GOVERNMENT ASSETS: RISKS AND OPPORTUNITIES IN A CHANGING CLIMATE POLICY LANDSCAPE

European Bank
for Reconstruction and Development

Methodology for calculating exposure under alternative policy scenarios

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Contents

Executive summary

The global transition to a low-carbon energy economy will, overall, have a positive impact on the global economy, as the costs of a low-carbon energy system are significantly less than those of a fossil-fuel-based economy.[1] The specific impacts on individual players will, however, depend greatly on demand levels, technology costs, and on the timing and shape of policy action. Countries that are net consumers of fossil fuels are more likely to face net benefits to their economies, while net fossil-fuel-producing countries, even those whose consumers may benefit from the transition, must plan proactively for risks to their government budgets.[2]

Policy change will therefore be a necessity for all governmental players, and assessing its impact is a complex task that must take into account several key concepts. Policy changes will affect not just overall revenues from fossil fuels, but also national infrastructure needs and costs. The effects reduced fossil-fuel use will have on revenues will depend not only on the levels of reduction, but on the markets

[1] Climate Policy Initiative (2014), *Moving to a low-carbon economy: The financial impact of the low-carbon transition.*

[2] Climate Policy Initiative (2014), *Moving to a low-carbon economy: the impacts of policy pathways on fossil-fuel asset values*

in which the fossil-fuel assets participate. For example, assets that produce primarily for domestic consumption may be insulated from policies that have an impact on global prices. The extent of the effect that policy changes have on government revenues (as opposed to their impact on consumers or the commercial sector) will depend on how fees and prices are regulated, on asset ownership, regulation and contractual arrangements for existing assets, and on the ownership of new infrastructure assets.

This report proposes the following five-step methodology for calculating budgetary risk arising from climate change-related policies:

1. **Establish a base case.** Identify the most significant sectors likely to be affected by international and domestic climate change and energy policies. For each sector, establish expectations of the impact of changes to these policies on prices, costs, production levels, investments and revenues. Determine the government's dependence on these revenue expectations.

2. **Develop scenarios and sensitivities.** Highlight the important policy and market scenarios that will affect production, prices, costs and values of these assets.

The sensitivity of the value of a particular asset to the policy change depends on the market in which the asset participates. For instance, policy changes that affect export prices may have a limited impact on products that are sold only in the local market.

Policy and market changes will also have an impact on infrastructure needs and costs, which will further affect asset values.

3. **Assess the impact of policy changes on the overall economic contribution of the assets.** Model the impact of scenarios and sensitivities on the likely production, realised prices and costs of the assets identified in the base case.

4. **Allocate the change in value among consumers and producers.** Determine whether price changes affect consumers or producers (either government or commercial producers). For example, would lower global commodity prices lead to lower petrol prices to consumers, or to lower government subsidies, or to higher revenues to government or refiners? Current regulation and pricing policies give important indications of how global price effects feed through to consumers. For infrastructure and domestic assets, the budget impact depends on whether the government provides a service for free, subsidises it, or recovers its full cost.

5. **Allocate the change in value among government producers and commercial producers.** Determine how much of the value of the asset will accrue to the government and how much to commercial producers. Governments generally either own the assets or collect taxes and royalties from the producer; value sharing with commercial producers will depend on contracts, regulation, or royalty and tax regimes.

In this report, we have applied this methodology to four EBRD countries of operations (Russia,[a] Egypt, Azerbaijan, and Kazakhstan), focusing on the impact of policy change on the coal, oil, gas and power sectors. The results illustrate how the individual characteristics of assets in each sector and region affect the impact of policy changes on national budgets; the results also suggest various strategies that can be undertaken to minimise the risk of value loss for these assets.

Oil and gas

The oil market, which is characterised by its global nature, is extremely sensitive to international

[a] The Bank is currently making no new investments in Russia. This follows guidance from a majority of shareholders in July 2014 that for the time being they would not consider new projects in the country.

price changes. The current significant oversupply also means that changes in demand for oil often translate into major reductions in economic value. Gas markets, which are fragmented due to regional pipeline networks and local access to LNG infrastructure, are linked to oil both through supply contracts that are priced to crude and because of the substitutability of fuel oil and gas for heating.

