY

Energy investment worldwide is plunging in the face of a tougher financing environment, weakening final demand for energy and falling cash flows – the result, primarily, of the global financial crisis and the worst recession since the Second World War. Reliable data on recent trends in capital spending and demand are still coming in, but there is clear evidence that energy investment in most regions and sectors will drop sharply in 2009. Preliminary data points to sharp falls in demand for energy, especially in the OECD, contributing to the recent sharp decline in the international prices of oil, natural gas and coal.

Both supply and demand side investments are being affected. Energy companies are drilling fewer oil and gas wells and cutting back spending on refineries, pipelines and power stations. Many ongoing projects are being slowed and a number of planned projects have been postponed or cancelled – for lack of finance and/or because of downward revisions in expected profitability. Meanwhile, businesses and households are spending less on energy-using appliances, equipment and vehicles, with important knock-on effects for efficiency of energy use. Tighter credit and lower prices make investment in energy savings less attractive financially, while the economic crisis is encouraging end users to rein in spending across the board, as a defensive measure. This is delaying the deployment of a more efficient generation of equipment. Furthermore, equipment manufacturers are expected to reduce investment in research, development and commercialisation of more energy-efficient models, unless they are able to secure financial support from governments.

Impact by sector

In the oil and gas sector, there has been a steady stream of announcements of cutbacks in capital spending and project delays and cancellations, mainly as a result of lower prices and cash flow. We estimate that global upstream oil and gas investment budgets for 2009 have already been cut by around 21% compared with 2008 – a reduction of almost \$100 billion. Between October 2008 and end-April 2009, over 20 planned large-scale upstream oil and gas projects, valued at a total of more than \$170 billion and involving around 2 mb/d of oil production capacity and 1 bcf/d of gas capacity, were deferred indefinitely or cancelled. A further 35 projects, involving 4.2 mb/d of oil capacity and 2.3 bcf/d of gas capacity, were delayed by at least 18 months. It is likely that the upstream industry will reduce spending on exploration most sharply in 2009 – largely because the bulk of spending on development projects is associated with completing projects that had already been launched before the slump in prices. Oil sands projects in Canada account for the bulk of the postponed oil capacity. The drop in upstream spending is most pronounced in the regions with the highest development costs and where the industry is dominated by small players and small projects. For these reasons, investment in non-OPEC countries is expected to drop the most. In addition, cuts in spending on existing fields risk pushing-up decline rates.

Power-sector investment is expected to be severely affected by financing difficulties, as well as by weak demand. We estimate that global electricity consumption could drop by as much as 3.5% in 2009 – the first annual contraction since the end of the Second World War. In the OECD, electricity demand in the first quarter of 2009 fell by 4.9% on a year-on-year basis. Non-OECD regions have also seen weaker demand: in China, for example, demand fell by 7.1% in the fourth quarter of 2008 and by a further 4% in the first quarter of 2009. Weak demand growth is reducing the immediate need for new capacity additions. At the same time, commercial borrowing has become more difficult and the cost of capital has risen markedly; venture capital and private equity investment has fallen sharply. If a recovery takes longer than expected, and energy prices remain at depressed levels relative to recent peaks, we would expect to see a shift to coal- and gas-fired plants at the expense of more capital-intensive options such as nuclear and renewables, although this will depend on the policies and support mechanisms individual countries and regions have in place.

The outlook for investment in renewables-based power projects is mixed, depending on the policy framework, but is generally falling proportionately more than that in other types of generating capacity. We estimate that for 2009 as a whole investment in renewables could drop by as much as 38%, although stimulus provided by government fiscal packages can probably offset a small proportion of this decline. Investment in renewable energy assets surged in recent years, recording year-on-year growth of 85% in 2007. But activity slowed in 2008 as sources of finance contracted and lower fossil-fuel prices reduced the economic incentive for new investment, particularly in the last few months of the year. Preliminary data for the first quarter of 2009 indicates that the slump in investment has accelerated, with spending 42% lower than in the previous quarter. In most regions, investment in bio-refineries has all but dried up due to lower ethanol prices and scarce finance.

Industry surveys suggest investment in the coal sector could drop by 40% in 2009 compared to 2008. Nonetheless, this drop is from very high levels reached in 2007 and 2008, which were exceptionally profitable: coal companies used free cash flows to sharply increase their investments, as well as paying out large dividends to shareholders. Expected reductions in capital spending in 2009 are most marked among high-cost producers, especially those supplying export markets, such as in the United States and Russia. In contrast, Indonesian coal producers continue to enjoy high margins with little apparent disruption to planned expansions.

Implications for energy security, climate change and energy poverty

Falling energy investment will have far-reaching and, depending on how governments respond, potentially grave effects on energy security, climate change and energy poverty. Cutbacks in investment in energy infrastructure will only affect capacity with a lag, often amounting to several years. So, in the near term at least, weaker demand is likely to result in an increase in spare or reserve production capacity. But there is a real danger that sustained lower investment in supply in the coming months and years, could lead to a shortage of capacity and another spike in energy prices in several years time, when the economy is on the road to recovery. The faster the recovery, the more likely that such a scenario will happen.



The impact on greenhouse-gas emissions will depend on how the crisis affects investment in different types of energy technology. In the short term, slower economic growth will curb growth in emissions. But, in the medium and longer-term, the crisis may lead to higher emissions, as weak fossil-energy prices and financing difficulties curb investment in clean energy technologies, increasing reliance on fossil-fuelled capacity. At the same time, investors will remain risk averse, so that funding for clean energy projects will be available primarily for proven technologies in attractive markets. Once the recession is over, the likely burst of economic growth or "catch-up effect" may also cancel out any short-term emissions benefit. There is also a very real risk that the world's preoccupation with dealing with the crisis will lessen the chance of reaching a comprehensive climate-change agreement in Copenhagen.

Cutbacks in energy investment will impede access by poor households to electricity and other forms of modern energy – a vital factor in pulling people out of poverty. There are an estimated 1.6 billion people worldwide still lacking access to electricity – most of them in sub-Saharan Africa and southern Asia. This figure may grow as a result of the crisis, as some of the households that previously had access are no longer able to afford to pay for the service and financial problems limit the ability of utilities to connect new customers.

IEA urges governments to act on economic, energy security and environmental goals

These concerns justify government action to support investment in energy efficiency and clean energy. Many countries recognise this: a small but significant share of the additional public spending in short-term economic stimulus packages announced to date (about 5% of a total of \$2.6 trillion) is directed at energy efficiency and clean energy – either direct investment or fiscal incentives for low-carbon power technologies and the development and commercialisation of more energy-efficient end-use technologies. These moves are a positive step in the right direction, potentially killing three birds with one stone: tackling climate change, enhancing energy security and combating the recession.

But much more needs to be done. The investment needed to put the world onto an energy path consistent with limiting the rise in global temperature to around 2°C far exceeds the additional investments that are expected to occur as a result of the stimulus packages so far announced. Our analysis suggests that, relative to their recent announcements, governments should be looking to increase the level of new funds they commit to energy efficiency and low-carbon energy policies by a factor of around four. And, at a minimum, this level of investment would have to be sustained each and every year for decades to come. The IEA, therefore, encourages world leaders attending the 2009 G8 Summit under the Italian Presidency to push for such action on a global scale – a *Clean Energy New Deal* – to exploit the opportunity the financial and economic crisis presents to improve energy efficiency and effect a permanent shift in investment to low-carbon technologies including carbon capture and storage. This must be seen as a long-term commitment that extends well beyond the limited time horizon of the economic stimulus packages.



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How is the crisis affecting energy investment?

A twin global crisis

It is no longer in doubt that the world economy has entered into a severe recession – quite possibly the worst since the 1930s. The economies of most OECD countries and most non-OECD countries are already contracting, and economic growth rates are slowing abruptly everywhere else. According to preliminary data, global GDP fell by an unprecedented 5% in the fourth quarter of 2008 on an annualised basis, with the advanced economies contracting by around 7%. GDP declined in the fourth quarter by around 6% in both the United States and the euro area and at a post-war record rate of 13% in Japan. Growth also plunged across a broad swathe of emerging economies. Preliminary data now coming in confirms the severity of the recession. The synchronised manner of the downturn across all regions, as well as the speed of the contraction, is unprecedented.

The global economic crisis was triggered by the financial crisis, which began in mid-2007 and took a dramatic turn for the worse in the second half of 2008. Financial difficulties caused by plunging asset values have curtailed sharply the ability and willingness of banks to lend money, which is impeding investment, undermining consumption and paralysing economic activity. The deteriorating economic climate is, in turn, aggravating the financial crisis, sending the world's financial and economic systems into a sharp downward spiral. Inflation is falling rapidly in response to economic contraction and the collapse of commodity prices since mid-2008. The precise role of other factors in causing the initial economic downturn, including the impact of high oil prices and the global trade imbalances that had been building up over several years, is unclear (Box 1).

The energy sector, like all other economic sectors, is being profoundly affected by the worsening business climate and the credit crunch. A fall in the levels of investment and a change in the patterns of investment across the economy constitute a central component of the process of structural adjustment to weaker demand. The credit crunch is exacerbating this process. Overall investment in energy supply, including oil and gas wells, refineries, pipelines and power stations, is likely to be reduced substantially in the next year or two and the allocation of capital across the different energy sectors changed markedly. Investment by businesses in energy-consuming appliances, equipment and vehicles will also be affected, slowing the improvement in efficiency of energy use and altering demand patterns. The consequences for energy security and climate change will be far-reaching; depending on how governments respond, the net effects could be negative.

There is enormous uncertainty about near-term economic prospects worldwide as the ramifications of the credit crunch and the full effects of the economic slump unfold. The leading forecasting bodies – private and public – have in recent months revised downwards repeatedly

their projections for the next year and beyond. In mid-April 2009, the International Monetary Fund slashed its global GDP forecasts yet again, with growth now expected to drop from 5% in 2007 and an estimated 3.2% in 2008 to -1.3% in 2009 on an annual average basis (IMF, 2009). This represents a downward revision of one-and-a-half percentage points compared with the IMF forecasts released just three months previously. The downturn is being led by the advanced economies, which are now forecast to contract in aggregate by 3.8% in 2009. This would be the first annual contraction since the Second World War. The IMF still expects the world economy to stage a modest recovery next year, conditional on comprehensive policy steps to stabilise financial conditions, sizeable fiscal support, a gradual improvement in credit conditions, a bottoming of the US housing market, and the cushioning effect from sharply lower oil and other major commodity prices. Global GDP is projected to rebound by 1.9% in 2010, though the advanced economies are expected to see no growth. However, the IMF points out that the recession will be deeper and more prolonged in the event of further delays in implementing policies to stabilise financial conditions.

The problems that have beset global financial and credit markets since mid-2007 are both a cause and effect of the broader slump in the real economy. Concerns about the stability of the financial system first appeared in mid-2007 as large losses on mortgage-backed securities caused by defaults in the United States came to light. The crisis intensified with the collapse of the US securities firm, Bear Stearns, in March, and the investment bank, Lehman Brothers, in September, and the subsequent intervention of the monetary authorities to bail out several institutions in the United States and Europe. The crisis spread rapidly across the financial markets in the OECD and to emerging markets as falling asset values have damaged the balance sheets of banks and other financial institutions, forcing them to rein in lending and tighten the terms of new loans, including raising interest rates sharply. Growing concerns about counterparty risk have also disrupted credit markets, especially the interbank and commercial paper markets. This has made it much harder – and more expensive – for businesses of all types to borrow money on a short-term or long-term basis. The credit crunch is both causing and feeding on the sharp downturn in economic growth, as the value of physical and financial assets spiral lower, liquidity and credit diminishes and economic activity contracts.

Governments in the advanced economies, through their central banks, have responded forcefully to the financial crisis with extraordinary measures. These include large injections of liquidity (more recently by introducing or printing “new” money, a tactic known as quantitative easing), coordinated cuts in interest rates to almost zero in all OECD countries, the full or part nationalisation of major financial institutions and direct interventions in commercial paper markets. These moves have sought to shore up the financial system and sustain lending to businesses and households. Governments have also launched programmes to provide economic stimuli to sustain demand and combat recession, involving big increases in public spending (often to support sectors that have been particularly badly hit by the economic slump and the



credit crunch, notably the car industry) and tax cuts. In mid-February, President Obama signed into law a \$787-billion package of measures to be introduced over ten years, including about \$50 billion of incentives to develop and deploy clean energy technologies (see the last section). Most European countries, Japan, Korea and Australia have also introduced or proposed strong measures to stimulate the economy. China introduced a sweeping stimulus package worth \$585 billion over two years in late 2008, and is reportedly planning another massive injection of spending. A growing number of countries in other parts of the world are following suit.

Box 1: To what extent were high oil prices to blame for the initial economic downturn?

Although it is generally considered that the financial crisis was the principal immediate cause of the sudden, sharp and synchronised economic downturn that took hold in 2008, other factors – including the run-up in oil prices in the period 2003 to mid-2008 – arguably played an important, albeit secondary, role. High oil prices certainly helped to render the economies of oil-importing industrialised countries more vulnerable to the financial crisis, by damaging their trade balances, reducing household and business income, putting upward pressure on inflation and interest rates, and dampening economic growth. Such concerns prompted the Kingdom of Saudi Arabia to convene the Jeddah Energy Meeting on 22 June 2008 and the United Kingdom to host the follow-up London Energy Meeting on 19 December 2008. Both meetings were aimed at enhancing dialogue between producers and consumers during a time of extremely volatile prices.

Action was clearly needed. The share of energy bills in, for example, US household spending more than doubled to about 8% over the five years to 2008, reducing spending on other goods and services and increasing household indebtedness. The rise in oil prices contributed significantly to the surge in flows of capital from emerging economies to the advanced economies, notably the United States, which helped to sustain temporarily consumption and imports.

Analysis carried out by the IEA in 2006 concluded that the rise in oil prices over the previous four years had lowered average world GDP growth by an average of 0.3 percentage points per year. It also drew attention to the fact that not all of the effects of higher prices had fully worked their way through the economic system and that any further price increases would pose a significant threat to the world economy, by causing a worsening of current account imbalances and by triggering abrupt exchange rate realignments, a rise in interest rates and a slump in house and other asset prices. Nonetheless, the actual speed and the depth of the resulting economic and financial crisis took almost everyone by surprise. It follows that if there to be a sharp rebound in oil prices in the months to come, this would risk causing the economic recovery – when it comes – to stall.

Sources: IEA (2006); IMF (2009).

The impact on energy investment

Investment in energy-supply infrastructure is being affected in three main ways by the financial and economic crisis:

- *Tighter credit:* Energy companies are finding it much harder than in the past to obtain credit for both ongoing operations and to raise fresh capital for new projects, because of paralysed credit markets. In addition, plunging share prices are driving up gearing ratios and pressuring companies to cut absolute levels of debt. In some cases, the cost of capital has risen in absolute terms despite very substantial across-the-board cuts in central bank lending rates – especially for the riskiest projects – making marginal investments uneconomic.
- *Lower profitability:* The slump in the prices of oil and other forms of energy since mid-2008 resulting from weak demand, together with expectations of lower prices compared with several months ago, have made new investments in production facilities generally less profitable, as costs (while starting to fall back) generally remain high. The price collapse (and, in Europe, a big drop in carbon prices) has also shifted the relative economics of power-generating plant, to the detriment of low-carbon renewables-based and nuclear power.
- *Less need for capacity:* Falling demand for energy caused by the economic slowdown has reduced the appetite and urgency for suppliers to invest now in new capacity (Box 2). Spare capacity or reserve margins in many cases have grown in recent months and are expected to expand further in the next year or two.

The combined effect, so far, has been a scaling back of all types of energy investment in most countries along the supply chain, especially those projects considered to be most risky and funded off the balance sheet. Although these are early days in the crisis and hard data is difficult to come by,¹ a number of energy companies have announced their intention to cut capital spending programmes for 2009 and beyond and to seek greater flexibility in planning and completing projects. The picture will become clearer over the coming months as companies complete their review of spending plans. Most projects under development are proceeding and are not expected to be halted, unless sponsors or financiers are directly hit or project economics to sour considerably in the months ahead (for instance, if oil prices fall back again). But many ongoing projects are being slowed and many planned or proposed projects have already been

¹ The IEA compiles data on energy investment by sector on an ongoing basis; an updated picture of how investment is changing in response to the financial and economic crises will be presented in the



postponed or cancelled – for lack of finance and/or because of downward revisions in expected profitability.

The impact of the crisis on investment varies considerably across fuels and countries, reflecting differences in risk, market and ownership structures, the level of leverage, the state of local credit markets, changes in relative fuel prices and costs, project lead times, the economic outlook and prospects for energy demand in the near to medium term. In some cases, notably in the power sector, the main reason for cutbacks in investment has been difficulties in securing finance, both for new projects and current operations; in the oil and gas sector, the drop in prices has been the main driver of cutbacks in capital spending (see below).

Box 2: How is the crisis impacting energy demand so far?

Comprehensive data on energy demand trends in the second half of 2008 and 2009 will not be available for many months. But partial data on consumption of specific fuels for some countries point to plunging energy demand in the face of economic contraction. The May edition of the IEA's monthly *Oil Market Report* estimates that global oil demand dipped by 2.5% in the fourth quarter of 2008 (year-on-year) and by a further 3.6% in the first quarter of 2009, based on preliminary data. The fall in demand is sharpest in the OECD, plunging by 5.2% in the fourth quarter of 2008 and 5.0% in the first quarter of 2009. On current trends, world demand is expected to drop by 3.0% in 2009 as a whole, following a drop of 0.3% in 2008.

Partial data for other fuels and certain regions also points to much weaker demand, particularly in the industrial sector. In the United States, for example, total primary energy use in December 2008 was 3% lower than a year earlier, with gas use down fractionally, oil use down by more than 8% and electricity use flat; industrial energy use in total was 12% lower. Demand in Europe also fell heavily this past winter, despite the coldest weather for twenty years: preliminary data point to a fall of 15-20% in electricity use by industry, which has driven down demand for gas in power generation. The slump in demand was particularly pronounced in France, Spain and the United Kingdom, where industrial production has fallen most. Japan, Korea and most Asian countries have also reported big declines in industrial energy use.

Sources: US Energy Information Administration (www.eia.doe.gov); industry sources.

Investment in energy-related capital stock – equipment, buildings and appliances – which affects the efficiency and pattern of energy use is similarly affected by financing difficulties and

lower prices, which make energy savings less attractive financially. The economic crisis is impacting consumer behaviour in three main ways:

- Consumers (businesses and households) are spending less on new durable goods, delaying the deployment of a more efficient generation of equipments, buildings and appliances.
- They are less willing and able to pay the premium for more efficient goods, as their disposable income decreases and energy prices slump.
- They are using less the goods once they have purchased them.

The economic crisis is also encouraging businesses to rein in capital spending across the board as a defensive measure, while households are reducing their spending on new appliances and cars in the face of worries about future income. Furthermore, equipment manufacturers – including carmakers – are expected to reduce investment in research, development and commercialisation of more energy-efficient models, unless they are able to secure financial support from governments. For example, the timely development of alternative-fuel vehicle technologies is threatened by the slump in new car sales (Box 3), lower oil prices and the dire financial state of many of the world's leading carmakers. Other durable goods, as well as energy efficiency in buildings, have been affected in a similar manner. Governments in many countries have recognised the negative impact of the crisis on consumer spending on more efficient (and more expensive) technologies and have put in place measures to try to counterbalance this effect.

The crisis is affecting energy-supply industries and individual firms in different ways, mainly according to how dependent they are on external finance, the sensitivity of demand and final price to economic trends, capital intensity and the degree of government ownership and regulation. Power-sector investment is expected to be particularly severely affected by financing difficulties, as well as the prospect of stagnant demand. The outlook for investment in renewables-based power projects is mixed, depending on the policy framework, but is likely to suffer disproportionately as a result of the improved competitiveness of fossil-fuel generation technologies – unless policymakers take countervailing action. Oil and gas investment is already being trimmed back, largely because of lower prices. Coal investment programmes have also been cut sharply as a result of falling coal prices and pressure on mining companies to cut debt. One likely consequence of the crisis may be consolidation across the energy sector, as small and medium-sized firms that are struggling to meet their ongoing financial needs are taken over by or merge with competitors with stronger balance sheets. Falling share prices are likely to encourage this trend.



The short to medium-term ramifications of the crisis for energy investment are extremely uncertain, not least because of the uncertainty about just how deep and how long the recession will be and the recovery profile, and, linked to that, how quickly paralysed credit markets will revive. There are some signs that the strong medicine administered by governments to the financial system may be beginning to work, with a drop in interbank rates and an easing of credit conditions in some markets in recent weeks. But the global financial system remains fragile amid fears of further losses as asset values continue to fall. There is little prospect of a return to the days of cheap and easy credit. In general, financing energy investment will certainly be more difficult and costly in the medium term than before the crisis took hold.

Even assuming a gradual easing of credit conditions, any rebound in energy demand and prices, which would create new opportunities for profitable investment on both the supply and demand sides, will hinge to a large degree on economic recovery: demand in the short term for most types of energy is highly sensitive to immediate changes in economic activity and incomes (and much less sensitive to price movements). Energy companies will seek reassurance that any uptick in energy demand and price, when it comes, is durable before committing to a significant increase in capital spending.

Box 3: The effect of the slump in car sales on vehicle fuel efficiency

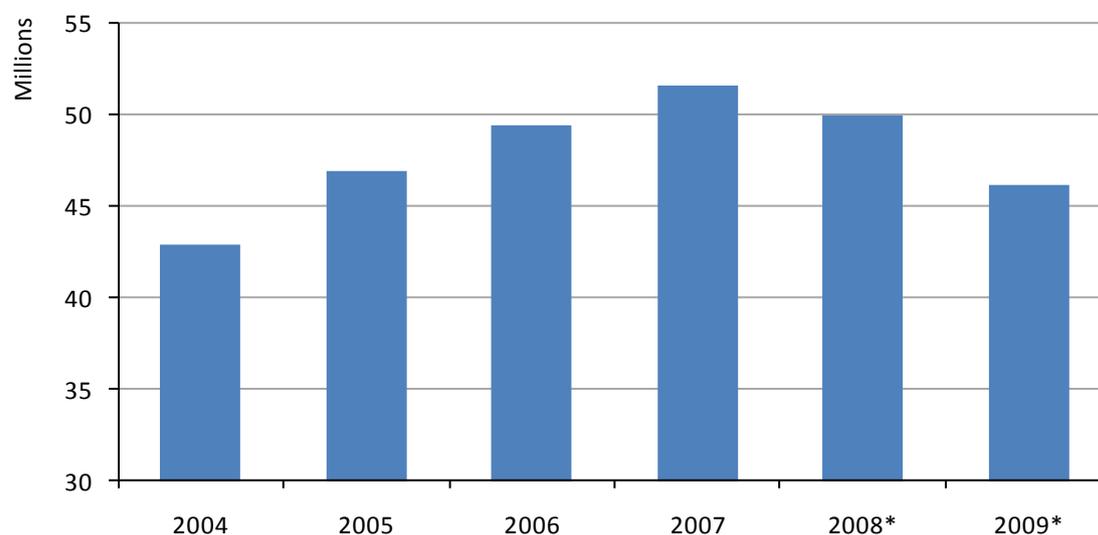
New car sales have fallen heavily throughout the world, by 36% in the United States, 30% in the European Union and 23% in Japan between the first quarter of 2008 and the first quarter of 2009. We expect global sales for passenger cars to fall by about 8% to 46 million units in 2009 as compared to last year, where strong decreases in countries that have been deeply hit by the crisis are offset by countries such as China where car sales in the first quarter of 2009 are 8% larger than first quarter 2008 (Figure 1). The current economic crisis will leave a lasting mark. The new 2009 and 2010 forecasts of car sales worldwide are 20%, or more than 11 million units, lower than pre-crisis forecasts. We expect light duty vehicles sales to recover to pre-crisis levels around 2014. Not all regions have had the same negative slump. The regions which have seen the biggest slump in house prices have generally seen the biggest fall in car sales, notably the United States, the United Kingdom and Spain. Demand for light-duty vehicles remains strong in developing countries, but has slowed. Sales in China are still rising, hitting a record in the first quarter of 2009 (up 8% on a year before).

The average length of time of replacement of a new car in the United States has increased from 49 in 2003 to 56 months in early 2009. According to a recent consumer survey more than two-thirds of respondents expressed their intention to keep their car longer than they would have done in the absence of the crisis and 70% said that they were somewhat likely to consider buying a used vehicle instead of a new one for their next automotive purchase (P.R. Polk, 2009). This will cause average on-road car fleet efficiency to fall compared to what it would otherwise have been as the take up of new and more efficient technologies is delayed. In addition, sales of the most fuel-efficient cars have fallen disproportionately quicker: sales of hybrid cars in the United States fell 46% in April year-on-year compared with a fall of 34% in sales of all light-duty vehicles.* Toyota – the world's leading manufacturer of hybrids – sold some 24 300 Prius hybrids in the United States in the fourth quarter of 2008 – about the same number as in May 2008 alone. The economic incentive of buying a hybrid has declined dramatically as a result of lower oil prices. In the past year, the payback period of a hybrid has increase by five years in Europe and by ten years in the United States.

Energy consumption levels depend upon the average efficiency of the capital stock as well as the utilisation of it. Given declines in disposable income, kilometres driven per car have fallen; for example, by 10% in the United States (US Department of Transportation, 2009). The income effect has generally more than offset the fall in energy prices that, other things being equal, would have encouraged an increase in driving.

* From www.greencarcongress.com.

Figure 1: Worldwide new car sales



* IEA estimate (partial for 2008).

Sources: IEA databases and analysis; IHS Global Insights database.

Implications for energy security

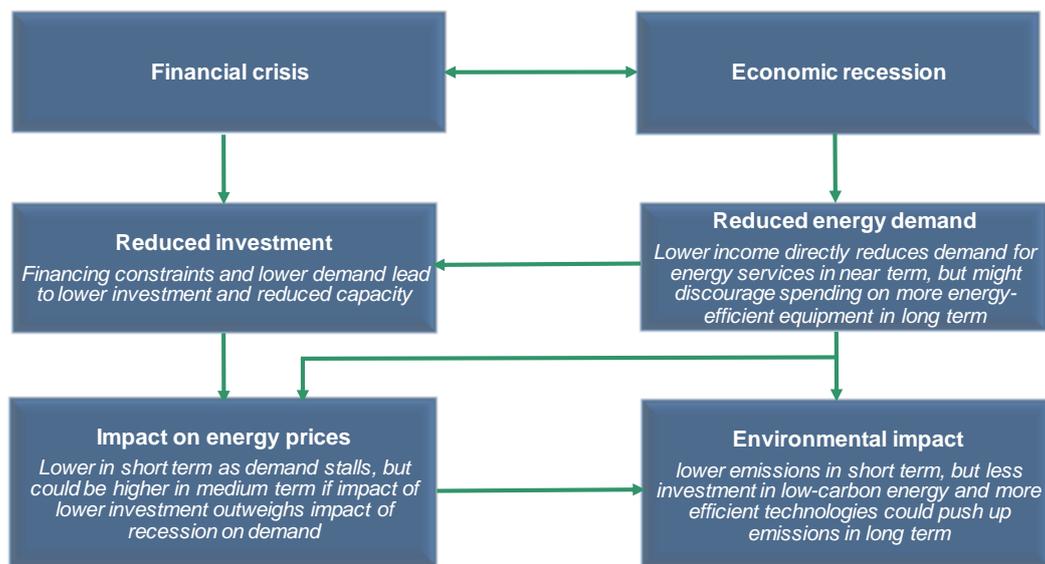
How energy-related investment ultimately responds to developments in financial markets, the global economy and policy action will have important implications for energy security and climate change (Figure 2). Recent cutbacks in investment in energy-supply infrastructure will only affect capacity with a lag, often amounting to several years. So, in the near term at least, weaker demand than previously expected is likely to result in a sharp increase in spare or reserve production capacity. But there is a real danger that investment in the coming months and years falls too much, leading to a shortage of capacity and another spike in prices several years later when the economy is on the road to recovery. This is especially the case for large, complex investments with long lead times, such as major upstream oil and gas, LNG and nuclear projects. Opportunities to invest in cleaner energy technologies may also be missed, leading to higher demand for fossil fuels than would otherwise have been the case. Cutbacks in spending by energy consumers on more efficient equipment and appliances will exacerbate this risk, as demand and imports would not be curtailed as much. The faster the economic recovery, the more likely such a scenario will come to pass.

Implications for climate change

The impact on greenhouse-gas emissions will similarly depend on how the crisis affects investment in different types of energy technology. In the near term, slower economic growth

will undoubtedly curb the growth in emissions. Preliminary estimates for the European Union, for example, point to a drop of around 6% in CO₂ of emissions in 2008,² and a similar fall in 2009 is likely. As emitted greenhouse gases largely stay in the atmosphere, the environmental benefit of the downward blip in emissions will effectively last forever. The reduction in emissions growth in the immediate future is particularly opportune, as any new global agreement on climate change to be negotiated in Copenhagen is not due to take effect until after 2012. In other words, the recession is preventing some investment decisions being taken that may otherwise have locked-in carbon-intensive technologies for many years.³

Figure 2: The impact of the financial and economic crises on energy security and the environment



In the longer term, however, the financial and economic crisis may well lead to *higher* emissions. Weak fossil-energy prices (and, in Europe, carbon prices) and financing difficulties could result in lower investment in clean energy technologies, increasing the need for fossil-fuelled capacity and putting the world onto a higher emissions trajectory than might otherwise have been the case. Renewable and nuclear energy projects are generally much more capital

² According to Point Carbon (www.pointcarbon.com/aboutus/pressroom/pressreleases/1.1089982).

³ For more information, see the IEA’s accompanying Background Paper on Climate Policy.

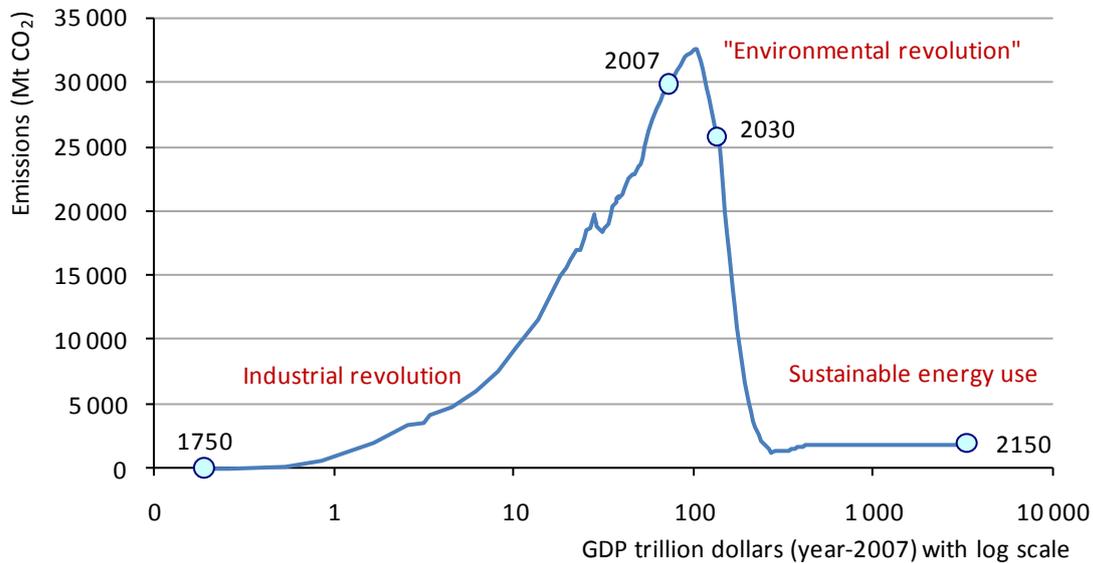


intensive, are less able to compete in a low energy price environment, have longer lead times (in the case of nuclear) and are subject to greater technology and market risk. Investment in renewables has already fallen sharply in recent months (see below). Moreover, investment in more energy-efficient end-use technologies may suffer through both lack of finance and lower energy prices, though this effect may be at least partially offset by the permanent closure of the oldest and most inefficient industrial plant (such as iron and steel mills). Any catch-up effect once the recession is over would also cancel out any short-term emissions benefit. There is also a risk that the world's preoccupation with dealing with the crisis will result in a weaker climate deal at Copenhagen.

Government policy at the national level could redress the balance, through stronger financial incentives and tougher regulatory interventions to promote low-carbon technologies (see the last section). Some governments have already adopted such measures and others are expected to follow suit, though other measures – such as support for the car industry and steelmaking – may offset some, if not all, of the environmental benefits. The recession may provide a breathing space to give time for new sustainable energy policies to be introduced and take effect, in which case greenhouse-gas emissions and concentrations will turn out to be lower.

Ultimately, the impact will hinge on how closely global emissions track economic output. There is an argument that the timing of an eventual peak in annual emissions is linked to the level of economic output – that an environmental revolution that will reverse the rise in emissions brought about by the industrial revolution will begin once economic output has attained a certain level (Figure 3). This is based on the premise that research and development, technological breakthroughs and society's willingness to pay for the cost of switching to more sustainable ways of producing and using energy are a function of prosperity, rather than time. On this basis, the recession (which implies a move back down to the left along the emissions curve) would be expected to delay the timing of the eventual peak and lead to higher cumulative emissions. It would also push down the level of sustainable annual emissions corresponding to a given level of concentration and temperature increase.

Figure 3: Link between CO₂ emissions and economic output



Note: Projected trend is that required to achieve long-term stabilisation of total greenhouse-gas concentration in the atmosphere at 450 parts per million CO₂-equivalent, corresponding to a global average temperature increase of around 2°C. World GDP is assumed to grow at a rate of 2.7% per year after 2030.

Source: IEA databases and analysis.

On balance, the negative impact of the financial and economic crisis on technological innovation, the lock-in of fossil-energy technologies and the willingness of countries to accept tough commitments to curb emissions at the Copenhagen meeting could well outweigh the short-term reductions in emissions that result from economic contraction and lower energy demand. The critical factor is how governments respond to this risk.

Implications for energy poverty

Cutbacks in investment in energy infrastructure also threaten to impede access by poor households to electricity and other forms of modern energy – a vital factor in pulling people out of poverty. This will exacerbate the broader impact of recession on the poor, who often bear the brunt of the fall in incomes and employment, reversing many of the recent gains in reducing poverty in the least developed countries. According to the World Bank, the global crisis is likely to keep 46 million more people below the absolute poverty line of \$1.25 per day, and another seven million under \$2 per day in 2009, compared with its previous forecast.⁴ The food and fuel price increases had already pushed an additional 130-150 million poor people into poverty in

⁴ www.worldbank.org.



2008. For example, the International Labour Organization estimates, in the Asia-Pacific region alone, a dramatic increase in the unemployment rate among the poor of more than 140 million people in 2009, bringing back the region to the same rate of 2004.

There are an estimated 1.6 billion people worldwide still lacking access to electricity – most of them in sub-Saharan Africa and southern Asia. This figure may grow as a result of the crisis, as some of the households that previously had access are no longer able to afford to pay for the service. There is a strong correlation between number of people lacking electricity access and people living under the poverty line. The crisis is also holding back progress in expanding access to electricity among the poor, as the financial crisis and falling cash flow is stymieing the ability of utilities to fund investment in expanding networks. The governments of many emerging economies are facing serious difficulties in raising the funds they need to curb the effects of the downturn, with the implementation of energy-poverty alleviation programmes encountering delays in many cases. Africa, in particular, is already experiencing power shortages and this situation will worsen if investment in networks and new power generation capacity is reduced. The crisis is also expected to slow rural-to-urban migration and force some workers to return to their villages, which often lack access to modern energy services. At present, roughly 2.4 billion people still rely on traditional fuels for their basic cooking and heating needs.

We estimate that achieving the UN Millennium Project goal of reducing poverty by half by 2015 would be accompanied by a switch away from traditional biomass to modern fuels for cooking for 1.3 billion people (IEA, 2006). This would require \$1.5 billion per year in financing. Another \$25 billion per year would be needed in total to 2030 to supply electricity to the 1.6 billion people lacking access today. This investment would almost certainly have to come mainly from the private sector. Financing difficulties and reduced cash flow as a consequence of the crisis will make it much harder to mobilise this investment. Many renewable power projects in emerging economies to bring power to remote, poor rural areas, for example, have been delayed or cancelled.

Impact on oil and gas investment

Global trends and near-term outlook

Investment is being scaled back across the oil and gas sector, largely as a result of the precipitous drop in prices since July 2008 (in large part due to weak demand) and, to a lesser extent, because of financing difficulties.⁵ The collapse in prices, which has so far outpaced that in costs, has starved companies of cash flow which could be used to finance capital spending. It

⁵ Oil and gas investment has generally been relatively less affected by tighter credit environment than other energy sectors, mainly because the sector relies less on external finance.

has also led many companies to revise down their assumptions about future price levels and, therefore, projected cash flows, undermining the profitability of new projects. Some national companies' investment programmes are set to be cut because dwindling revenues are needed to cover spending in other sectors. A growing number of companies have announced cuts in investment budgets (compared with 2008 spending and that originally planned for 2009) and postponements of planned and proposed projects. Upstream investment has so far been hit hardest. More cutbacks may be announced in the coming months unless prices bounce back sharply.

Total oil and gas investment across the industry is expected to drop significantly in 2009, both year-on-year and compared with planned capital spending just a few months ago. The pattern of spending cuts is by no means even. In general, the smaller the company, the bigger the cutback. We have surveyed the capital spending plans of 50 leading oil and gas companies. The results point to a drop of 14% in investment compared with 2008, from \$513 billion to \$442 billion (Table 1). In aggregate, the super-majors⁶ plan to cut spending by only about 5%. A few, notably Mexico's Pemex and China's CNOOC, have announced increases in spending. But most other companies are cutting spending, in some cases drastically. The spending by the top 25 companies is set to fall by 12% while the next 25 are planning to cut by almost 20%. Spending cuts are even bigger when compared to the level of spending planned in mid-2008 for 2009, according to the results of a survey published in *World Energy Outlook 2008* (IEA, 2008a). On this basis, the real planned spending reductions by the 50 leading companies are 15.4%. Smaller operators than those covered by our survey are more affected by the credit crunch because they tend to have higher debt-to-equity ratios and smaller cash reserves. As a result, the magnitude of the overall reduction in oil and gas investment worldwide is certainly even bigger than that of the leading companies. In general, spending is expected to fall more heavily in the upstream than in the downstream.