Currently, gas markets are segmented into three major price zones: the Asian LNG market, the North American gas market, and the Continental European/UK gas markets. Each of these markets is somewhat insulated from dynamics in the other two. However, changing demand levels and growing LNG capacity is likely to disrupt the status quo and could significantly impact the economic value of assets to governments, albeit to a lesser extent than is expected for the oil sector.

In terms of policy change, governments should adopt the following approaches towards oil and gas assets:

- Commit less capital upfront so they have more flexibility with which to respond to policy changes. They could do this by sharing capital expenses with the commercial sector through production-sharing contracts and by reducing or sharing exploration risks.
- Adapt royalty and taxation regimes to optimise current revenues, given the uncertainty of future demand levels. They could do this through fixed fees for licences or through faster infrastructure cost recovery.
- Hedge their exposure to commodity prices through investments in low-carbon energy technology (as the United Arab Emirates and Saudi Arabia have done).

Coal and power

In the coal sector, climate change policies will most affect thermal coal, which is used to produce electricity, heat and steam for industrial and residential use. This is because there are many low-carbon substitutes for thermal coal. Coking coal, however, is difficult to replace and is therefore more insulated from demand changes due to policy shifts, as is “mine-mouth” coal, which is used at or close to where it is extracted and is thus less sensitive to global price changes.

In the power sector, in a low-carbon scenario, coal plants will be replaced by gas plants as the primary baseload generators. Thus there is likely to be no stranding of natural-gas power plants before 2030 as additional capacity comes online to meet rising demand. In the long term, however, relying on natural gas could lead to the loss of asset value. This is for several reasons: first, renewable energy and energy-efficiency technology are likely to become cost competitive, disrupting the demand for gas assets. Second, as the LNG market matures into an international market similar to the current oil market, global gas prices will converge, creating disruptions to current prices. The risk of revenue loss could be further reduced as generators diversify away from gas and into other renewable sources.

For the coal and power sectors, governments should adopt the following approaches:

- Avoid exposure to thermal coal, particularly through direct ownership of mining interests via state-owned enterprises.
- Use resources in ways that maximise their value in the climate change policy transition phase. For example, using and valuing coal-fired power as

backup generation when renewable production is low.

- In countries where energy demand is growing, prioritise the development of alternative low-carbon energy supplies and develop transmission sources in order to support the energy system's transition to these supplies.

Governments should seek global agreements that create an organised and transparent withdrawal from fossil-fuel use across all sectors, and should facilitate better planning of investment and maintenance expenditures, and of timing. Cost-efficient financing, using currencies with lower interest costs, together with royalty and taxation schemes, can also decrease the cost of alternative energy sources and position economies to benefit from lower long-term energy prices and help make them more resilient to increasing power and infrastructure costs.

Overall, managing the challenges raised by a low-carbon transition will benefit governments and the national budgets they administer. Domestic policy mechanisms, including price controls and infrastructure financing schemes, can, and should, be utilised to manage risk as far as possible, and to allocate economic benefits among taxpayers, consumers and the government, in order to achieve maximum economic benefit. However, in many cases, such as with internationally traded commodities, domestic policy can have only a limited impact, leaving governments exposed to movements in market prices.

The purpose of this paper is to help policy-makers and stakeholders better understand how issues around climate related policies affect national budgets. It also offers suggestions about how policy-makers and stakeholders can develop appropriate strategies in response to the challenges these issues present.

Chapter 1
Introduction

Between August 2014 and January 2016, global oil prices fell from more than US$ 100 per barrel to less than US$ 30 per barrel. Countries that relied upon sales of oil, gas or coal to finance infrastructure, consumption or government budgets, suddenly faced shrinking revenues. The economies of oil-importing countries took advantage of the lower energy costs, while in some cases national budgets benefited as the cost of providing fuel subsidies to consumers fell. Strong and credible policies designed to reduce carbon emissions and global energy consumption could have similar impacts on government budgets and national energy strategies.