⁶ ExxonMobil, Shell, BP, Chevron and Total.

Table 1: Total investment plans of 50 leading oil and gas companies

Company	2008	2009	Change 2009/2008	Change 2009 vs. plan of mid- 2008
PetroChina	34.1	34.3	0.3%	-5.5%
Shell	32.0	31.0	-3.1%	-8.1%
Gazprom	31.9	25.7	-19.4%	-7.4%
Petrobras	29.1	28.0	-3.7%	-6.6%
ExxonMobil	23.9	24.9	4.3%	-1.4%
Chevron	22.8	19.7	-13.5%	-20.9%
BP	22.0	19.0	-13.6%	-16.7%
ConocoPhillips	19.1	12.5	-34.8%	-22.2%
Total	18.3	18.2	-0.5%	-16.5%
Pemex	18.0	20.4	13.3%	10.9%
Sinopec	15.8	16.4	4.2%	-22.3%
StatoilHydro	13.6	14.0	2.3%	-3.8%
Eni	12.2	12.2	0.7%	-25.8%
Lukoil	11.1	5.1	-54.4%	-51.7%
Devon Energy Corp	9.4	4.5	-52.0%	-30.8%
Rosneft	8.7	6.5	-25.3%	-30.9%
Repsol	8.2	8.5	3.7%	-3.4%
Marathon	7.4	5.5	-25.1%	-14.7%
EnCana	7.4	5.7	-23.3%	-19.6%
Occidental	6.8	3.5	-48.2%	17.4%
Canadian Natural Resources	6.4	2.7	-57.2%	-51.0%
Apache	5.9	3.4	-43.5%	-39.0%
Anadarko	5.3	4.2	-20.8%	-12.4%
Talisman	5.2	3.2	-39.9%	-24.9%
CNOOC	5.1	5.7	11.8%	-3.4%
Sub-total top 25	379.8	334.8	-11.9%	-13.5%
Next 25	133.2	107.2	-19.5%	-21.1%
Total 50 companies	513.0	442.0	-13.8%	-15.4%

Source: IEA databases; IEA (2008a).

The actual reductions in investment may turn out to be even larger than current plans suggest. Some companies have not yet announced their revised plans for 2009 and others that have are likely to announce further cuts later in the year unless oil prices pick up. In any case, oil companies may not spend as much as they are budgeting, for example if government owners decide to divert cash from the national company for other purposes or if costs fall back. As in the power sector, almost all projects already under construction are expected to be completed, though work is being slowed in many cases to limit the need to raise fresh capital and to profit from an expected fall in costs (see below). Planned projects – especially those in the early stages

of design – are most heavily affected by spending cuts: most projects not yet under construction have already been pushed back, in some cases indefinitely, or cancelled outright.

Impact of the credit crunch on oil and gas financing

The paralysis in financial markets is affecting oil and gas companies capital spending to varying degrees. Relative to other energy sectors, the oil industry is characterised by a high level of self financing (out of cash flow) and low debt-equity ratios. International oil companies, which currently account for around half of global oil and gas investment, are generally the least affected among energy companies by the difficulties faced in raising capital. They typically finance the bulk of their capital needs from internal cash flows and have less need to borrow either short or long term. Their balance sheets are generally sound, so they still have little trouble in raising additional funds from financial markets.⁷ Nonetheless, most of the largest oil companies in early 2009 were unable to cover their capital spending programmes out of cash flow and have been forced to borrow as a result of the recent sharp drop in prices.⁸ The cost of borrowing has also recently risen with the credit crunch. Most of the largest companies are expected to respond to lower cash flow this year by scaling back share buybacks rather than by cutting capital spending or dividends, though some may need to increase borrowing. The supermajors have been returning large amounts of cash to shareholders in the form of dividends and share buybacks in recent years, while continuing to increase capital spending.

Wholly state-owned national companies, which account for a growing share of global crude oil production, are largely immune from tighter lending standards because of credit guarantees and favourable borrowing terms from their state owners. National companies that are part privately owned, including Petrobras, the Chinese national companies and Russia's Gazprom, have been hit by plunging share prices, which have constrained their ability to raise private capital. Nevertheless, most of the cutbacks in capital spending by national companies are the result of a weaker outlook for demand, prices and revenues rather than financing difficulties. Moreover, some Russian companies have been protected from the full impact by rouble devaluation.

Smaller private firms, especially independent exploration and production companies, are affected much more by the credit crunch, as they rely more on commercial debt and borrowing to cover their investment programmes. Independent companies in the United States and elsewhere – especially non-investment grade companies – have endured a sharp rise in borrowing costs. Most are cutting capital spending to keep it within cash flow, borrowing from

⁷ At the end of September 2008, net debt represented only 8% of total capital for international integrated oil companies, compared with around 20% for small to medium-sized US and Canadian exploration and production companies and 35% for large US E&P companies (IHS Herold, 2009).

⁸ A large proportion of their capital spending goes to multi-billion dollar projects that take several years to complete.



banks or issuing commercial paper only as a last resort. Some have disposed of non-core assets in order to raise funds for upstream developments. In March 2009, Hallwood Energy, an independent shale gas producer, became the largest US upstream company to go bankrupt since the crisis broke. Others in severe financial difficulties are being forced to refinance debt and sell off core assets to stave off bankruptcy. Some companies have filed for bankruptcy. But there are signs that fresh financing, where necessary, has become easier in recent months.

Private downstream oil and gas companies are generally more highly leveraged than the international companies, with an average equity to debt ratio of around 30:70, and are, therefore, facing more difficulties and higher costs in refinancing debt and raising fresh capital for their long-term investment programmes. The European gas utilities, GDF Suez and Gasunie, for example, successfully issued long-term bonds in October, but had to pay significant premia (over 200 basis points above the Euribor interest rate). The longer it takes for credit markets to thaw, the more likely their investment programmes will be reined in.

One area that has been hit hard is project finance, which is commonly used for large-scale and high-risk oil refining and mid-stream activities such as LNG chains and oil and gas pipeline projects. Project finance on a non-recourse or limited-recourse basis, which keeps debt off a participating company's balance sheet, has become much more costly and much harder to secure as a result of diminishing liquidity and increased risk-aversion among lenders. This will inevitably affect the development of large oil and gas projects. One example is First Calgary Petroleum, which was acquired by ENI in September 2008 after it failed to secure financing for the \$1.3 billion development of the Menzel Ledjmet East field in Algeria.

Upstream investment

There has been a steady stream of announcements of delays to and cancellations of high-cost oil and gas projects and cutbacks in capital spending budgets since late 2008. Many of the announced project delays are the direct result of the financial crisis and lower oil prices, though attributing all the delays to the crisis would be misleading: some of the delays would no doubt have occurred regardless of the crisis as a result of "normal" project slippage, which has been running at up to one year on average over the past couple of years. Between October 2008 and mid-April 2009, over 20 planned large-scale upstream oil and gas projects involving around 2 mb/d of peak oil capacity and close to 1 bcf/d of peak gas capacity were deferred indefinitely or cancelled (Table 2). The total value of these delayed investments, mainly involving oil, is over \$170 billion. Oil sands projects, which are among the most expensive of all upstream developments on a per barrel basis, account for the bulk of the postponed oil capacity (Box 4). In addition, 35 projects involving 4.2 mb/d of peak oil capacity and 2.3 bcf/d of gas capacity (involving more than \$70 billion of investment) were delayed by at least 18 months. The largest of these projects is the 900 kb/d Manifa oil field in Saudi Arabia, which was originally due to be

brought on stream by 2011.⁹ Saudi Aramco is now looking to extend the duration of the project by up to 18 months and switch from a lump-sum to an open-book contract basis, in order to reap the benefit of falling costs.

Many other projects have been delayed for a year or more, in many cases at least in part due to efforts to negotiate lower costs with contractors (or because the project developer is short of cash to cover development costs). OPEC announced in February 2009 that the collapse of oil prices had led its members to delay completion of 35 out of a total of 150 upstream projects, resulting in the addition of 5 mb/d of gross capacity being delayed from 2012 to some time after 2013. OPEC has provided no details as yet on which projects have been affected.¹⁰ Moreover, it is worth noting that earlier IEA analysis of medium-term supply prospects had already discounted some of this new capacity on the basis of over-ambitious target dates and offsetting decline at other fields. Nonetheless, upstream oil projects have been affected much more than gas projects so far. As yet, only major gas projects – Manifa in Saudi Arabia (oil and gas), Karachaganak Phase 3 in Kazakhstan, Shah Deniz in Azerbaijan and the smaller Reindeer field in Australia – have been suspended or delayed.

Global upstream budgets are set to fall this year for the first time this decade. Excluding acquisitions, we estimate that budgeted spending on exploration and production in aggregate worldwide for 2009 currently totals around \$375 billion, down about \$100 billion, or 21%, on 2008 (Figure 4). This includes spending by national and international companies. The budget cuts are sharpest among the independent exploration and production companies, especially in North America (in some cases, due to postponements of high-cost oil-sands projects). US independents with a strong focus on natural gas production are among the companies expected to cut budgets the most, on average by more than half. Russian companies are also cutting spending sharply too. Trends vary considerably by the type of company: the super-majors expect to keep upstream spending broadly flat, while the national companies are reducing spending by more than 7% and other international companies by around 37% (Figure 5). Actual spending may well turn out to be much lower than that budgeted, especially if costs fall sharply.

⁹ Saudi Aramco has also delayed development of the 1.8 bcf/d offshore Karan gas field development for a short while at least to allow time to renegotiate contracts with suppliers.

¹⁰ We have identified 30 delayed OPEC projects (21 for at least 18 months), though it is unclear which of them have been deliberately stalled because of weaker demand and/or lower prices.



Table 2: Major upstream oil and gas projects deferred by at least 18 months, suspended or cancelled since mid-2008 (as of end-April 2009)

Project	Country	Type	Operator	Original start date of first production	New completion date (estimated)	Peak capacity addition oil (kb/d)	Gas (mcf/d)
Jackpine 1B	Canada	Oil sands	Shell	2012	Suspended	100	
Carmon Creek 1	Canada	Oil sands	Shell	2008	Suspended	50	
BA Phase 1	Canada	Oil sands	Value Creation Group	2009	Suspended	70	
BA Phase 2	Canada	Oil sands	Value Creation Group	2010	Suspended	70	
BA Phase 3	Canada	Oil sands	Value Creation Group	2011	Suspended	70	
Firebag 5	Canada	Oil sands	Suncor	2012	Suspended	68	
Firebag 6	Canada	Oil sands	Suncor	2012	Suspended	68	
Fort Hills 1 (with upgrader)	Canada	Oil sands	Petro-Canada	2012	Suspended	140	
Fort Hills 2	Canada	Oil sands	Petro-Canada	2014	Suspended	130	
Surmont expansion	Canada	Oil sands	ConocoPhillips	2012	Suspended	65	
Horizon 2nd phase	Canada	Oil sands	CNRL	2010	Suspended	45	
Voyageur expansion upgrader	Canada	Oil sands	Suncor	2010	Suspended	200	
Kai Kos Dehseh upgrader	Canada	Oil sands	StatoilHydro	2016	Suspended	200	
Heartland upgrader	Canada	Oil sands	Value Creation Group	2009	Suspended	250	
Sunrise	Canada	Oil sands	Husky/BP	2012	Suspended	200	
Karachaganak Phase III	Kazakhstan	Gas condensate	BG Group	2012	Suspended	27	650
Forties	UK	Offshore oil	Kessog	2009	Suspended	25	
Shenhua 2	China	Coal-to-liquids	Shell	2011	Suspended	60	
Ivanhoe	Egypt	Gas-to-liquids	Ivanhoe Energy	2010	Suspended	95	
Reindeer	Australia	Offshore gas	Santos	2010	Suspended		210
Entrada	US Gulf of Mexico	Offshore oil	Callon Petroleum	2009	Cancelled	14	
Trebs & Titov	Russia	Onshore oil	Lukoil	2008	Cancelled	80	
Total suspension/cancellations						2 027	860
Puma	US Gulf of Mexico	Offshore oil	BP	2010	2013	40	
Kearl 1	Canada	Oil sands	Imperial	2012	2014	100	
Goliat (FPSO)	Norway	Offshore oil	ENI	Apr-12	End-2013	100	
Cheviot (former Emerald)	UK	Offshore oil	ATP	Oct-08	Oct-10	30	
Lochnagar	UK	Offshore oil	Chevron	Aug-10	Jul-12	90	



Kuyumbinskoye	Russia - E.Siberia	Onshore oil	Slavneft	2010	2013	60	
Vankor	Russia - E.Siberia	Onshore oil	Rosneft	2008	Jul-09	380	
Vladimir Filanovsky	Russia - N.Caspian	Offshore oil	Lukoil	2012	2014	120	
Shah Deniz Phase 2	Azerbaijan	Offshore gas	BP	2014	2016	40	1070
Jidong Nanpu	China	Offshore oil	PetroChina	Feb-10	End-2011	300	
Bhagyama	India	Onshore oil	Cairn	2009	Mar-11	30	
Calauit	Philippines	Offshore oil	Otto Energy	Apr-08	2011	12	
Menzel Ledjmet East (Block 405b)	Algeria	Onshore oil	Sonatrach/First Calgary	2010	2012	8	
Jufeyr I	Iran	Onshore oil	INOC	2009	2012	25	
Azadegan South II	Iran	Onshore oil	INOC	2012	2014	110	
Darkhovin III	Iran	Onshore oil	INOC	2012	2014+	120	
Kharg NGL	Iran	Onshore NGL	INOC	2012	2014+	85	
Burgan water treatment etc	Kuwait	Onshore oil	KPC	2009	2013	120	
Sabriya GC-24	Kuwait	Onshore oil	KPC	2010	2013	160	
NC186 expansion	Libya	Onshore oil	LNOC	2008	2012	35	
Zuetina expansion	Libya	Onshore oil	LNOC	2010	2013	50	
Nafoora expansion	Libya	Onshore oil	LNOC	2010	2013	150	
Al Farigh expansion	Libya	Onshore oil	LNOC	2010	2014	45	
Amal	Libya	Onshore oil	LNOC	2010	2015	75	
Verenex Ghadames Basin Area 47	Libya	Onshore oil	LNOC	2010	2012	50	
Bonga SW/Aparo	Nigeria	Offshore oil	Shell	2012	2014	150	
Egina	Nigeria	Offshore oil	Total	2012	2014	150	
Nsiko	Nigeria	Offshore oil	Chevron	2011	2015	100	
Gbaran/Ubie	Nigeria	Offshore oil	Shell	2009	2011	160	
Al Shaheen increments	Qatar	Offshore oil	Maersk	2008	2010	80	
Manifa crude	Saudi Arabia	Onshore oil	Saudi Aramco	2012	2014	900	1 240
Lower Zakum expansion	UAE	Offshore oil	ADNOC	2011	2013	75	
Upper Zakum expansion	UAE	Offshore oil	Zadco/ExxonMobil	2012	2015+	150	
North East Bab EOR	UAE	Offshore oil	ADNOC/ExxonMobil	2012	2014	120	
Total postponed (>18 months)						4 220	2 310
Total						6 247	3 170

Source: IEA databases.



Box 4: Canadian oil sands: What lies ahead now the boom is over?

Canada's once booming oil sands industry has been hit extremely hard by the oil price slump and the fallout of the global credit crisis, mainly because such projects are very capital intensive and much of their output is destined for the United States where demand is waning. Canada ranks second only to Saudi Arabia in terms of proven oil reserves with 179 billion barrels that can be recovered using current technology. The vast bulk is in the form of oil sands – a thick, viscous mixture of sand, water, clay and bitumen concentrated in three major deposits in northern Alberta. Oil sands projects require much greater capital expenditure than conventional oil to extract the oil-rich bitumen and then refine it into oil. Nonetheless, thanks to high oil prices and a lack of opportunities in other parts of the world to grow production that are open to foreign investment, oil companies flocked to Alberta over the past decade and output from the oil sands rose from 600 kb/d in 2000 to 1.3 mb/d in 2008. This rapid growth led to shortages in skilled labour and rapid cost inflation, prompting concerns that the pace of development was not sustainable.

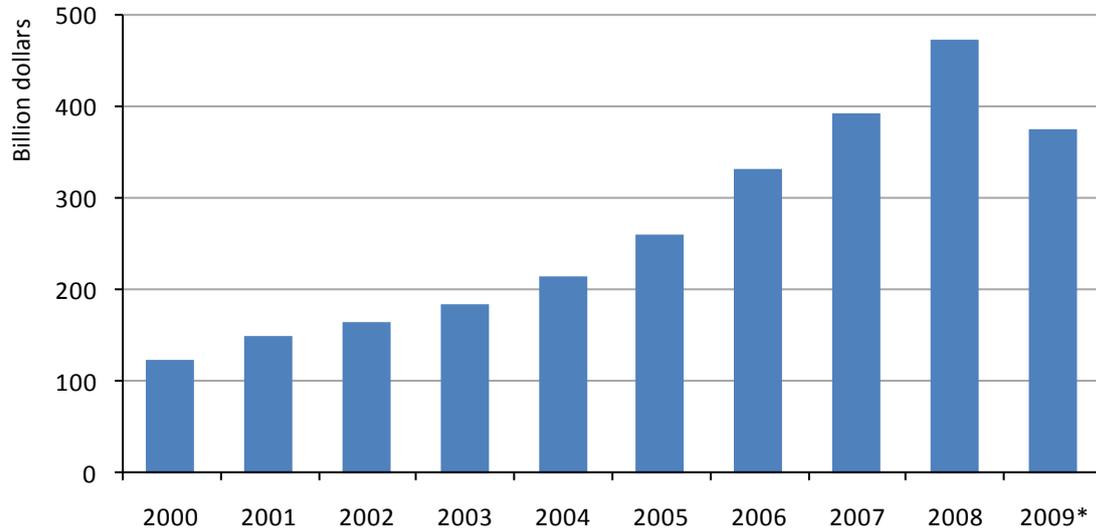
The outlook has changed dramatically since mid-2008. Projects involving around 1.7 mb/d of peak capacity and worth around \$150 billion of investment have been suspended or cancelled (Table 2).^{*} These announcements led the Canadian Association of Petroleum Producers to revise downwards their oil sands production forecast for 2020 by 200 kb/d to 3.3 mb/d, though this is still double current capacity (CAPP, 2009). These economic challenges come on top of fresh worries about the environmental impact of the oil sands industry. In addition to needing huge amounts of water and natural gas, oil sands generate about 20% higher CO₂ emissions than conventional oil on a “well-to-wheel” basis. In today’s uncertain regulatory framework, this is creating worries for investors – a carbon price of \$50 per tonne of CO₂ could increase the cost of producing oil sands by up to \$5 per barrel.

Providing the current challenges can be overcome, Canadian oil sands have the potential to make a significantly greater contribution to global energy security for decades ahead by increasing diversity of supply. As it represents one of the few growth areas among non-OPEC countries, many countries – particularly the United States and China – will be looking for a bigger share of the oil sands' output in order to reduce their dependence on Persian Gulf oil. However, as an industry whose profitability currently relies on oil prices of around \$75-80^{**}, the outlook in the medium term is much less certain. While existing projects will continue to produce as current crude prices are more than adequate to cover operating costs, it is hard to see new investment sanctioned until the overall economics improve – either through a rise in the oil price or a significant reduction in production costs.

^{*} Not all planned oil-sands projects have been postponed. The 300-kb/d Kearn project, a joint venture of ExxonMobil and Imperial, is expected to receive the green light in mid-2009.

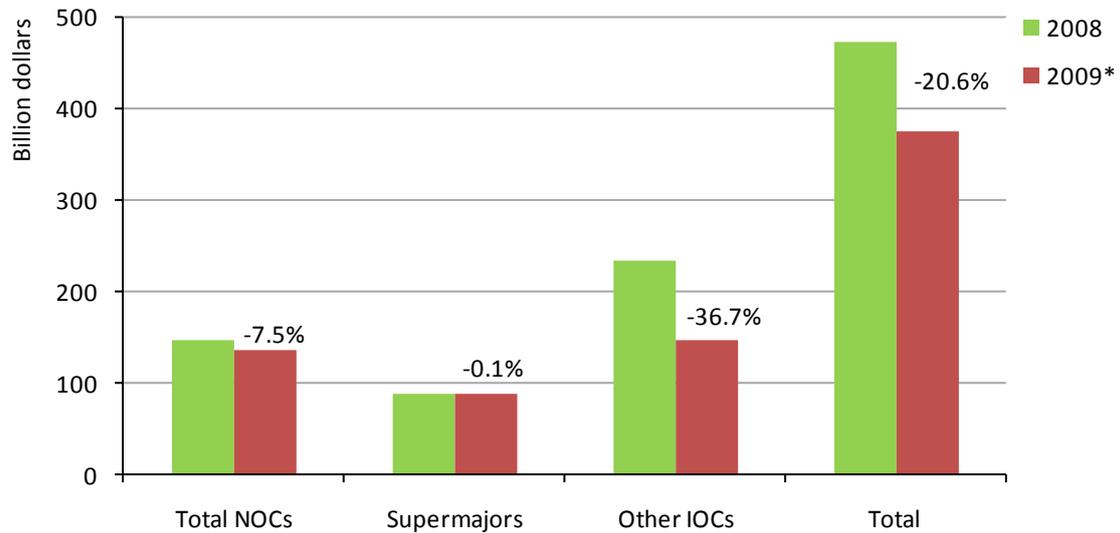
^{**} Falling costs will probably lower this hurdle price in the medium term. Reductions of 15-20% in capital costs for some planned oil-sands projects, including Kearnly, have been reported.

Figure 4: Worldwide upstream capital expenditures



* Based on company plans.
Sources: IEA databases and analysis.

Figure 5: Worldwide upstream capital expenditures by type of company



* Based on company plans.
Sources: IEA databases and analysis.

The drop in upstream spending will be most pronounced in the regions with the highest development costs and where the industry is dominated by small players and small developments. For these reasons, investment in non-OPEC countries is expected to drop the most. The spending slump in 2009 is expected to be strongest in North America, Russia and the North Sea. Drilling activity in the United States and Canada has already fallen precipitously: rig counts – a measure of drilling activity – have plunged in recent months to a three-year low. On average, there were 1 008 active rigs in the first week of April 2009 across the United States and Canada – a fall of 44% compared with a year earlier.¹¹ In response to a fall-off in drilling, the Alberta government announced a new royalty and drilling incentives programme in March 2009 aimed at lowering charges and improving the economics of new upstream projects. Russian investment is also thought to be especially vulnerable to lower prices because of high development costs and an unattractive fiscal regime, unless the government is prepared to lend or guarantee loans to firms in which it holds stakes. In the North Sea, another high-cost region, drilling has already fallen sharply. In the UK sector, only 18 exploration and development wells were drilled in the first quarter of 2009 – a fall of 41% on the same period in 2008.

The Middle East and North Africa look less prone to spending cuts, notwithstanding the decision by the Saudi government to delay work on the Manifa and Karan fields. There are signs that Saudi Aramco may scale back its investment programme for the five-year period to 2014, but the company has not confirmed press reports that spending may be halved compared to what was budgeted last year. Again, the picture is clouded by potentially lower negotiated project costs. Elsewhere, the picture is mixed. West Africa is characterised by large-scale projects with long lead-times, so spending there is likely to hold up better in the near term. But investment may fall in the longer term if prices remain low. Significant cuts in spending are likely in Venezuela, where central government revenue needs will constrain the amount of revenue that the national companies will be allowed to retain to cover capital spending. Petroleos de Venezuela SA is already struggling to find cash to pay suppliers and partners and may delay plans to help Nicaragua build a refinery, while similar promises with Ecuador and Cuba may well suffer the same fate. The Ecuadorian state oil company, Petroecuador, has just halved its 2009 capital spending budget to under \$1 billion.

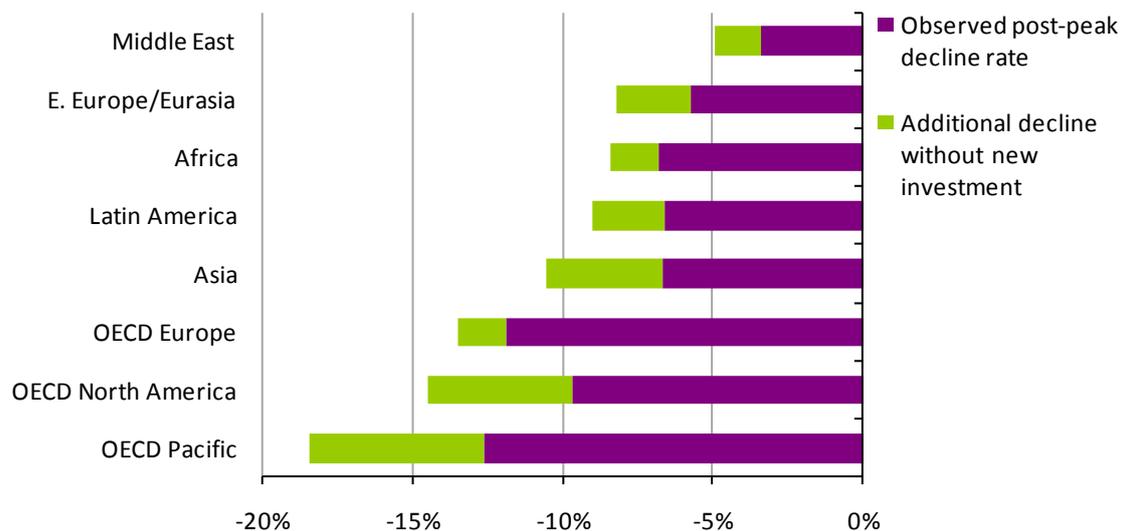
Investment in deepwater developments is expected to be less affected than onshore drilling, largely because deepwater projects tend to be much larger in scale and undertaken by the largest international and national companies, which rely to only a limited degree of corporate borrowing. These projects are mostly based on hurdle prices of \$40 to \$50 per barrel, yielding an internal rate of return of 8% to 9%. Most companies are unlikely to cancel such projects if prices were to remain below that range for several months, on the assumption that they would eventually rebound. Despite the recent collapse in prices, Petrobras – the Brazilian national

¹¹ Baker Hughes rig count, available at http://investor.shareholder.com/bhi/rig_counts/rc_index.cfm.

company – is pressing ahead with ambitious plans to develop its pre-salt deepwater finds in the Santos Basin, with pilot production beginning in 2009.

Initial soundings among industry participants suggest that upstream capital spending cuts will impact new field developments more than ongoing development of fields already in production. In recent years, more than half of total development spending has gone to existing fields. However, Chevron announced in late January 2009 that it was focusing its spending cutbacks on programmes to mitigate decline at existing fields, with observed decline rates rising from a typical level of 4 to 5% to 7% in 2009. It expects to reinstate that spending when market conditions improve. For the industry as a whole, there is a risk that, decline rates could rise as a result of capital spending cuts. Based on the analysis of decline rates set out in *World Energy Outlook 2008*, were capital spending on developing existing fields to be reduced by the same proportionate amount as total upstream spending in 2009 and 2010 (i.e. by 21% compared with 2008), the production-weighted post-peak year-on-year decline rate of existing fields globally would rise by about 0.5 percentage points within two years or so – assuming that the investment cutbacks are the same across all types of field and all regions (IEA, 2008a). This implies that an *additional* 350 kb/d of capacity would be lost each year. The increase would be much greater for non-OPEC countries – roughly 0.6 percentage points compared with 0.3 for OPEC countries. Worldwide, decline rates are currently lowest in the Middle East and highest in the OECD (Figure 6).

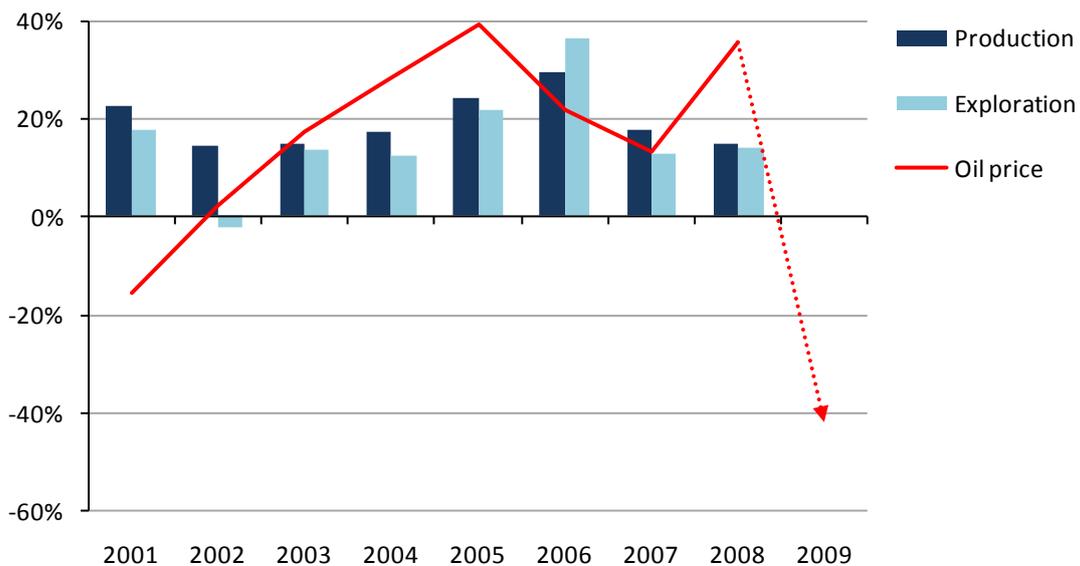
Figure 6: Indicative observed and natural post-peak oil decline rates by region



Notes: The observed decline rate is the cumulative average annual rate of change in observed production over the life of each field since its production peaked, weighted by cumulative production. The natural decline rate is the notional rate of decline in production had there been no investment beyond that associated with the initial development of the field. Source: IEA (2008a).

Although little hard data is yet at hand, it is likely that the upstream industry will reduce spending on exploration most sharply in 2009 – largely because the bulk of spending on development projects is associated with completing projects that had already been launched before the slump in prices. In the United Kingdom, for example, exploration drilling fell by 78% in the first quarter of 2009 – almost twice as fast as the overall drop in drilling. Exploration spending has historically been affected more than development spending by swings in oil prices and cash flow (Figure 7). Upstream companies can usually cut spending on exploration more quickly, especially onshore as drilling is faster and rigs are hired for shorter periods. Moreover, the impact of reduced spending on exploration will only be felt several years later, whereas delaying the completion of a current development project can undermine cash flow within a short period.

Figure 7: Exploration and development capital spending and average IEA crude oil import price (year-on-year change)



Source: IEA databases and analysis.

Downstream investment

A number of downstream oil projects have also been delayed as result of the financial crisis and the weaker outlook for oil-product demand. Since September 2008, seven refining projects have been postponed indefinitely and another two cancelled. The combined capacity of these projects is over 1.6 mb/d (Table 3). These include four grassroots refineries, including the planned 400 kb/d refinery at Jubail in Saudi Arabia and the Al Zour refinery in Kuwait. In addition, a number of other refinery projects – with a combined capacity of over 800 kb/d – have been

delayed by 18 months or more. In total, refiners are expected to reduce capital spending in 2009 by up to 20%, as the prospective returns potentially on offer are balanced against continued problems for some refiners in accessing debt markets, and the overall level of profitability achievable under the current conditions.

The near-term outlook for LNG supply has eased in recent months, with the prospect of a slowdown in demand growth and 14 new liquefaction trains under construction and due to come on stream between 2009 and 2013. Five of them, including three mega-trains in Qatar (each with capacity of 10.6 bcm/year) are due to be commissioned this year alone. But only a handful of new projects have received the green light in the last four years. In view of the dismal economic outlook and financing problems, there are formidable barriers to new projects being sanctioned in 2009 and even 2010 (though investment in regasification terminals and ships remains strong). As a result, global liquefaction capacity is set to plateau in 2013.

Investment in transmission pipelines and local distribution networks is likely to be much less affected.¹² Large-scale cross-border and inter-regional pipeline projects were facing difficulties in obtaining approvals and financing even before the crisis took hold for a number of reasons, including local resistance to routing, geopolitical factors and regulatory and market risks. The crisis has undoubtedly added to these hurdles. Certainly, few major projects have been given the green light in recent months. In Europe, for example, final investment decisions have yet to be taken on several major projects that have been under discussion for some time, including the Nabucco pipeline from the Caspian region through Turkey and southeast Europe and South Stream from Russia to southern Europe. Nord Stream from Russia to Germany continues to be delayed by planning and environmental issues, though the proponents are confident that these can be resolved to allow construction to begin in early 2010. In most regions, plunging gas demand has removed any urgency in pressing ahead with pipeline projects. The planned Skanled project, a pipeline running from western Norway to Denmark and eastern Sweden, was suspended in April 2009.

Impact of lower investment on costs

On the positive side, with an expected decline in unit costs, planned investments should translate into larger capacity additions in the upstream and downstream than would otherwise have been the case. In practice, there is a two-way relationship between investment levels and costs: lower investment should help to bring down costs, which in turn will improve the profitability of new investments (for a given level of prices) and help support investment. Construction costs in both the upstream and downstream sectors have soared in recent years. According to *WEO-2008*, upstream costs almost doubled between 2000 and 2008. But there are

¹² Because of the highly fragmented nature of the industry, there is little data available on investment trends by region.



signs that they may now be starting to fall back. The prices of other major inputs – especially concrete, steel and drilling rig day-rates – have been falling in recent months. Day-rates have been driven lower by reduced drilling (particularly on land in North America), a trend that is expected to spread through 2009. Well drilling and completion costs in the United States fell by 10% in the fourth quarter of 2008 compared with the previous quarter (when costs peaked at an all-time high) and around 14% in the first quarter of 2009, with costs expected to average almost one-quarter less in 2009 than in 2008 (Spears, 2009). Rig day-rates are strongly correlated with oil prices, with day-rates typically following prices with a lag of several months.

**Table 3: Major oil refinery projects deferred by at least 18 months, suspended or cancelled since September 2008 (as of end-April 2009)**

Project/location	Country	Type	Operator	Original start date of first production	New completion date (estimated)	Peak capacity addition (kb/d)
Toledo	US	Heavy oil expansion	BP/Husky	1Q2011	Suspended	15
Wilhelmshaven	Germany	Heavy oil expansion	ConocoPhillips	3Q2012	Suspended	50
Yosu	South Korea	Heavy oil expansion	GS-Caltex	4Q2011	Suspended	55
Al Zour	Kuwait	New refinery	KPC	4Q2012	Suspended	615
Al Shaheen	Qatar	New refinery	QPC	3Q2013	Suspended	250
Jubail	Saudi Arabia	New refinery	Saudi Aramco/Total	1Q2013	Suspended	400
Porto Marghera	Italy	Heavy oil expansion	ENI	2Q2011	Cancelled	50
Ras Laffan	Qatar	New refinery	Qatar Petroleum	1Q2011	Cancelled	140
Total suspension/cancellations						1 575
Detroit	US	Heavy oil expansion	Marathon	3Q2011	1Q2013	15
Borger	US	Heavy oil expansion	ConocoPhillips/EnCana	2Q2011	1Q2013	50
Port Arthur	US	Refinery expansion	Motiva	1Q2011	3Q2012	325
Thessaloniki	Greece	Refinery expansion	Hellenic Petroleum	1Q2009	1Q2011	10
Sines	Portugal	Heavy oil expansion	Galp Energia	1Q2011	1Q2013	45
Nizhnekamsk	Russia	Refinery expansion	Tatneft	4Q2010	1Q2012	140
Nansha	China	New refinery	Sinopec/KPC	4Q2012	2Q2014	250
Total postponed (>18 months)						835
Total						2 410

Source: IEA databases.

Upstream costs are particularly sticky, as the prices for equipment and services are usually fixed in contracts for specific projects. In principle, once a contract is signed, the agreed prices cannot be revised. As a result, costs tend to follow prices with a lag. But some oil companies are seeking to renegotiate contracts in order to mitigate the effect of lower prices on their margins, holding out to contractors the carrot of additional work in the future if they are prepared to accept price cuts in current contracts. The possibility of lower costs in the future is one of the reasons why many companies are delaying spending on new projects. For example, Japan's Inpex is holding off on making a final investment decision on developing its Masela gas field in Indonesia in the expectation that the cost will drop to \$10 billion from an earlier estimate of \$19.7 billion.

Implications for industry structure – a new merger wave in the offing?

The disparate fortunes of oil and gas companies in dealing with the twin challenge of tighter credit and weaker market prospects point to the likelihood of a new wave of merger and acquisitions (M&A). Periods of lower prices and weak demand growth have historically prompted waves of mergers and acquisitions of corporate and physical assets. But, for the time being at least, enormous uncertainty about the near-term prospects for prices together with the paralysis of financial markets is stymieing M&As. Worldwide M&A activity fell sharply in the second half of 2008 with the slump in oil prices. According to a recent survey by Ernst and Young, oil industry M&As in value were more than a quarter down in 2008 compared with 2007 (a record year) as a result of plunging market valuations and the financial turmoil (Ernst & Young, 2009). Another report put the spending on M&As in the upstream alone in 2008 at \$104 billion – a drop of 32% (IHS Herold/Harrison Lovegrove, 2009). The fall in spending on an annual basis masked a record-level of deal-making in the first seven months of the year and a drying up of activity in the rest of the year.

Many in the industry believe it is just a matter of time before cash-rich companies seize the opportunity to purchase competitors and assets on the cheap. Financially robust international and national companies, with little or no debt and large cash stockpiles are well-placed to take over smaller firms that are struggling to refinance their debt and raise fresh capital for project developments. Struggling smaller operators may also be forced to sell assets. Consolidation in the so-called junior oil and gas sector has been expected for some time, and financial difficulties may provide the trigger for that process to unfold. One recent report predicts that 30 to 40 oil companies will merge, be acquired or go out of business in 2009 (Bain & Co, 2009). Nonetheless, the oil majors are expected to proceed cautiously with any acquisitions, suggesting that a repeat of the mega-mergers that reshaped the industry in the late 1990s is unlikely. In general, buyers and sellers are biding their time for now: buyers are waiting for share prices to hit bottom and for borrowing terms to ease, while sellers are waiting for a share and oil price recovery. The only large-scale merger that has been announced since late 2008 is that between PetroCanada and Suncor, announced in March 2009, which will create the fifth-largest oil and gas company in North America, with assets of \$43 billion.