The causes of the oil price decline included a global economic slow-down, new production sources,

Table 1: Diverging impact on governments' budget when global and national policies affect consumption and production

Policy	Impact on consumers	Impact on producers
International and global climate and energy policies	• The combined impact of international policies will raise or lower commodity prices. • Lower commodity prices will benefit consumers. • Higher commodity prices will hurt consumers.	• The combined impact of international policies will raise or lower commodity prices. • Lower commodity prices will benefit producers. • Higher commodity prices will hurt producers.
Domestic climate and energy policy	• Domestic government policies will determine to what extent lower commodity prices benefit government budgets and taxpayers or consumers. • Governments can choose to keep the benefits of lower commodity prices (for example, by taxing the commodities or reducing subsidies) or allow the benefits to flow through to consumers. • Government policy will help determine the cost to consumers and national budgets of measures designed to reduce national emissions. • Reducing emissions through taxation and price rises will benefit government budgets, but may negatively impact consumers. • Reducing emissions through regulation could have a variety of effects on consumers, budgets and producers. • Reducing emissions through investment in new technologies and infrastructure could benefit consumers, but at a cost to national budgets. • In most cases, policy can balance the various options and allocate costs and benefits among government and consumers.	• To some extent, domestic policy will determine how much of the impact of commodity-price changes will flow through to producers rather than government budgets, although much of this impact may already be set through legal agreements or market forces. • Domestic policy will also determine production, pricing and government revenues for resources that do not compete on global markets, for logistical and cost reasons. • Domestic policy will determine whether undeveloped assets are produced.

Note: Shading denotes level of control of domestic national government on impact to government budget.
Source: CPI.

technological change, the policy of the Organization of Petroleum Exporting Countries (OPEC), and the shifting nature of economic growth in China. Similar forces – specifically technological change, alternative energy sources, energy efficiency and shifting economic models – will also play important roles in efforts to reduce greenhouse gas emissions. There will be, however, one key difference: in the case of climate change policy, national governments and their economies should have more time to adapt, as changes to energy and climate policies will roll out more slowly and should not be unexpected. This additional time should provide opportunities to use policy design and planning to mitigate any negative impacts and to increase the benefits that climate change policy can have on national budgets.

Understanding the impact of energy and climate change policy developments is the first step in creating robust and appropriate domestic policy and investment strategies that enable countries and economies adapt to and benefit from the changing global economy. This understanding must address what is and what is not in a single government's control and take account of the very different perspectives of consumers and producers.

- Global commodity markets are not under the control of any single government, but rather respond to the collective force of various national policies.

- Domestic policies will determine the costs and benefits of a country's own contribution to the global efforts to reduce carbon emissions.

- Governments can allocate the costs and benefits of both shifting global commodity markets and domestic policy actions between domestic consumers, taxpayers and producers.

In general, the likely benefits of climate change policy, including lower energy prices and reduced air pollution, will flow to the consumption side, with governments having the option to allocate those benefits between the national budget, taxpayers and consumers. The risks associated with lower production or lower commodity prices lie with the producers and with the ultimate owners of the natural resources being produced; that is, for the most part, with governments and their national budgets.

This paper provides a methodology for calculating budgetary risk and for analysing that risk for sample countries. It focuses on the risks to government budgets arising from the production side, as it is these risks that a government must learn to respond to. Governments have more power to influence the risks and the benefits on the consumption side as they respond to the production-side challenge. Because this paper's focus is on the production side, the analysis is mostly applicable to countries that are net producers of fossil fuels. Previous analysis of climate change policy impacts[3] suggests that net-consuming countries will face net benefits to their economies. These countries have plenty of options, through the use of policy tools on the consumption side, to allocate these net benefits to consumers, national budgets or both. Therefore, while the net consuming countries should consider this methodology and analysis in the course of policy-making, they are not the primary focus of this paper.

The remainder of this paper is organised as follows. Chapter 2 outlines the basic concepts that governments should use to assess the impact of different policy scenarios and describes a methodology that policy-makers can use in their assessments. The chapter also offers a methodology that can be used to assess the impact of climate change policies on national budgets. The chapter is

[3] Climate Policy Initiative (2014), *Moving to a low-carbon economy: the impacts of policy pathways on fossil-fuel asset values*

divided into three sections: Section 1 discusses the major effects of climate change policies on national budgets, including the effects of reduced fossil-fuel use and the change in the use of infrastructure; section 2 details the core methodology, walking through the process of setting up scenarios for analysis, estimating changes in the economic value of assets resulting from climate change policies and examining how that value is captured by governments; section 3 highlights the special methodological issues around natural resources and infrastructure assets.