Some national oil companies are already seizing opportunities to buy up assets at much lower prices than were on offer just a few months ago. Chinese companies and government agencies are actively seeking to secure supplies for when demand begins to recover. A number of deals announced in recent months by Chinese entities show a determination to take advantage of lower prices and easier access terms, and potentially also to diversify the government's estimated \$2 trillion of foreign exchange reserves. China's national oil companies have recently increased their direct equity participation in the upstream abroad, including major deals in Venezuela, Iran and Africa. China has also adopted a parallel approach of loans-for-oil, whereby China Development Bank (CDB) will make loans to Russian and Brazilian companies in return for access to future crude oil deliveries. Chinese companies are also reportedly considering further acquisitions of independent producing companies with significant upstream growth potential in Africa, including Tullow Oil, which holds resource-rich acreage in Uganda and Ghana.

Implications for capacity – are we heading for a mid-term supply crunch?

The consequences of investment cutbacks for the adequacy of oil and gas supply capacity in the medium term are very uncertain. Lower investment and project postponements or cancellations will inevitably reduce the gross and net additions to capacity in crude oil and natural gas production, refining and processing and transportation. But the long lead times of many projects means that recently announced delays will only affect capacity additions fully after several years.

In non-OPEC countries alone, total crude oil production capacity is now expected to fall by 300 kb/d in 2009 according to the May 2009 edition of the IEA's monthly *Oil Market Report*; in the July 2008 *Medium-Term Oil Market Report (MTOMR)*, it was projected to grow by 520 kb/d. This downward revision results from delays to new projects, from lower spending on existing fields and from some unexpected problems in some countries, notably Azerbaijan. OPEC capacity is also now expected to grow more slowly than previously thought, in part because of project postponements and delays prompted by the financial and economic crisis. In aggregate, gross capacity of around 1 mb/d has been deferred for 2009 and 2010, though much of this will enter production later on.

Nonetheless, the downward revision to supply is much smaller than that to demand: 2009 demand is currently projected to drop to 83.2 mb/d – 2.6 mb/d less than in 2008 and 4.3 mb/d less than projected in the 2008 *MTOMR*. As a result, spare crude oil production capacity is set to rise much more quickly than previously projected (the July 2008 *MTOMR* projected spare capacity to reach 4.2 mb/d in 2010, but it had already reached 6.8 mb/d in March 2009). Surplus refining capacity is also set to expand substantially in the near term. Around 2.7 mb/d of new refining capacity is expected to be added globally during 2009, almost three-quarters of it in Asia. Spare capacity is set to increase by more than 4 mb/d in 2009.

The outlook for spare crude oil production and refining capacity in the longer term hinges on how quickly demand recovers once the global economy is back on the road to recovery, how much further investment is scaled back in the coming months and how quickly investment rebounds in the coming years. The faster the rebound in demand, the more likely it is that capacity will be squeezed in the medium term: the latest GDP projections from the IMF imply that oil demand could indeed recover rapidly. Even if investment recovers strongly and quickly with economic recovery and higher oil prices, gross crude-oil production capacity additions are likely to remain modest in the next three to four years as relatively few major projects have been sanctioned in the last two to three years. On the other hand, were the global economy and thus oil demand to recover on a slower and lower L-shaped path, spare capacity could remain at current levels until around the middle of the next decade.

The near-term outlook for LNG supply has eased in recent months, with the prospect of a slowdown in demand growth and more than 15 new liquefaction trains under construction due to come on stream within the next three years. But it is increasingly less likely there will be any new final investment decisions on large-scale plants taken before the end of 2009 in view of the dismal economic outlook and financing problems. There are around a dozen projects lined up that are facing a final investment decision before the end of 2010. The earliest any of these would come on-stream would be 2014 or 2015. But it is far from certain that any of them will proceed, in view of the prospect of lower prices, persistently high construction costs, scarce finance and reluctance on the part of buyers to sign long-term purchase contracts given the uncertainty about the outlook for demand in the medium term. As a result, global liquefaction capacity is set to plateau by 2013. Given the long lead times in building new plants, LNG markets could tighten once again beyond 2013-2014, depending on how quickly economic activity and gas demand revives in the main consuming markets, particularly in Japan.

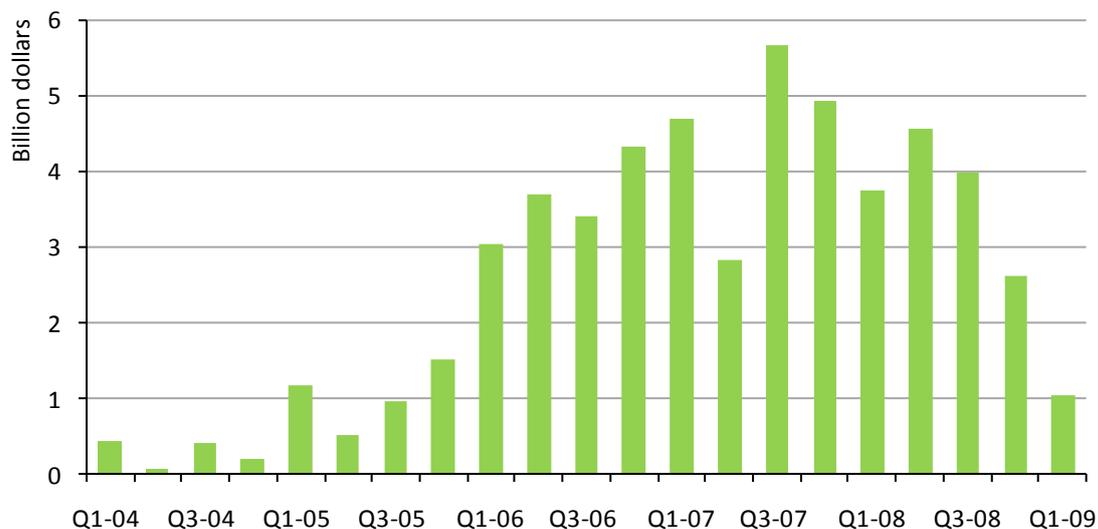
Impact on biofuels investment

Biofuels investment has fallen heavily over the past year or so. The biofuels industry is particularly susceptible to the fall in oil prices because of the high cost of production and limits of the amount of fuel that can be absorbed by gasoline and diesel blending pools. A wave of construction of new bio-refineries across the world appears to be dissipating and many plants that were brought into operation in recent years are now standing idle because of a worsening of economics: biofuel prices in many cases are too low to cover the rising cost of the feedstock and operating the plant. The higher cost of credit and restricted access to new finance, in addition to regulatory changes (for example in Germany and the United States) related to the environmental benefits of first-generation biofuels technology, is also deterring new investment. Worldwide, asset financing of bio-refineries – now almost the sole source of physical biofuels investment – plunged from around \$5.7 billion in the last quarter of 2007 to about \$1 billion in the first quarter of 2009 (Figure 8). Though never a large share of total investment, public investment and venture capital funding (part of which normally goes to physical assets), have also

collapsed. Lower investment, together with lower utilisation rates of existing plants, will reduce incremental biofuels supply: in the five years to 2008, biofuels met 12% of the increase in world demand for oil products and 16% of the increase in demand for transport fuels.

New investment in bio-refineries has all but dried up in the United States for the moment with the axing of a number of proposed corn-based ethanol projects in recent months either due to financing problems, lower ethanol prices or a combination of the two. A growing number of biofuels producers are in severe financial difficulty. At the end of 2008, the country's second-largest ethanol producer, Verasun filed for Chapter 11 bankruptcy protection, along with Greater Ohio Ethanol and Gateway Ethanol. Since the start of the year, Renew Energy, Northeast Biofuels and – most recently – Aventine Renewable Energy have also filed, while a number of other companies are struggling to avoid the same fate. It is worth noting however that some of these assets will be bought and operated by other, more financially robust owners. Reportedly, about a fifth of US ethanol production capacity is currently idle because of low crush spreads – the gap in price between corn and ethanol. A wave of mergers is expected unless ethanol prices and asset values improve soon.

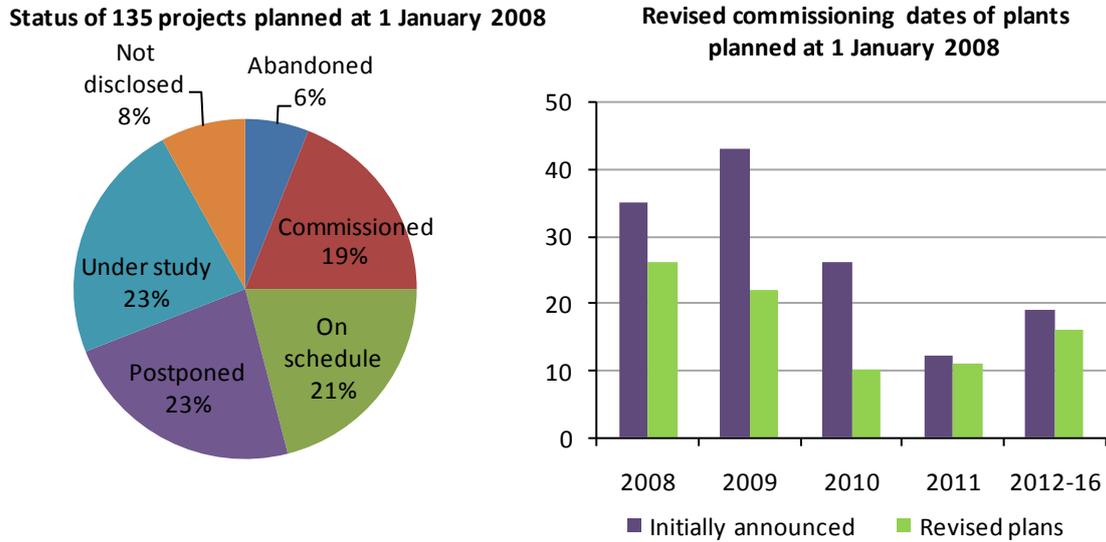
Figure 8: Global asset financing of bio-refineries



Source: New Energy Finance database.

Many ethanol producers are also in difficulty in Brazil, where the sector is highly leveraged. New projects which have already secured funding will continue, but many of those that have not are likely to be cancelled. Of 135 projects that were under development at the start of 2008, 29% have been postponed or abandoned and another 23% have stalled (Figure 9). Only 85 plants are now expected to be commissioned by 2016. The government is considering a bail-out plan for ethanol producers.

Figure 9: Ethanol plants in Brazil



Source: New Energy Finance databases.

The European Union is also seeing a slowdown in biofuel capacity additions due to both lower diesel prices (most of the biofuels produced are methyl esters blended into diesel) and financing problems. A scaling back of the EU target for the share of biofuels in total transport fuel use to 5% by 2015 and a decision to review in 2014 the 2020 target, which remains unchanged at 10% for now, and uncertainty about incoming policy on sustainability criteria have also undermined interest in new plants.

The slowdown in investment will inevitably lead to a levelling off of biofuel production capacity in the near to medium term. At present, ethanol and biodiesel capacity in total stands at 2.4 mb/d – up from 1.6 mb/d in mid-2008 – though more than 0.2 mb/d is currently idle or mothballed (Table 4). A further 520 kb/d of capacity is under construction and a similar amount is planned, the bulk of it ethanol. It is likely that, unless crush spreads improve significantly in the coming months, many of the planned plants will be cancelled.

Table 4: Status of biofuel-production capacity worldwide (kb/d)

	Mid-2008	March 2009	New listings	Baseline difference
In operation	1568	2154	35	551
Idle	5	173	9	160
Shut	0	48	9	39
Under construction	820	519	88	-389
Project	864	518	28	-374
Cancelled	23	97	0	73
Unknown	0	143	0	143

Source: IEA databases and analysis.

Although investment in conventional biofuels plants has dropped significantly, funding to second-generation biofuels – notably ligno-cellulosic ethanol – is likely to grow, with large amounts of stimulus package funds being directed to research and development of these technologies. A number of companies are pursuing investments in demonstration plants. For example, BP and Verenium recently committed \$45 million to a joint venture to develop a cellulosic ethanol plant. In the United States, part of the \$16.8 billion allocated to the Department of Energy’s (DOE) Office of Energy Efficiency & Renewable Energy (EERE) is expected to be devoted to advanced biofuels.

Impact on coal investment

Overview

Coal-sector investment is expected to be significantly lower in 2009 than in 2008, falling by perhaps half.¹³ Nonetheless, the drop in spending is from very high levels reached in 2007 and 2008, which were exceptionally profitable years: coal companies increased their investments sharply then, in part to absorb some of their free cash flows, and paid out large dividends to shareholders. Expected reductions in capital spending in 2009 are most marked among high-cost producers, especially those supplying the export market, such as coal mining companies in the

¹³ The coal sector comprises mining companies, rail and shipping companies who transport coal and owners of port assets where bulk carriers are loaded or unloaded. It is often not possible to disaggregate coal-related activities from other activities undertaken by these companies. For example, mining companies may extract other minerals such as iron ore and alumina (horizontal diversification) or may be part of an integrated utility company with power generation assets (vertical integration). In such cases, published information specific to their coal business is often sparse. More generally, companies are not obliged to disclose or update their capital expenditure plans. These are typically subject to ongoing review in light of market conditions, acquisition and divestment opportunities, regulatory approvals and permits, and competitor behaviour. The picture presented here is therefore a best estimate using data from a sample of 25 large coal-producing companies and recent developments in the world’s bulk shipping fleet and at ports.



United States and Russia. In contrast, Indonesian coal producers continue to enjoy high margins with little apparent disruption to planned expansions.

The large multinational mining companies are also taking steps to address a sharp drop in cash flow. High debt to equity ratios following earlier acquisitions and their exposure to the steep downturn in demand for commodities, such as iron ore and other minerals, mean that many new projects have been cancelled or delayed. For other mining companies, the picture is mixed. Those with single customers, such as Sasol in South Africa which produces mainly for its Secunda chemical plant, and RWE, which produces mainly for its lignite power plants in Germany, have not made any changes to capital investment plans at their coal business units. Low-cost suppliers, such as those in Indonesia, anticipate continued strong demand and aim to continue raising production with new investments. State-owned companies, such as those in China and Coal India, can be expected to direct their investments toward government objectives to promote economic growth (as outlined in China's economic stimulus package and in India's 11th Five-Year Plan).

The year 2008 was an exceptional one for the coal sector with many mining companies reporting remarkable financial results on the back of strong spot prices. Steam coal prices peaked at over \$200 per tonne CIF in July 2008. Tightness in the coking coal market, partly due to the flooding of mines in Queensland, Australia, led to contract prices reaching over \$300/tonne – three times higher than in 2007. Higher prices boosted profitability enormously. At Xstrata, for example, earnings before interest and tax on coal sales rose more than four-fold to \$3.5 billion; Rio Tinto's net earnings from its energy and minerals business unit (including uranium) rose from \$687 million to \$2.9 billion with coal sales accounting for two-thirds of this increase; in the United States, Peabody's operating profit rose 135% to \$1.4 billion. In India, on 30 March 2009, the wholly state-owned mining company Coal India paid its largest ever dividend of 17 billion rupees (\$330 million) for the 2008/09 financial year. Other companies reported similarly positive performances, and capital expenditures in 2008 were significantly above previous years as companies responded to the healthy demand for coal.

The industry euphoria that flowed from rising coal prices during 2007 and 2008 came to an abrupt end with the steep fall in prices after July 2008. By the end of 2008, international prices had fallen over 70% from their peak and returned to 2006 levels, while earlier talk of a long "super cycle" was replaced by statements describing the steps being taken by mining companies in response to the sudden downturn in demand for commodities and downwards revisions to projected cash flows and the general need to reduce indebtedness. For some companies, remaining solvent became the priority. This was particularly the case with Rio Tinto, which had taken on massive borrowings to fund its expansion. In early 2009, it entered into an agreement with state-owned Chinalco, China's largest aluminium conglomerate, which, if concluded, would double its equity stake in Rio Tinto to 18%, an agreement worth \$20 billion. In a related move, BHP Billiton abandoned its ambitious attempt to take over Rio Tinto in a deal that had been worth around \$150 billion. Both BHP Billiton and Rio Tinto have raised significant

amounts of capital in recent weeks through bond issues, with the proceeds being used to cover short-term debt.

All mining companies have moved to bolster their cash flows by divesting non-core assets (Anglo American, for example, has sold its stake in China Shenhua Energy), issuing bonds and reducing or eliminating non-essential expenses. The latter includes delaying or cancelling capital investments, idling high-cost production units (for example, a longwall face at Xstrata's Oakey Number 1 mine in Australia and a dragline at Arch Coal's Black Thunder mine in the United States), trimming employee numbers to match reduced production targets and cutting or even suspending dividend payments. In terms of job losses, contractors have been particularly hard hit since mining companies can lay them off more easily than their own employees with employment rights.

Impact on major coal producers

Investment in 2008 and 2009 by 25 leading coal companies around the world is set out in Table 5. Together, these companies account for around 37% of total global coal production (hard coal and brown coal) and over 60% of global coal trade. Privately owned companies, such as Drummond and SUEK, whose shares are not publicly traded or listed, have limited reporting requirements and publish very little information about their business activities. In these instances and others where companies are state-owned (Coal India, Datong Coal Mining Group and Shanxi Coking Coal Group), capital investments are not reliably reported.

Uniquely among the companies listed above, Shenhua has published its revised capital spending plan for 2009 (Table 6), shifting investment from coal production and power generation to investment in infrastructure, notably railways. This includes the adoption of 10 000-tonne trains with light-weight wagons and high-powered locomotives, which will be needed to transport more coal from western China. This is in line with the economic stimulus package announced by the Chinese government in November 2008 (see below). In addition, Shenhua intends to be more cautious with its power project investments and will now await approvals before making investment commitments.

Other companies have given new guidance on capital expenditure during 2009, without issuing precise numbers on coal-mining investment plans. Xstrata has announced that it will slash spending by 45% across all its activities, which include coal mining, Anglo American expects a year-on-year fall in capital expenditure of 50% in 2009 and has abandoned its earlier plan to raise coking-coal production by 10%. In the United States, following a second revision statement, Arch Coal's 2009 production target is now 15% lower than 2008 production. In contrast, PT Bumi Resources intends raising production by 10% in 2009. More broadly, a survey of media reports during the first quarter of 2009 indicates that investment in coal mining projects has declined by 39% to \$5 billion, compared with the same period in 2008. The aggregate production capacity of new projects has declined by 49% in comparison to the first quarter of 2008. This all points to a total coal sector investment in 2009 significantly below the 2008 peak – perhaps by as much as 40% – and below the average long-term investment trend.

Table 5: Production, exports and investment of 25 leading coal companies

Company	Corporate base	Production in 2008 (Mt)	Export in 2008 (Mt)	Investment (\$ million)	
				2007	2008
BHP Billiton	UK-Australia listed	116.1	76.7	873	938
Xstrata Coal	UK listed	85.5	74.8	807	1 204
Anglo American	UK listed	99.5	50.4	1 052	933
Rio Tinto	UK-Australia listed	160.5	31.8	1 198	1 868
Peabody Energy	US	231.8	22.6	429	266
Arch Coal	US	126.6	15.0	488	497
Consol Energy	US	59.0	3.3	743	1 062
Massey Energy	US	37.3	7.3	271	737
Drummond	US	35.0	35.0	n.a.	n.a.
Teck Cominco	Canada	23.0	16.9	532	880
SUEK	Russia	96.2	28.2	n.a.	n.a.
Kuzbassrazrezugol	Russia	46.0	23.0	n.a.	n.a.
RWE Power	Germany	103.8	0.9	263	331
Kompania Węglowa	Poland	44.6	6.6	234	371
Sasol	South Africa	40.4	0.0	85	120
Coal India	India	403.5	0.0	862	n.a.
China Shenhua Energy	China	232.7	21.2	2 080	2 090
China National Coal Group	China	100.4	16.0	761	1 142
Datong Coal Mining Group	China	116.7	5.0	n.a.	n.a.
Shanxi Coking Coal Group	China	72.4	3.2	n.a.	n.a.
Banpu	Thailand	18.5	16.3	92	120
Mitsubishi Development	Japan	33.1	33.1	n.a.	n.a.
PT Bumi Resources	Indonesia	53.0	41.0	210	567
PT Adaro Indonesia	Indonesia	38.5	27.0	67	151
PT Kideco Jaya Agung	Indonesia	21.7	15.0	n.a.	n.a.
Total		2 395.8	570.3	11 047	13 277

Sources: Company reports; IEA databases.

Table 6: China Shenhua Energy capital spending (\$ million)

Company	2008 (actual)	2009 (planned)	Change (2009/2008)
Coal mining	2 090	1 387	-34.7%
Railways	360	1 106	202.3%
Ports	56	118	108.8%
Power	2 564	1 750	-32.9%
Others	81	14	-82.7%
Total	5 150	4 375	-16.4%

Sources: Company statements.

Shipping and port investment makes up a small component of total investment in coal supply, typically less than 10%. During the boom period leading up to 2008, many investments in port expansions were committed and these projects are now coming to fruition – notably in Australia (at Newcastle and Dalrymple Bay), in South Africa (at Richards Bay Coal Terminal) and in Colombia. These developments are important because, historically, it has been a lack of investment in port (and rail) infrastructure that has led to bottlenecks in the coal supply chain. Investment in shipping reached a peak in 2007 in response to soaring freight rates. The shipping industry is cyclical and well used to responding quickly to economic slowdowns: scheduled deliveries of new vessels have been delayed, scrapping rates have increased substantially and, where possible, orders have been cancelled with the payment of penalties.

Implications for capacity

The recent scaling back of investment in coal mining will undoubtedly slow the growth in production capacity, but probably not to the extent that coal will be in short supply in the near future. When demand and prices recover, most of the mining projects that have recently been postponed will be revived. In most case, projects can be producing within two to five years of an investment decision. We can expect an acceleration of the trend, seen now over many decades, of a shift in production to those regions with large, easily accessible resources, such as Indonesia, Australia and west of the Mississippi River in the United States.

Impact on power-sector investment

Electricity demand

As in the oil and gas sectors, the first, most immediate effect of the financial and economic crisis on the power sector has been a lowering of electricity demand, particularly in industrial applications, in almost all countries. This is despite a sharp fall in electricity prices – linked to the drop in fossil fuel prices – and cold winter temperatures in the Northern Hemisphere which would normally support growth in consumption. In the OECD, electricity demand in the fourth quarter of 2008 fell by 2.5% compared to the corresponding quarter of 2007. The drop-off accelerated in the first quarter of 2009, with electricity consumption reduced by a further 4.9%

compared to the first quarter of 2008. Non-OECD regions have also seen weaker demand: China electricity demand fell by a staggering 7.1% in the fourth quarter of 2008 and by a further 4% in the first quarter of 2009, while demand has also fallen heavily in Russia. Demand has slowed considerably in India too.

Based on the IMF's latest GDP growth forecast for 2009, we estimate that global electricity demand could drop by as much as 3.5% in 2009 (Table 7). This would represent the first contraction in global electricity demand since the end of the Second World War; even during the first and second oil shocks and US recession in the early 1980s, global electricity demand continued on its upward trend (Figure 10). Our analysis suggests demand will fall the most in Russia, by 8.8%, followed by the OECD (4.8%) and China (2.9%). In contrast, electricity demand in India is expected to continue to grow, but by only 0.9% – well down on growth of 7.0% in 2008.

Table 7: Electricity demand growth rates for selected countries

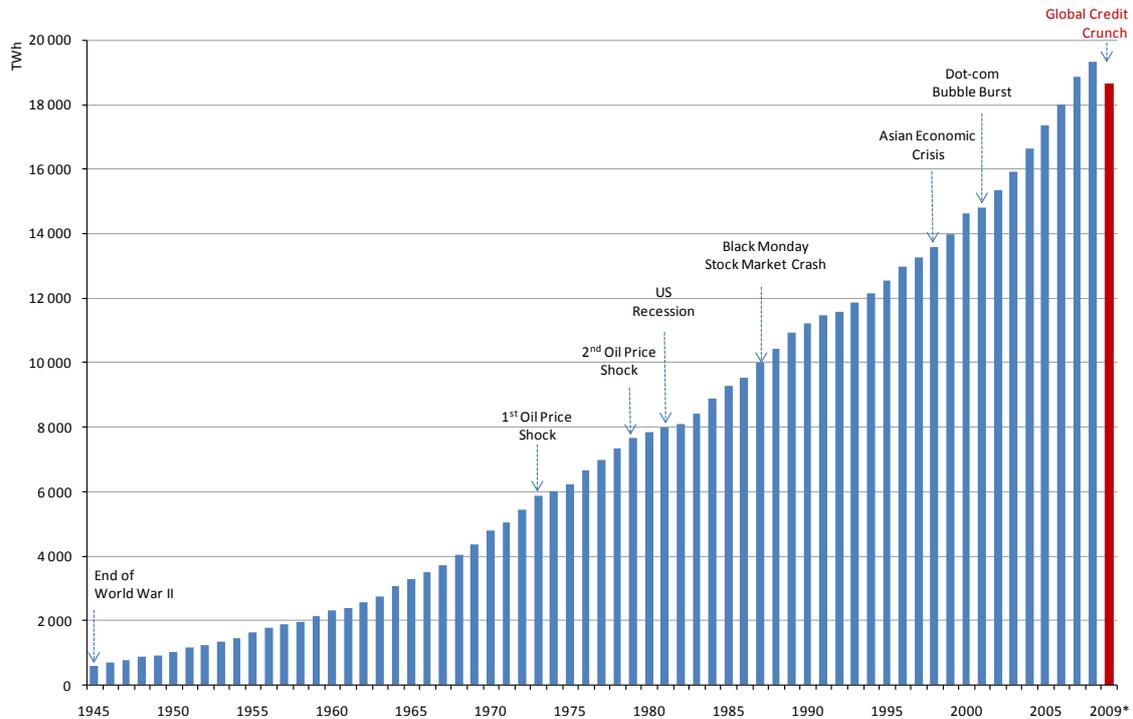
	Quarterly growth rates (year-on-year)*				Annual growth rates			
	Q1-08	Q2-08	Q3-08	Q4-08	Q1-09	2007*	2008*	2009**
Canada	-0.1%	-0.5%	-1.1%	-1.9%	-3.3%	1.0%	-0.9%	n.a.
France	5.1%	6.3%	1.4%	-1.4%	2.6%	0.4%	2.7%	n.a.
Germany	0.8%	4.0%	1.7%	-2.3%	-4.9%	-0.5%	0.9%	n.a.
Italy	1.2%	-0.8%	2.4%	-5.4%	-8.0%	0.4%	-0.7%	n.a.
Japan	8.5%	1.0%	-1.1%	-4.6%	-10.2%	2.9%	0.9%	n.a.
Korea	8.8%	4.3%	5.9%	2.5%	-9.5%	5.8%	5.4%	n.a.
UK	1.8%	1.1%	0.5%	-3.0%	-6.8%	-0.9%	0.0%	n.a.
USA	2.1%	0.4%	-3.2%	-2.2%	-4.2%	2.4%	-0.8%	n.a.
Russia	6.6%	4.3%	5.1%	0.5%	-3.7%	4.0%	4.0%	-8.8%
China	13.1%	10.4%	6.2%	-7.1%	-4.0%	14.8%	5.2%	-2.9%
India	8.5%	4.8%	11.1%	4.0%	0.3%	7.1%	7.0%	0.9%
OECD	3.4%	1.5%	-1.0%	-2.5%	-4.9%	2.0%	0.3%	-4.8%
World	n.a.	n.a.	n.a.	n.a.	n.a.	4.7%	2.5%	-3.5%

*Actual data.

**IEA estimate.

Source: IEA databases and analysis.

Figure 10: Historical world electricity consumption



* IEA estimate
Source: IEA databases and analysis.

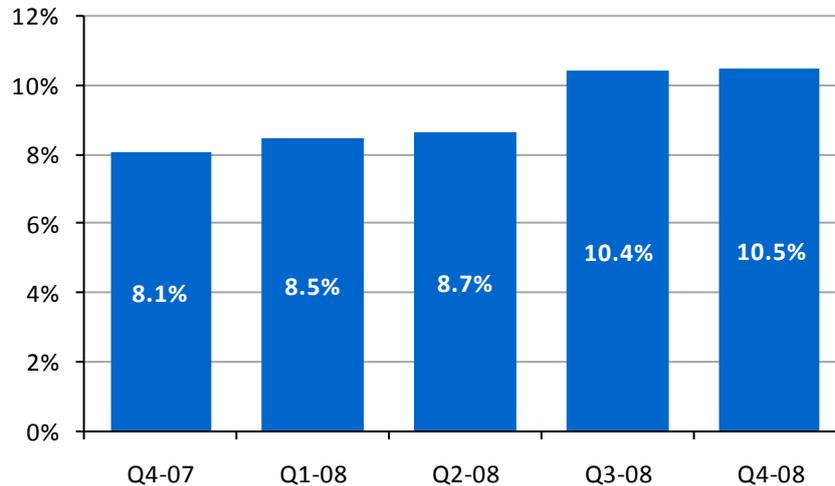
Cost of capital in the power sector

The power sector is currently confronted with increasing costs of capital despite record low interbank offered rates,¹⁴ reflecting the more stringent returns demanded by investors associated with perceived higher risk. For example, for electricity services companies in the United States, the weighted average cost of capital (WACC) – which essentially measures the return needed to satisfy debt and equity holders – increased by almost 2.5 percentage points by the fourth quarter of 2008 on a year-on-year basis¹⁵ (Figure 11). Even though unit investment and equipment costs are now falling, this increasing cost of debt could threaten the profitability of new and existing projects and possibly lead to further delays, particularly in a low electricity price environment.

¹⁴ Interbank offered rates: The interest rates at which banks borrow unsecured funds from other banks.

¹⁵ Morningstar Ibbotson Cost of Capital Resource Center (2009).

Figure 11: Weighted average cost of capital (WACC) for US electricity companies



Note: For small composite US companies using the Capital Asset Pricing Model (CAPM) methodology. Sample includes 44 companies for December 2007 and 46 companies for all other quarters.
 Source: Morningstar Ibbotson Cost of Capital Resource Center (2009).

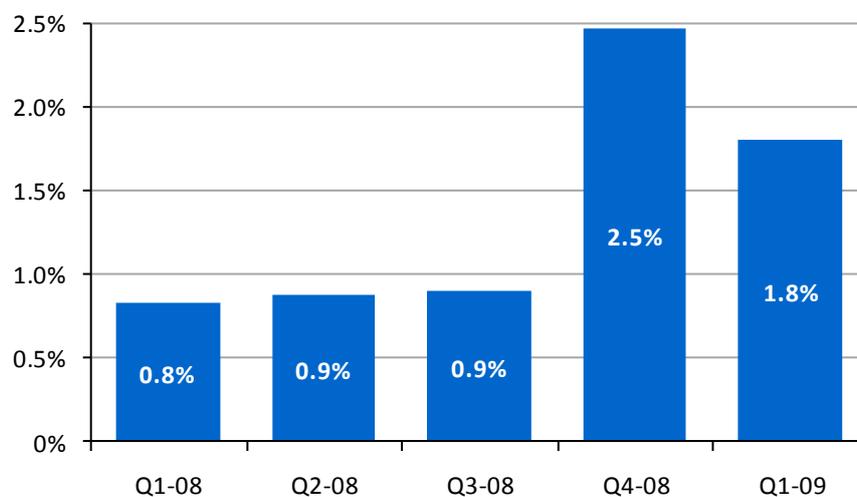
Our analysis of corporate bond yields – used as a proxy for the cost of debt – provides evidence that the power sector has been paying above-average interest rates since the financial crisis began. This analysis involves a comparison of bond yields of large diversified electric utility companies from the United States, Europe, South Korea and Japan against a benchmark consisting of European and US Government Bonds. In the fourth quarter of 2008, the average yield of the government bonds was 2.5 percentage points less than that of the electric utilities (Figure 12). Although the spread fell to an average of 1.8 points in the first quarter of 2009, reports from industry players suggest that absolute cost of debt has risen more than 2 points.¹⁶ Bond yield analysis of a number of wind and solar companies indicates that the interest rates they are currently paying remain well above pre-crisis levels. Additional evidence for increased costs of debt for high yield companies comes from the Merrill High Yield Index, an indication of the absolute cost of debt to companies. The average yield was 12.4% in September 2008, twice the level of March 2008.¹⁷ Large diversified electric utility companies are less affected by the current rise in interest rates as they have better credit ratings and stronger balance sheets

¹⁶ New Energy Finance (2009); European Wind Energy Conference (2009); Nuclear Energy Agency (2009).

¹⁷ IEA analysis.

than smaller and/or start-up renewable energy companies. Smaller developers below the publicly traded radar screen will be even more affected as they are heavily reliant on the project finance market.

Figure 12: Yield spreads between government bonds and corporate bonds in the power sector



Note: Sample includes 13 corporate bonds with different ratings of large diversified electric utility companies. Data includes average corporate bond yields compared to average government bond yields per quarter. Companies include American Electric Power, Dominion, Duke, EDF, ENEL, E.ON, Exelon, FPL Group, Iberdrola, KEPCO, RWE, Southern and TEPCO. As a benchmark the average of 10-year US Treasury and Euro bonds was applied.

Source: IEA analysis.

Power sector investment trends and outlook

The economic crisis is changing the outlook for power sector investment both in terms of the amount of new capacity that is expected to come on line and the generation fuel mix. Low or negative rates of electricity demand growth are reducing the immediate need for new capacity additions. In addition, the crisis, by helping to drive down fossil-fuel prices, has led to much lower power prices, which, all other things being equal, typically favour less capital-intensive generation options such as natural gas and coal over costlier options such as nuclear and renewables. At the same time, commercial borrowing has become more difficult and venture capital and private equity investment has fallen sharply. The extent to which these factors influence the evolution of the electricity generation mix will depend largely on the duration of the economic downturn. If a recovery takes longer than expected, and fossil-fuel prices remain at depressed levels relative to recent peaks, we would expect to see a shift to coal- and gas-fired plants in the longer term.



While construction work on most new power projects already underway is continuing, market commentators have suggested that new power plant orders worldwide could fall by as much as 50% in 2009, although large equipment manufacturers have quoted figures closer to 30%. Many power companies across Europe have been slashing their investment programmes. For example, Spanish utilities have announced cuts totalling €30 billion, or about 44% of planned spending while E.ON announced in February 2009 a downward revision of their investment plan for 2009-2011 from €36 to €30 billion, with most of the cut expected to be in fossil fuel-fired power generation and Enel announced cuts in investment in excess of 20%. In contrast, several other large European utilities, including GDF Suez, RWE and EnBW, have each stated their intent to keep previous investment plans intact. Reduced costs for raw materials and intense competition in the power sector in the face of dwindling orders have contributed to a drop in unit investment and equipment costs by 20-30% from the record highs reached in 2008.

Although there have been a number of postponements to new coal-fired power plants, these have been linked in significant part to climate and environmental policy, rather than problems stemming from the financial crisis. For example, in the United States, plans for 8 642 MW of new coal capacity were cancelled during the first quarter of 2009, primarily as a result of regulatory uncertainty over greenhouse gas legislation.¹⁸ Similarly, in the Netherlands, plans to construct three new coal plants have been shelved for approximately 18 months while an interpretation of EU rules on emissions of oxides of nitrogen and sulphur dioxide is handed down. Nonetheless, as it can take between four to six years to build new coal-fired capacity – which is longer than other generating options with the exception of nuclear – investment in new coal plants will be affected by the rising cost of debt.

In contrast, natural gas plants, which have much shorter lead-times, could potentially benefit in this respect although their proponents face the heightened uncertainty over the near-term outlook for electricity demand. However, several gas projects are facing difficulty, including the \$2.2 billion Al Dur power and water project in Bahrain – a joint-venture between the Gulf Investment Corp and France's GDF Suez – which has been delayed by several months as the project proponents seek to negotiate new terms with lenders in the case of tight international credit market conditions

As yet, there have been very few delays or abandonments to transmission and distribution (T&D) projects that were already underway or announced, including key cross-country power grid interconnections. In fact, a number of countries, including France and the United States, have boosted investment in T&D as part of their economic stimulus plans. However, over time, a reduction or contraction in demand for electricity will reduce the need for investment in T&D networks. In addition, there remains the possibility that projects to upgrade existing distribution

¹⁸ National Energy Technology Laboratory, April 6 2009, <http://www.netl.doe.gov/coal/refshelf/ncp.pdf>

lines will be delayed as price formulas used by transmission system operators (TSO) are revised to take into account recent changes to credit rates.

Given the combination of comparatively stronger rates of electricity demand growth in the coming years and limited financial resources, the power sector in developing countries is likely to be disproportionately affected by the financial crisis. This will hinder efforts to tackle energy poverty (see the first section). Indeed, a number of key projects have already been postponed or abandoned. For example, the 750 MW Kufue Gorge Lower hydropower station that was expected to end Zambia's power shortages has been delayed by one year as several of the international firms interested in providing capital withdrew. Similarly, in Tanzania, a 200 MW coal-power project valued at \$400m that was due to start operation by 2011 has been postponed, and a 300 MW natural gas-powered project valued at \$300m is struggling to secure financing.

Nuclear investment

The financial and economic crisis could lead to delays and possibly cancellations of new nuclear power plants, and hinder efforts to revive new construction programmes, reducing the capacity that is likely to be commissioned in the period 2015-2020. Some 45 reactors are currently under construction, with a total capacity of approximately 40 GW; 35 of these units are in non-OECD countries. Projects that were already well-advanced are, for the most part, proceeding. One exception is in South Africa, where the national utility, Eskom, has been forced to delay plans to build a second nuclear reactor, extending the date of commissioning by two years to 2018, partly because a downgrading of its credit rating has increased the company's cost of borrowing.

Recent years have seen an increased interest in building new nuclear plants in both nuclear and non-nuclear countries. Nuclear technology is the only large-scale, base-load, electricity production technology with a near zero carbon footprint, apart from hydro power (where potential is often limited). The economics of nuclear relative to fossil-fuelled generation, particularly coal, improves with carbon pricing. The cost of nuclear power is highly sensitive to its capital costs (both the absolute levels of capital expenditure and the cost of capital) because of high capital intensity (typically likely to exceed \$5 billion for a new 1600 MW plant) and the long lead times. However, nuclear is significantly less sensitive to fuel cost than coal and gas-fired generation. Third generation technology is being built in China, Finland and France. Such technology promises lower costs, improved safety, more efficient fuel use and lower volumes of waste. A number of other countries including the United States, China, Italy, the United Kingdom, Hungary, the Czech Republic and Poland have recently announced plans to construct new nuclear reactors. In the case of Italy, which invoked a complete phase-out of nuclear energy in a 1987 referendum, the government hopes to begin construction of its first new reactor by 2013. However, the recession and financial crisis may hold back moves to launch some of these programmes.