Chapter 3 applies the methodology from chapter 2 to specific sectors and countries. The examples are drawn from four industries that are particularly susceptible to the effects of climate related policies (coal, oil, gas and power) and from EBRD countries of operations where these four industries are significant.

Chapter 4 offers some conclusions and suggests how policy-makers can reap the benefits of the transition to a less carbon-intensive economy and how they can optimise the impacts of transition on their national budgets.

As a final note, in order to provide clearer guidance, this paper focuses on fossil fuels and infrastructure. While many of the lessons and principles developed here can be applied to other major sources of risk, such as land use, fossil fuels and infrastructure provide the major part of the risk (see Box 1) and concentrating on them makes the analysis and discussion more comprehensible.

Box 1. The significance of fossil fuels and infrastructure

According to McKinsey & Company's 2010 report "Impact of the financial crisis on carbon economics", 96 per cent of the greenhouse gas emission reductions required to meet the UNFCCC's targeted limit for greenhouse gas concentrations come from either land use or fossil-fuel use, with 65 per cent derived from reducing fossil-fuel use in power generation, industry, buildings and transport. The budgetary impact of reducing deforestation is concentrated in a few countries and is highly dependent upon their specific forest and agricultural issues.[a] In most cases, the impact of land use on the budget will be small compared to fossil fuels and infrastructure, so this analysis and methodology focuses on just those two sectors.

[a] Extreme deforestation in countries such as Brazil, Nicaragua, Nigeria, DR Congo, Indonesia and Cambodia is driven by a mix of economic activities – agricultural expansion, logging and infrastructure development – that raise government revenues through land concessions and taxation (when done legally). Some countries, however, are taking initial steps to curb deforestation; for example, in Indonesia, the world's largest producer of palm oil, the government has extended a 2011 moratorium on new land concessions in primary forests and peatlands.
"Indonesia extends moratorium on partial forest clearing", *The Guardian* (2015). Available at: http://www.theguardian.com/environment/2015/may/14/indonesia-extends-moratorium-on-partial-forest-clearing

Chapter 2

A methodology for assessing climate policy effects on national budgets

1. Major effects of reduced fossil-fuel use on national budgets

Policies designed to reduce greenhouse-gas emissions can diminish the revenues that a national economy makes from the sales of fossil-fuel resources. In addition, such policies may also change how much infrastructure investment is required, how that investment is targeted, and ultimately could affect – positively or negatively – national economic growth.

Reduced overall revenues from fossil fuels

As demand for fossil fuels falls in a less carbon-intensive economy, the prices and production levels of fossil fuels such as coal, oil and gas are likely to fall. Governments of countries that are endowed with oil, gas or coal reserves often use revenues from the export or domestic use of these resources to finance government projects, such as building new infrastructure. Often these governments have borrowed against future export revenues both in order to finance these initiatives, but also to ensure continued extraction and production of the fossil fuels.

Changing infrastructure investment needs

All countries, whether they have fossil-fuel reserves or not, have built infrastructure, such as power plants, transmission systems, roads, railways and ports, based on assumptions of fossil-fuel use, cost and availability. As the price and availability of fossil fuels change, and as fossil fuels are replaced by alternative sources, some existing infrastructure may become idle, while some new infrastructure may be needed to accommodate the new energy sources.

Changing infrastructure investment needs may or may not have an impact on government budgets, depending on how infrastructure is built and financed in a country and by whom. The key determinants of whether changing infrastructure investment needs will have an impact on government budgets include:

- **Usage fees and price regulation.** Governments make choices about whether consumers or taxpayers pay for infrastructure. Some infrastructure, such as many roads, is provided free to consumers and paid for by taxpayers. Users pay a share or all of the costs of toll roads, and may pay for most of the cost of ports, railroads or electricity transmission.

- **Asset ownership, regulation and contractual arrangements for existing assets.** For state-owned assets that are no longer used, governments may have to pay decommissioning costs or may see changes to revenues if they have been charging consumers to use the assets. These lower revenues may be partially or totally offset by lower maintenance costs. For privately owned assets, the impact on government budgets depends on how the use of these assets is priced, on the nature of any concession, or how the asset is regulated. Governments may have to sustain falling revenues if the asset is operated as a concession; otherwise consumers may bear the impact of lower revenues through higher charges for any remaining use of the assets.

- **Ownership of new assets.** Investments in new infrastructure assets, such as renewable energy, electricity transmission or new transit systems, could come either from government budgets or from private companies, depending on whether the assets are state owned and operated, or built under concession or price-regulation and user-fee arrangements. Investment schemes and user pricing are two ways of managing the impact on government budgets of new assets.

Impacts on economic growth

Coal, oil and gas production often employs many people, as does constructing new energy or transport systems. Reducing fossil-fuel use could mean that personal incomes and corporate investment and profits could rise or fall, affecting government revenues from income, sales and corporate taxes. Some research indicates a "resource curse", in which investment in resource extraction crowds out other investment and the resulting inflation makes economies relatively uncompetitive.[4] Other examples suggest that export revenues can help develop an economy, leading to higher employment and economic growth.[5] A complete analysis would also need to include the costs associated with environmental degradation, health externalities and asset retirement, which this methodology does not consider.[6]

By estimating these three effects of reduced fossil-fuel use, governments can form an understanding of how climate change policies affect national budgets. The five-step methodology proposed in the next section establishes a framework for making these estimates.

2. Methodology for analysing the impact of climate change policies on government budgets

Climate change related developments, including policy changes, technological developments and behavioural changes, will affect how much of its natural resources a nation will produce, the price it will receive for those resources, and how much

infrastructure a country will need to build, operate and maintain.[7]

Table 2 and Chart 1 summarise how governments could approach the evaluation of the risks to national budgets of climate related policies (including global, international and domestic policies) by addressing the impacts of such policies on both exports and domestic consumption. The suggested methodology encompasses five major steps, which are explored in detail in section 2.1.

[4] Coined in economic literature as "the Dutch Disease", the terminology became popular in the late 1970s when The Economist newspaper described the decline of the manufacturing sector in the Netherlands after the discovery of the large Groningen natural-gas field in 1959. Harvard economists Jeffrey Sachs and Andrew Warner examined a group of 95 countries from around the world between 1971 and 1989 and found that countries with larger primary-product exports grew more slowly than resource-poor countries. More recently, McKinsey showed that more than half of countries largely dependent on natural resources for economic output have matched the average growth rate of all countries globally since 1995, and 80 per cent of these countries have per-capita income below the global average.
McKinsey & Company (2013), "Reverse the curse: maximizing the potential of resource-driven economies", available at: http://www.mckinsey.com/insights/energy_resources_materials/reverse_the_curse_maximizing_the_ potential_of_resource_driven_economies

[5] Although economists debate causality, in China and other developing countries there has been a clear correlation between an increased trade surplus and economic growth.
International Monetary Fund (2007), "China's growing external dependence", Available at: http://www.imf.org/ external/pubs/ft/fandd/2007/09/cui.htm