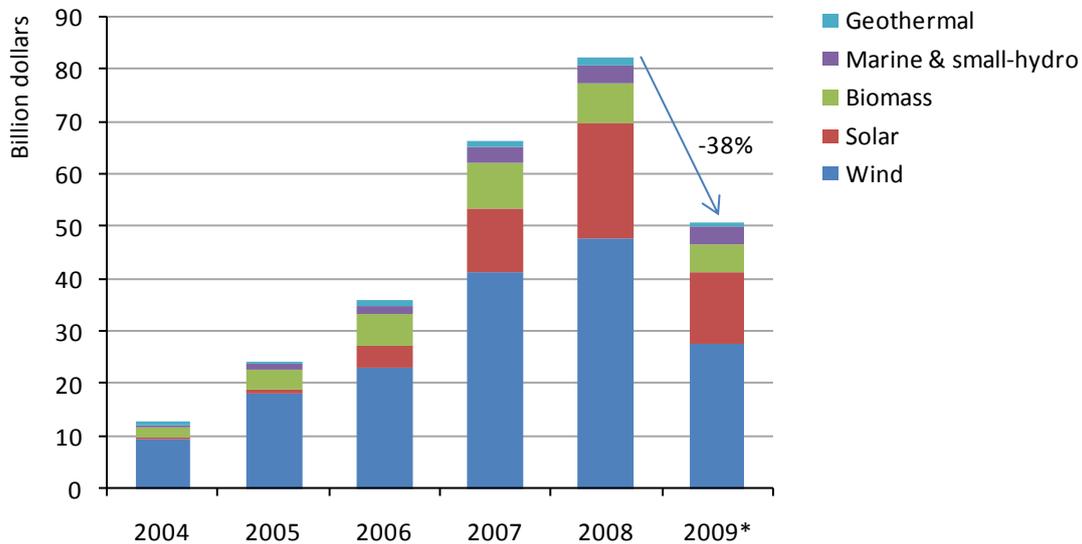


A nuclear renaissance is possible but cannot occur overnight. Nuclear projects face significant hurdles, including extended construction periods and related risks, long licensing processes and manpower shortages, plus long standing issues related to waste disposal, proliferation and local opposition. The financing of new nuclear power plants in liberalised markets remains an important issue, and the financial crisis seems almost certain to have made it even more difficult. The huge capital requirements combined with risks of cost overruns and regulatory uncertainties, make investors and lenders very cautious, even when demand growth is robust. Certain financial models which might have underwritten new nuclear plant development are likely to be unavailable for some time, depending on the speed of recovery. This includes project financing, which typically involves syndication and securitisation, and industry consortia funding (such as occurred in Finland). Only a few electricity utilities are big enough to finance nuclear plants from their balance sheets, and that number has diminished in the current crisis. Governments wishing to encourage investment in nuclear may need to remove or mitigate some risks investors are facing, especially for first-of-a-kind nuclear plants and in countries where there is no existing nuclear programme or where there have been no new builds for many years. The United States provides the clearest example of state support, providing loan guarantees, risk insurance for licensing delays, and production tax credits, through its 2005 Energy Act. However, the United Kingdom for example, has stated its intention to not financially support nuclear projects. The new, first-of-a-kind projects in Europe have proceeded with the benefit of guaranteed capital cost.

Renewables-based power-generation investment

Investment in new-build renewable energy assets in the power sector grew tremendously over recent years, recording year-on-year growth of 85% in 2007. Activity in the sector continued to grow rapidly until the third quarter of 2008 but then fell away dramatically as the financial crisis dried up sources of project finance and lower fossil-fuel prices reduced the economic incentive to invest in renewables. The latest preliminary data, covering the first quarter of 2009, indicates that the slump in renewables investment has accelerated, with spending 42% lower than in the fourth quarter of 2008. Based on current investment trends in the sector, the IMF's most recent global GDP forecasts and assuming fossil-fuel prices remain close to current levels for the remainder of the year, we estimate that worldwide investment in renewables-based power-generation technologies in 2009 would drop to as little as \$51 billion without taking account of the impact of fiscal stimulus packages (Figure 13). This would represent a 38% decline on the level of 2008, and a 23% decline on that of 2007. The slump in investment in renewables represents a setback in the fight against climate change (see the last section).

Figure 13: Global investment in new renewables-based power generation assets



* IEA estimate based on 1st quarter data.

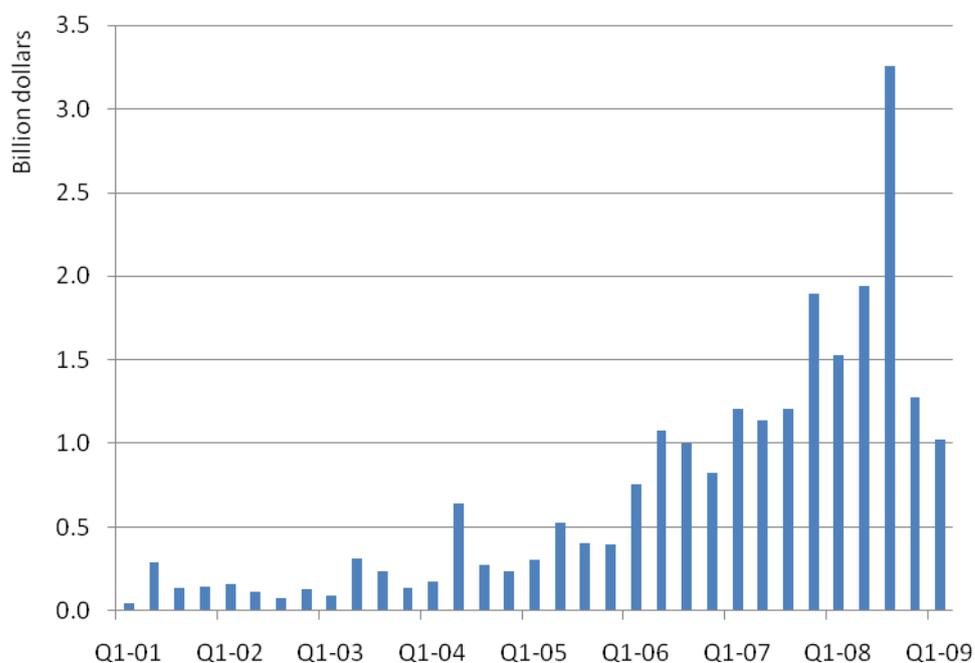
Sources: New Energy Finance databases; IEA analysis.

Note: The stimulus provided by government fiscal packages may offset a small proportion of this expected decline in investment in new renewables-based power generation.

New investment flows from private equity and venture capital – which play an important role in funding early-stage clean energy technology companies – fell to just over \$1 billion in the first quarter of 2009. This was the lowest capital inflow on a quarterly basis since the last quarter of 2006 and represented a 70% drop from the record level reached in the third quarter of 2008 (Figure 14). In the first quarter of 2009, only one-third of venture capital invested in US clean technology companies went to alternative energy firms.

Globally, new orders for wind turbines dropped precipitously through 2008 from a peak of almost 15 GW in the second quarter to just 2 GW by the fourth quarter, though orders rebounded to about 4 GW in the first quarter of 2009 (Figure 15). The downturn was particularly severe in the United States and China, whereas spending in the European Union held up comparatively well in comparison. As is the case with most types of renewables, the extent of the impact is linked to the policies and support mechanisms individual countries and regions have in place.

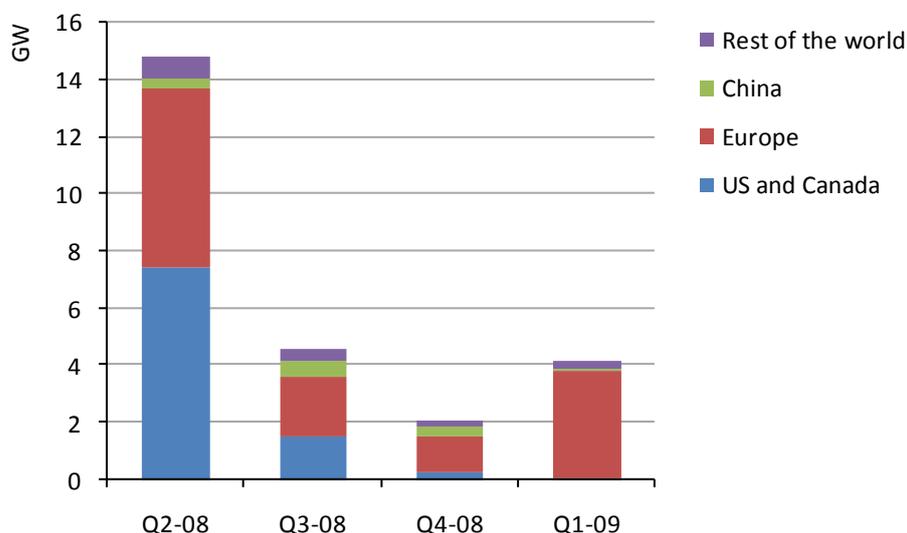
Figure 14: Venture capital and private equity new investment in clean energy companies



Source: New Energy Finance databases

Many wind energy projects rely relatively heavily on debt financing, which either has become much harder to find or more expensive due to higher risk premiums. More risky and high-investment projects such as off-shore wind and large wind farms are being hit the most. Centrica, a British energy company, has put three planned offshore wind farms on hold, partly because of rising financing costs and lower carbon prices under the EU Emissions Trading Scheme – the result of a projected slowdown in electricity demand. But other projects are proceeding, albeit at a sharply slower pace than planned, in several cases due to financing problems. For example, the Trianel Group, a German energy trading firm, has halved the size of its planned Borkum-West II offshore wind farm to 200 MW due to problems securing project finance. Similarly, the FPL Group, the largest wind-power operator in the United States, announced in January 2009 that it was cutting 2009 spending on new projects by almost a quarter to \$5.3 billion and wind-power generation capacity additions to 1 100 MW from 1 500 MW. Some major wind-farm developers – notably in the United States – have delayed placing orders in the hope of prices falling further and to profit from any fiscal stimuli or loan guarantees that may be introduced. Even so, with cash now at a premium, investors are reportedly demanding much higher returns on renewables projects.

Figure 15: Global orders for wind turbines in 2008 by quarter



Source: Various industry sources and IEA analysis.

Investment in solar energy held up relatively well through much of 2008 but then suffered a sharp downturn in late 2008. Preliminary data suggests that the decline deepened in the first quarter of 2009. The bulk of the downturn can be attributed to caps that have been placed on the very attractive feed-in tariff available to solar PV in Spain which will limit the growth in capacity to a maximum of 500 MW in 2009 from over 2.5 GW in 2008. As with wind, the largest projects are being hit hardest. Anecdotal evidence suggests that financing concentrated solar power (CSP) plants has also become challenging in many markets.

Implications for industry structure – fewer deals but greater consolidation?

In 2008, the value of acquisitions and mergers in electricity and gas utility markets worldwide fell by a dramatic 41% from their record highs in 2007.¹⁹ This fall was directly linked to tightening credit markets and evaporating cash flows as the financial crisis took hold. In contrast, the number of deals held up, suggesting valuations were reduced in line with the overall market downturn. In the United States, a slump in funding from so-called “tax equity investors” had a significant impact on deal activity. These investors, typically financial services or insurance companies with large tax liabilities, had been buying into renewables projects to secure federal and state tax credits. With several important investors, including Lehman Brothers, now gone and others facing large losses (which reduce the value of the tax credits),

¹⁹ Power Deals 2008 Annual Review – PricewaterhouseCoopers

interest in investing in renewables projects – especially mid-sized wind farms – has dropped sharply. For example, it is thought that only around half of the large investors that were active in financing wind-power projects in 2008 remained active in early 2009.

As in the oil and gas sector, financing difficulties may provide an opportunity for the largest and most financially robust companies to acquire assets. For example, Electricité de France recently agreed to acquire a 49.9% stake in the US power company, Constellation Energy, while Scottish and Southern Electric has already taken over the wind developer, Airtricity. Stiff competition and substantial overcapacity in solar PV manufacturing – which has resulted in cost reductions of up to 30% – have forced some companies, especially those focusing on less efficient crystalline silicon PV technologies, to exit the market, leading to their acquisition by larger players and market consolidation.

What role for government?

Governments are right to be concerned about the impact of the financial and economic crisis on energy investment because of its potential consequences for energy security and climate change, as well as the longer-term effects on economic and human development. Any prolonged downturn in investment threatens to hold back capacity growth in the medium term, particularly for long lead-time projects, risking a shortfall in supply and a renewed surge in prices a few years down the line when demand is likely to be recovering. That could, in turn, undermine the sustainability of the economic recovery. Weaker fossil-fuel prices are also undermining the attractiveness of investments in clean energy technology. And cutbacks in energy-infrastructure investments threaten to impede access by poor households to electricity and other forms of modern energy. These concerns justify government action to support investment. But such action must be based on a clear understanding of the reasons for falling spending and be consistent with overall energy and economic policy goals.

Lower investment is a normal response to weaker market prospects. There is always a risk of underinvestment in supply capacity because of the market does not accurately predict the timing and speed of the economic upturn at the end of a recession. But that does not by itself provide grounds for government intervention. After all, there is equally a risk of overinvestment because of over-optimism about economic prospects (which explains why most sectors are facing excessive spare capacity at present). However, there is strong evidence that the credit crunch is exacerbating investment cutbacks. Financing difficulties are, in some cases, impeding investment in economically viable projects that would, absent the credit crunch, have gone ahead. This is a market failure that *does* warrant government intervention, as part of a broader package of measures to stimulate lending by banks. But action may also be needed at the sectoral level to address funding bottlenecks to important projects.

Climate change provides an added reason for action on supporting energy investment of the right sort. There is growing concern that, while greenhouse-gas emissions are likely to be

considerably lower in the near term than would have been the case had the crisis not occurred, lower investment in low-carbon energy technologies – resulting from financing difficulties and lower fossil-energy prices – may well lead to higher emissions in the longer term. Some governments have announced plans to introduce (or at least their intention to accelerate the introduction of) a range of new climate-change measures as part of a broader package of increased public spending and other measures to stimulate the economy. But others have already indicated that priority will be given to dealing with the economic downturn and stabilising the financial system and that action to combat climate change will be stalled for the time being on the grounds of costs. There is a very real risk that this will derail efforts to reach a deal on climate change at the crucial meeting in Copenhagen at the end of 2009. The absence of any firm commitment in the agreement reached at the G20 meeting in London in April has heightened fears that climate change is indeed being accorded secondary importance by leading economies. It is of vital importance that this not be allowed to happen.

The IEA's most recent *World Energy Outlook* illustrates graphically the importance of taking early and rigorous action to combat rising energy-related emissions of greenhouse gases through a major decarbonisation of the world energy sources. In a Reference Scenario, in which there is no change in government policies, energy-related emissions of greenhouse gases will rise inexorably – by 45% between now and 2030 in the case of carbon dioxide (CO₂) – pushing up average global temperature by as much as 6°C in the long term (IEA, 2008a). In a 450 Policy Scenario, in which greenhouse-gas concentration is stabilised in the long term at 450 parts per million of CO₂ equivalent, limiting temperature rise to around 2°C, emissions must plateau by 2020 and start falling briskly soon after. Emissions would need to be almost 40% lower than in the Reference Scenario. G8 leaders, at their summit in Hokkaido in July 2008, agreed to consider and adopt a target of at least a 50% cut in carbon emissions by 2050, an objective broadly in line with the ultimate goal of limiting the temperature rise to around 2°C.

The scale of the challenge is immense: to reach this outcome, hundreds of millions of households and businesses around the world would need to be encouraged to change the way they use energy. This will require innovative policies, an appropriate regulatory framework, the rapid development of a global carbon market and increased investment in energy research, development and demonstration. And all countries need to participate in efforts to slash emissions: the 2030 emissions level for the world as a whole in this scenario is less than the level of projected emissions for non-OECD countries alone in the Reference Scenario. In other words, the OECD countries alone cannot put the world onto the path to 450-ppm trajectory, even if they were to reduce their emissions to zero. Any delay in reversing the current upward trend in emission will make it much more difficult and costly to achieve the 2°C goal.

The requisite transformation of the global energy system will not come cheap. In the 450 Policy Scenario, additional investment amounting to \$3.6 trillion is needed in power plants and a further \$5.7 trillion in energy efficiency over the period 2010-2030. These additional investments correspond to 0.6% of GDP per year on average. A large part of this cost is

nonetheless offset by the fuel cost savings to consumers, which are of the order of \$6 trillion over the same period (and continue to accrue well beyond 2030).

Stimulating energy investment – what are governments doing?

Most countries around the world have announced packages of fiscal measures aimed at stimulating their economies to combat the slump in economic activity and employment and stave off deflation. These packages, most of which involve quick and time-limited cash injections through increased government spending or reduced taxes, are intended to complement other measures aimed at addressing directly the banking crisis, including quantitative easing.²⁰ Of the G20 countries (which account for around 85% of world GDP), 19 have announced economic stimulus plans during the last year, with funds committed totalling over \$2.6 trillion. They vary greatly in size and design. According to OECD calculations, they amount on average to over 3% of 2008 GDP for OECD countries as measured by cumulated deviations of fiscal balances over the period 2008-2010 compared with a “no action” scenario. By far the largest package as a share of 2008 GDP so far announced is in the United States, where it amounts to about 5.5%, albeit spread over a period of ten years. This reflects both the extent of the economic contraction and the weaker impact of automatic stabilisers than in Europe, where more generous welfare systems counteract the impact of reduced business activity. China announced a \$586 billion stimulus package in November 2008. By contrast, a few countries – notably Hungary, Iceland and Ireland – have tightened their fiscal stance to support their currencies and limit the rise in national debt.

A small but nonetheless significant share of the economic stimuli announced to date is directed at clean energy – either direct investment or fiscal incentives for low-carbon power technologies or the development and commercialisation of more energy-efficient end-use technologies (including rail infrastructure). In most cases, the new measures constitute an extension or expansion of existing programmes and instruments, enabling the money to be disbursed quickly. We estimate that all the stimulus packages combined provide around \$132 billion of new funding for clean energy, including renewables, carbon capture and storage, nuclear power, improved grid systems and enhanced energy efficiency in buildings industry, and road transport.²¹ A further \$108 billion has been set aside for spending on rail infrastructure (rail investment lowers energy intensity and lower emissions to the extent that it permits a modal

²⁰ The creation by a central bank of a pre-determined quantity of money through open market operations aimed at increasing the money supply. Simply put, it amounts to printing money.

²¹ These figures are based on detailed IEA analysis of national stimulus packages. They include only announced, new funding on low-carbon programmes and consider only the low-carbon component of that funding. Consequently, they may be lower than official announcements. These numbers do not include other forms of funding that may be described as “green” but which are not directly related to clean energy, such as water and waste programmes.

shift away from more energy- and carbon-intensive car and truck use). These investments are to be spread over several years, with some of this front-loaded: clean energy components (excluding rail) of the stimulus packages total \$43 billion over 2009.