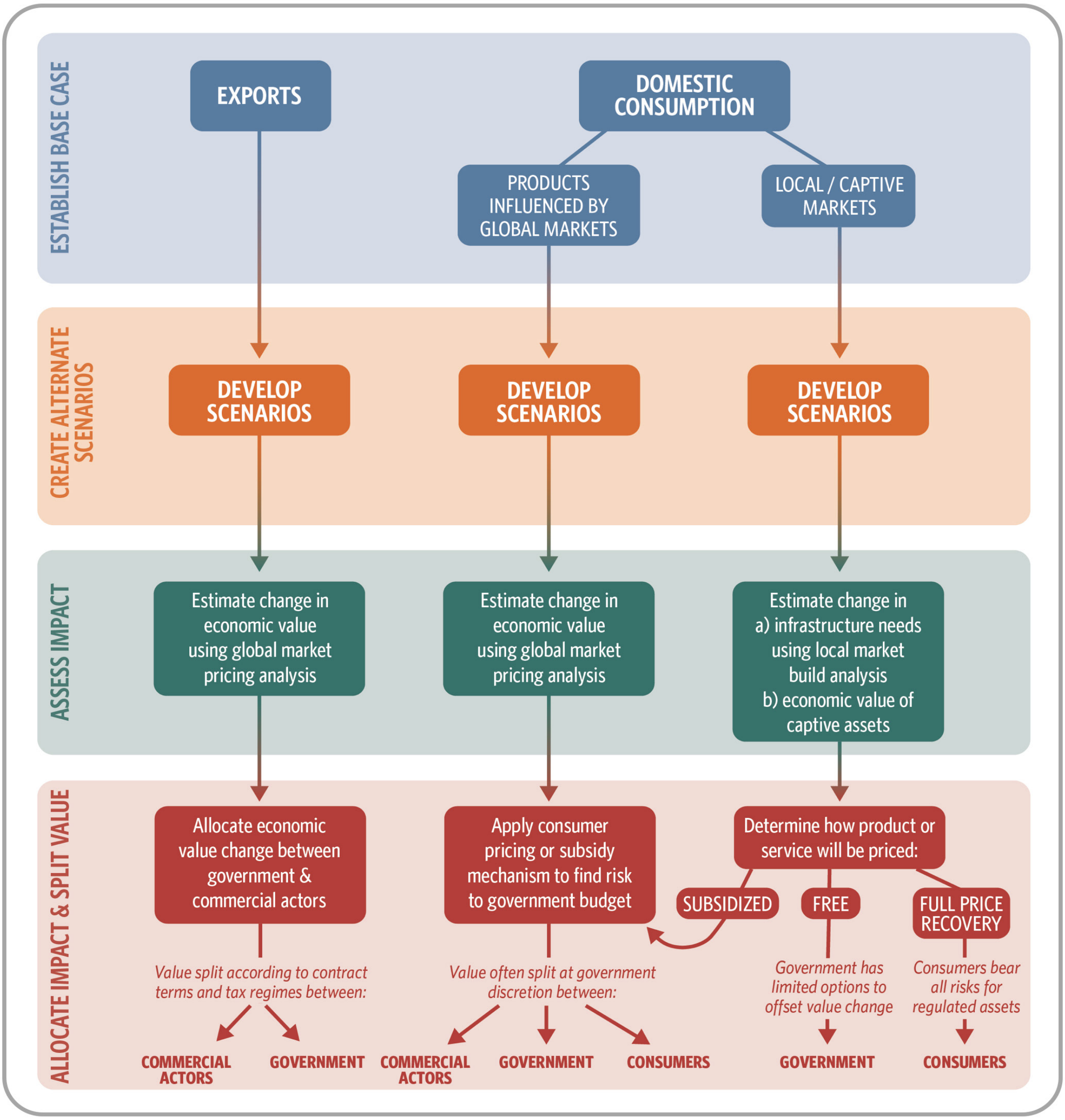
[6] Furthermore, this methodology does not look at the broader, macroeconomic effects that would indirectly derive from changes in the prices of commodities through, for example, fluctuations in income levels in other economic sectors or in employment figures

[7] There will also be second-order effects, such as limits to the ability of countries to raise debt and provide fuel subsidies provided to consumers, if these are part of the policy mix. These two indirect impacts are discussed in Box 2 and at the end of section 3.5.