The share and mixture of clean energy components in stimulus packages vary considerably across countries. Across all countries, the share averages 5% (including rail investment, the share increases to 9%). The biggest stimulus to investment in clean energy in absolute terms is in the United States, with European countries accounting for most of the rest (Figure 15):

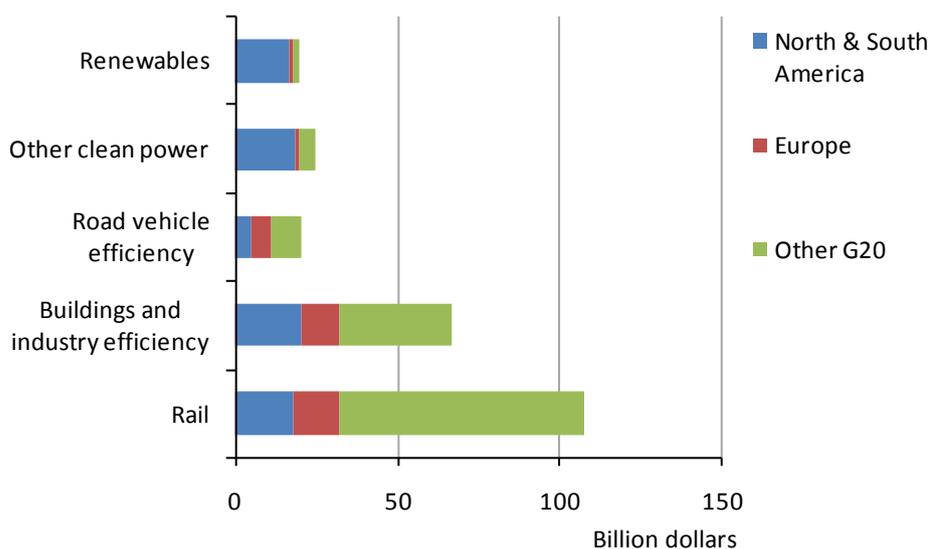
- In the United States, the energy-related components (including rail) of the US \$787 billion stimulus package contained in the American Recovery and Reinvestment Act (ARRA), signed into law by President Obama on 17 February, amount to an estimated \$75 billion, or about 10% of the total, to be spread over a ten-year period. The bulk of the energy spending is in the form of tax credits and other financial incentives to promote wind and solar energy, the provision of biofuels and other alternative fuels by service stations and investments in more energy-efficient buildings (including grants to low-income householders to weatherise their homes) – and many of these provisions are front-loaded, to stimulate investments in the next three years. Other areas of spending include railways and “smart” electricity networks.²² President Obama has also announced a significant tightening of vehicle fuel economy standards, a move that may be backed with loans to ailing US carmakers, and has asked Congress to propose a carbon cap-and-trade system to reinforce incentives to switch to lower-carbon energy technologies.
- Among Europe’s G20 members, around 10% of their total estimated spending of \$350 billion is allocated to clean energy, with a particularly strong emphasis on efficiency measures in buildings. Most of the EU spending is at the national level, with Germany and France at the forefront of efforts. Centralised EU spending focuses on R&D support for carbon capture and storage, as well as funds for buildings and vehicle efficiency.
- In Asia, new funding for clean energy amounts to 8% of total stimulus spending of over \$1 trillion. In China, over \$52 billion will be spent on the railways. Korea, which has been particularly badly hit by the economic crisis, has the largest package of fiscal measures to promote clean energy as a proportion of its overall stimulus package.

²² A smart grid uses information technology to collect, communicate and react to real-time data to make the system more reliable and efficient, by better detecting and fixing problems, by integrating effectively variable power sources such as wind and solar, and by allowing end users to respond to time-of-day pricing to smooth out peaks in load. ARRA allocates about \$4.5 billion for smart-grid investments and demonstrations.

According to our definition, it will invest an extra \$14 billion in clean energy, representing 38% of its total stimulus. With the new programme, the government hopes to create nearly one million jobs over the next four years, mainly in environmentally-focused construction projects and other “green” programmes. Japan has announced a series of large stimulus packages, most recently a ¥15.4 trillion (\$157 billion) package at the beginning of April. This latest package has a clean energy component of over 10%, including grants to solar-power generators and incentives for energy-efficient buildings, vehicles and appliances.

Some governments are also targeting energy security, by directing additional funding at strategic fossil-energy infrastructure projects, such as gas pipelines. In addition to the short-term economic benefits from the fiscal stimulus, such spending may also bring long-term economic and energy-security benefits through lower cost and diversified energy supplies. European Union leaders, for example, agreed at a summit in Brussels on 19-20 March 2009 to allocate an additional €4 billion in funding to energy projects, including cross-border gas pipelines (€1.44 billion), electricity links (€910 million), wind-power projects (€565 million) and carbon capture and storage projects (€1.05 billion). The package was approved by the European Parliament on 16 April 2009.

Figure 16: Clean energy components of economic stimulus packages by type and region



Note: Includes Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Korea, Mexico, Russia, Saudi Arabia, South Africa, Turkey, United States, United Kingdom and European Union. Based on market exchange rates at 29/4/09.

Sources: IEA analysis based on IEA (2008a - including unpublished data); Ecofys (2009); IMF (2009); HSBC (2009a, 2009b); information from the governments of Argentina, Australia, Canada, China, France, Germany, Italy, Japan, United Kingdom and United States, and the European Commission.

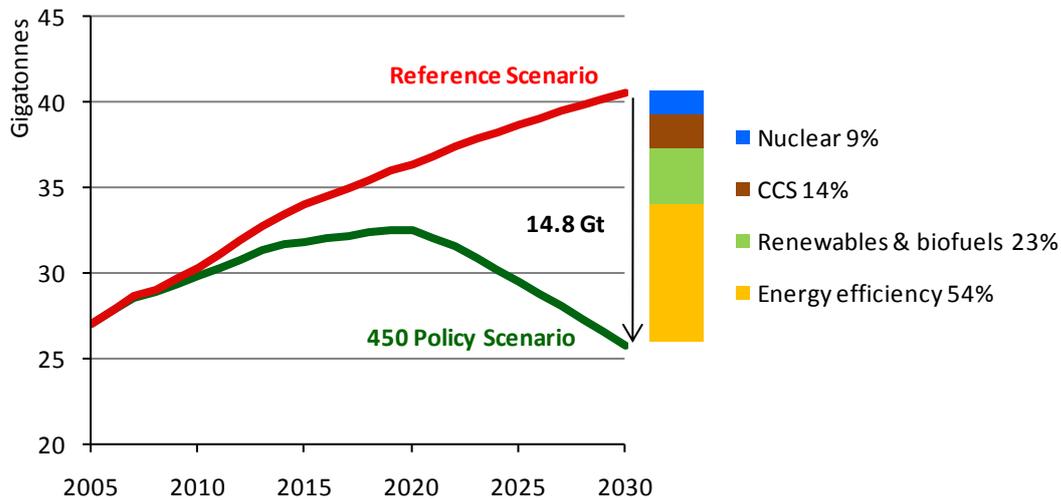
Clean energy investment – what should governments be doing?

There is a growing consensus on the benefits of promoting investment in clean energy infrastructure within the context of such short-term economic stimuli packages. It can kill three birds with one stone: tackling climate change, enhancing energy security and combating the recession. It also complements policies to tackle energy poverty. The IEA has called on all countries to take such action on a large-scale – a *Clean Energy New Deal* – to exploit the opportunity the financial and economic crisis presents to affect a permanent shift in investment to low-carbon technologies. Climate change and energy insecurity are market failures and governments need to act decisively and urgently to correct them. So the moves already taken by a number of member countries and non-members alike – described above – are clearly an important and encouraging step in the right direction. But much more needs to be done: the clean energy components of the stimulus packages so far announced, in aggregate, fall far short of what is needed to achieve sustainable energy use in the longer term (see below). And it needs to be done in the right way – within the framework of a long-term strategy – to be cost-effective. Most importantly, a Clean Energy New Deal must be seen as a long-term commitment that extends well beyond the limited time horizon of the economic stimulus packages.

World Energy Outlook 2008 describes how the global energy system will need to change through policy action over the period to 2030 in order to limit the rise in the concentration of greenhouse gases in the atmosphere. The 450 Policy Scenario describes the impact on energy markets of different international agreements and national/regional commitments on climate change aimed at limiting the concentration of greenhouse gases in the atmosphere to 450 parts per million (ppm) in CO₂-equivalent terms and the global temperature increase to around 2°C. It assumes strong and broad policy action, especially after 2020, inducing very rapid development and deployment of low-carbon technologies. Global energy-related CO₂ emissions peak around 2020 and then fall quickly to just below their level in 2006 (Figure 17). The scale of the challenge in this scenario is immense: the 2030 emissions level for the world as a whole in this scenario is less than the level of projected emissions for non-OECD countries alone in the Reference Scenario. The profound shifts in energy demand and supply required in attaining this emissions trajectory call for huge increases in spending on new capital stock, especially in low-carbon power plants and in more energy-efficient equipment and appliances.²³

²³ The IEA's *World Energy Outlook 2009* will provide detailed analysis of investment requirements and financial flows needed to achieve stabilisation of greenhouse gases at 450 ppm.

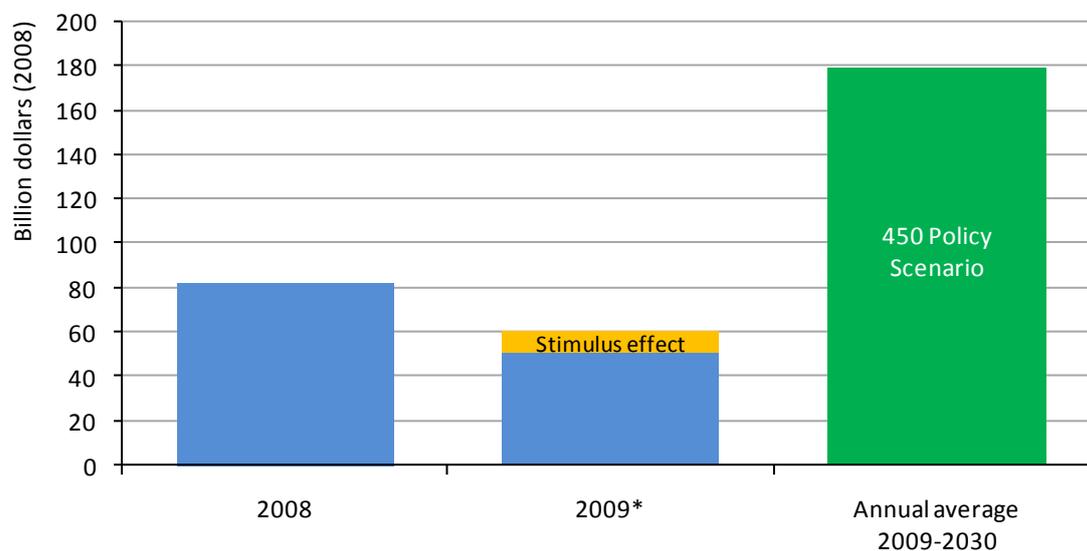
Figure 17: Reductions in energy-related CO₂ emissions in the 450 Policy Scenario



Source: IEA (2008).

The required shift in energy investment to achieve 450 ppm trajectory far exceeds that which is likely to result from the additional spending on clean energy in the stimulus packages. For example, we have estimated how much additional investment in renewables could come about as a result of the new funding in the stimulus packages and compared this to what would be required in the 450 Policy Scenario. Globally, we estimate that investment in renewables is on course to fall from over \$80 billion in 2008 to about \$60 billion in 2009, with the new government incentives in the stimulus packages accounting for about \$10 billion. The additional investment resulting from those incentives is expected to rise to over \$14 billion in 2010 – the year in which the incentives have the greatest impact. Total investment in renewables is well below the level reached in 2008 and even further below the average annual rate of around \$180 billion (in 2008 prices) that would be needed to 2030 in the 450 Policy Scenario (Figure 18).

Figure 18: Global investment in renewables-based power generation



* IEA estimate

Sources: IEA databases and analysis.

Notes: Stimulus investment denotes the additional private sector investment in renewables estimated to result from the financial stimulus packages, based on IEA analysis of the impact of these policies. In 2009, fiscal incentives totalling \$4.2bn are projected to stimulate renewable investments amounting to \$9.7bn. In order to incentivise renewables investment on a scale commensurate with the 450 Policy Scenario, our analysis indicates that stimulus provisions to promote renewables would need to be increased six-fold. This compares to an average four-fold increase across all low-carbon energy technologies in order to be in line with the 450 Scenario.

This analysis should not downplay the importance of the new initiatives undertaken in the context of the stimulus packages, nor the potential for stronger action in the near future. Many governments have yet to announce the full allocation of their stimulus packages, while others may have scope to release additional funds, or reprioritise spending, over their normal budgetary cycle. Providing a clean energy impetus now will greatly reduce costs in the future, reducing the need for an expensive realignment of the energy sector and premature scrapping of power plants and other capital. Taking 2009 as an example, our analysis suggests that, relative to their recent announcements, G20 governments should be looking to increase the level of new funds they commit to low-carbon investments (including CCS) by a factor of around four. And, at a minimum, this level of investment would have to be sustained each and every year for decades to come. This would be likely to stimulate a similar level of additional investment from the private sector and, if sustained over time, could keep open the possibility of achieving a greenhouse-gas emissions trajectory that is consistent with the 450 ppm stabilisation goal.



While a small share of stimulus spending is being directed to clean energy investment, some other components of the stimulus packages, subsidies to heavy industry, for example, may have the unintended effect of locking-in inefficient or carbon-intensive energy technologies. Governments need to take care that measures to prop up industries do not have the effect of undermining efforts to boost investment in clean energy.

In practice, all governments are currently faced with the challenge of devising stimulus packages that meet the goal of boosting demand in the near term while contributing to faster growth in the longer term through enhancements to physical supply infrastructure and human and institutional capacity. In other words, there is a need to reconcile short-term economic objectives with long-term economic, environmental and energy security objectives. Clearly, the faster investments in infrastructure can be stepped up, the more they will contribute to the first goal. Any assessment of the effectiveness of a given stimulus package needs to take account of this duality. The importance of boosting overall demand quickly – i.e. in 2009 and 2010 – calls for a focus on projects and types of investments that are “shovel ready”, i.e. with relatively short planning and implementation lead times. This would seem to favour fiscal incentives for and direct investment in more energy-efficient end-use technologies and low-carbon small-scale supply-side technologies, such as wind farms. The production capacity exists already to meet stronger demand for such capital stock, such that any rebound in demand could be quickly satisfied. Nonetheless, the precise design of the clean energy components of stimulus packages needs to be tailored to national circumstances and market conditions.

Energy efficiency investments, in general terms, most obviously fit the bill in meeting both short-term economic goals and longer-term energy and climate goals. Spending on more efficient capital stock can be stepped up very quickly. Such investment is also labour intensive compared with other types of energy investment, bringing an added employment benefit – a vital consideration. Macroeconomic studies, most of which have been carried out in the United States and European Union, show that these energy-efficiency measures lead to an overall net increase in jobs (UNEP *et al.*, 2008). A recent study suggests that spending \$100 billion on energy efficiency and renewables in the United States over two years would create two million new jobs (CAP, 2008). Furthermore, IEA analysis demonstrates that improving energy efficiency is among the lowest-cost emission abatement measures – the lowest of the low-hanging fruit (see, for example, IEA, 2008b).

In increasing fiscal incentives for renewable energy, governments need to focus on measures that are capable of triggering larger portions of private investments. Special attention needs to be given to improving access to credit and lowering the cost of debt. Loan guarantees, clean energy bonds, monetised tax credits included in the US stimulus package are likely to be the most effective measures in helping investment flowing again. To bridge the short- and mid-term orientation of stimulus packages with a more long-term policy perspective, governments need to provide clear long-term signals to investors, offer predictable incentive schemes and address at the same time non-economic barriers, such as administrative hurdles, obstacles to grid access

and poor grid planning, lack of information and training and social acceptance issues. These barriers can increase the risk of investment, the overall costs and ultimately limit the effectiveness of public economic support. Other measures that could boost renewables investment include increasing specific support measures for small and medium-sized companies, which are mostly hit by the current economic and financial crisis, and measures to improve and expand existing energy infrastructure, such as electricity grids, to increase the integration of variable renewable electricity, such as wind, in the longer term.

Support for research and development is a critical area of government action. There is growing evidence that the private sector is already slashing spending on energy research and development. This is in part because investment in innovation is essentially pro-cyclical, as it mainly financed from corporate cash flows, which are falling in most cases with lower prices and weaker demand. To counter these risks, it is essential that governments take action to directly or indirectly bolster innovation. Publicly funded energy research has been declining since the early 1980s. Regardless of the need for fiscal stimuli to combat the economic crisis, the need for governments to step up their support for research on clean energy has never been more urgent. Governments should seek to develop stronger partnerships with the private sector in collaborating on large-scale research and development projects.²⁴ Carbon capture and storage (CCS) – one of the most promising routes for mitigating emissions in the longer term – is one area in which government support will be vital. CCS could reconcile continued coal burning with the need to cut emissions in the longer term – if the technology can be demonstrated on a large scale and if adequate incentives to invest are put in place.

All clean energy programmes must harness the power of the market, whether in the context of stimulus packages or not, in order to ensure that climate goals are met at lowest cost. In most cases, measures should involve economic instruments to incentivise private investors and consumers to boost spending on more efficient or low-carbon capital goods, equipment and appliances. Central to this must be efficient pricing of carbon, whether through a cap-and-trade system or taxation of CO₂ emissions. Investors need a clear and credible price signal now to make the appropriate investment decisions for a greener future. New technologies, such as carbon capture and storage, will not be deployed quickly and on a large scale without proper pricing of carbon emissions. The sale or auctioning of emission permits would bring the added benefit of generating revenue, which would help to alleviate the pressure on public finances brought about by the economic contraction and the need for fiscal stimulus.

For practical and political reasons, other measures are also needed. These includes mandates and regulatory measures to lower barriers to clean energy trade and to address market failures

²⁴ For example, the Australian government has recently founded the Global Carbon capture and Storage Institute with \$70 million per year of public funding to help accelerate the development and commercialisation of CCS technology.



that impede improvements in the development, commercialisation and take-up of low-carbon supply-side technologies and more energy-efficient buildings, vehicles, equipment and appliances (for example, through building codes and household electric appliance standards). The crisis also provides an opportunity to reform or remove expensive and environmentally-harmful policies, notably subsidies to fossil fuel-based energy consumption. In most non-OECD countries, at least one fuel or form of energy continues to be subsidised, most often through price controls that hold the retail or wholesale price below the true market level. Some OECD countries also continue to subsidise certain fuels, though generally on a much smaller scale. Energy-related consumption subsidies, which encourage consumption by pricing energy below market levels, in 19 non-OECD countries (accounting for over 80% of total non-OECD primary energy demand) totalled about \$310 billion in 2007 (IEA, 2008a). Governments also need to assess carefully their policies to support renewables, to ensure they are cost-effective compared with other ways of reducing emissions. Some subsidy programmes for biofuels involve very high costs per tonne of CO₂ abated.²⁵

²⁵ Marginal abatement costs vary considerably across countries and technologies, but can exceed \$1 000 per tonne of CO₂ in some cases (OECD, 2008).



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