Table 2: Methodological steps

Step	Description	Hints
1. Establish a base case	• Begin by establishing current expectations of pricing, costs, production levels, investments, and government revenues and costs in sectors that will be affected by international and domestic climate change and energy policies. • Determine how a national government has relied on these revenue expectations.	• Limit the scope by concentrating on the most significant sectors. For example, for countries without significant land-use exposure, focus on the energy and industry sectors. • Simplify the analysis by sorting assets, related production and costs into assets relevant to exports and those related to domestic consumption.
2. Develop scenarios and sensitivities	• Explore important policy and market changes that will affect the production, prices, costs and values of the assets established in the base case. • These scenarios will bring together all of the policy inputs, such as commodity demand, supply, forecast prices and volumes, that are core to estimating the impact on national budgets.	• Focus on international and domestic policies that will impact the global macroeconomic environment, and in turn affect both exports and domestic consumption. • For infrastructure and resources that will not access global markets, concentrate on domestic consumption scenarios and plans, including how a country will change its infrastructure and related services in the face of climate change policy objectives.
3. Assess impact	• Model the impact of scenarios and sensitivities on the likely production, realised prices and costs of the assets identified in the base case. • The difference between revenue and cost profiles under different scenarios represents the anticipated annual change in economic value derived from the assets, but not yet the budget impact.	• The analysis is mainly applicable to those products – such as commodities – that are traded on international markets, or whose price is influenced by international commodity and energy prices. • Exports will experience the direct impact of market changes, while the effect on domestic consumption may be filtered by barriers (such as transportation costs) that isolate some local resources from global market prices.[8]
4. Allocate value between consumers and producers	• Filter impact results through current or expected government policy to determine whether price changes affect consumers, producers, government or all three. • For example, would lower global commodity prices lead to lower petrol prices to consumers, or lower government subsidies, or higher revenues to government or refiners?	• Export price changes are not generally shared by consumers, as exports have no domestic consumers. • Current regulation and pricing policy gives an important indication of how global price effects would feed through to consumers. • For infrastructure and domestic assets, the budget impact depends on whether the government provides services for free, subsidises them, or recovers the full cost.
5. Allocate value between government and commerce	• Determine how much of the value of the asset will accrue to the government rather than commercial producers. • Governments generally either own the assets or collect taxes and royalties from the producers.	• Resources produced by government-owned companies share value only with their government budgets and consumers. • Sharing with commercial producers will depend on contracts, regulation, or royalty and tax regimes.

Chart 1: Methodological diagram



Source: CPI, September 2015.

[8] For example, transportation costs could make the export and international trade of some coal and small gas deposits prohibitively expensive and non-competitive. However, the coal or gas might still have value in the local market, particularly if they replace gas or coal that would otherwise need to be imported. The value of these assets, then, depends on both global markets and local conditions and regulation.

Table 3: Natural resource and infrastructure asset classes likely to be affected by climate change policies

Natural resources	Infrastructure
• Coal and metal mining • Oil exploration and production • Gas exploration and production • Agriculture and forestry	• Power generation • Electricity transmission • Gas pipelines • Transport (including roads, rail, mass transit, aviation, ports) • Water and sanitation • Industrial manufacturing (including cement and steel/iron)

2.1 Establishing a base case

The starting point for any analysis of policy and climate change impact is the contribution (or cost) that the various resources and assets would have without the policy action. To establish a base case we need to address a number of questions:

- What natural resources would the country expect to produce over the time period to be assessed?
- What investment and operating costs would be expected in the development, extraction and refining of these resources?
- What infrastructure would be built, when and with what investment and operating costs?

This analysis focuses on those sectors that are likely to be affected most by changes to climate policy. The precise set will depend upon the specific circumstances of both the country and the policy elements to be tested, but important sectors are likely to include those listed in Table 3.

The process to establish a base case can be summarised in the following steps:

1. Identify the natural-resource and infrastructure assets that will be directly impacted by climate related policies.
2. Estimate future production of natural resources and infrastructure build based on demand projections under the current policies.
3. Project the investment and operating costs associated with the level of resource extraction and production and infrastructure development under the current policies.

2.2. Identifying alternative policies, policy sets and scenarios

The choice of scenarios to test will depend upon the specific question that is being addressed. For example, to understand a government's exposure to climate negotiations may require a scenario with different elements to a scenario used to evaluate domestic policy proposals.

The three critical variables that change between the base case and the alternative scenarios are demand, prices and costs (of supplying energy and building infrastructure). These variables are in turn the result of changes to a number of factors, such as timing, demographics, economic growth, technology and climate change policy sets.[9] For the purpose of evaluating the effects of climate change policies on national budgets, it is helpful to categorise assumptions that influence demand, prices and costs as either climate related policies or non-policy factors, as shown in Table 4.[10]

Energy and climate change policies include a broad set of measures that target practically every segment of an economy.[11] This policy set includes measures that are closely associated with the climate change debate, such as carbon pricing and emissions trading, but also policies not often associated with the discussion, for example, those that restructure industries by changing regulatory

[9] For example, the primary impact of a fuel tax will be to increase costs, which will have a secondary effect on demand. Similarly, the primary impact of a growing population will be increased demand for assets, which will have secondary effects on prices and costs.

[10] Climate related policies are discussed further in the appendix.

[11] Climate change policies can affect many sectors, including transport (electric vehicles, fuels, freight, infrastructure), energy (generation, transmission, distribution, efficiency, carbon capture and storage), buildings and appliances, industrial (manufacturing, extractive and energy-intensive industries), and adaptation investment. For more detail on policies in theory and practice see the International Energy Agency's policy database available at: http://www.iea.org/policiesandmeasures/ (last accessed 1 September 2015].

Table 4: Selected climate related policies and non-policy factors to be considered

Climate related policies	Non-policy factors
• Emissions pricing (including taxation and trading schemes) • Fossil-fuel taxes/subsidies • Direct support for renewable energy and energy efficiency (for example, feed-in tariffs, capital grants, tax exemptions, accelerated depreciation and other fiscal advantages) • Finance support (including green banking and loan guarantees) • Industry restructuring (including deregulation and privatisation)	• Economic growth • Technology (including innovation and improving efficiencies) • Demographics (including population and distribution/density) • Timing

regimes. As mentioned above, global policies will affect demand, prices and costs in different ways from national or local policies. National policies will clearly impact local markets but rarely global markets, while global policies will affect both global markets and local markets. This dynamic is complicated by the fact that certain assets are exposed only to local markets, whereas others are exposed only to global markets, and yet others to both (see Table 5). Section 2.3 discusses in more detail the impacts on national budgets of specific policies.

For non-policy factors, the first scenario analysis assumption should be timing. The time period studied should be long enough to capture in a meaningful way the future effects of climate policies on national budgets. Somewhere between 20 and 30 years is desirable, as it will take decades for the effects of policies enacted in the medium term (5-10 years) to filter through to national budgets.[12] Beyond 30 years, uncertainty around all aspects of policy or scenario impact increases, and governments and their creditors are unlikely to rely heavily on these longer-term revenue projections during their planning processes.

It is difficult to capture the total impact of climate change policies on demand levels, costs and prices, in particular because of feedback effects. Technological breakthroughs, which can render long-term cost and demand projections obsolete, are practically impossible to model because innovation is inherently unpredictable. For example, sudden advancements in battery technologies or carbon capture and storage (CCS) could disrupt the power industry in a similar way to fracking's disruption of the global natural gas industry. It is clear that technology costs will decline, but not by how much and over what time period. Likewise, uncertainty about policy means it is difficult to predict long-term interest rates and material prices – elements that affect capital costs. In addition, feedbacks between climate change policy and variables such as economic growth and technological change (for example, loan guarantees that encourage early-stage innovative firms) make it difficult to identify and capture all the effects of policy.

It is not realistic to include some climate change policies and non-policy assumptions in the same analysis, as many are mutually exclusive. For example, governments would not impose emissions trading and carbon taxation on the same sectors because these are competing policies, being different mechanisms used to achieve the same result.

The discussion in this section around developing alternative scenarios and sensitivities can be summarised in the following steps:

1. Establish the time period for comparative scenario analysis.

2. Estimate demand, costs and prices in the alternative scenario over the study period.

    a. Incorporate effects of climate change policies by either:

        i. Estimating and projecting demand, costs and prices from the bottom up, based on a defined set of climate change policies; or

        ii. assuming a future level of demand for resources and infrastructure based on a target (for example, global emissions levels) that assumes

[12] For example, the emission reductions required in the recently finalised Clean Power Plan from the US Environmental Protection Agency step up through to 2030 and will not begin, at the earliest, until 2022.

a set of climate change policies and non-policy assumptions sufficient to meet the target.[13]

b. Incorporate non-policy assumptions:

i. Estimate and project whatever non-policy assumptions are unaccounted for after incorporating effects of climate change policies on demand, cost and price projections; and

ii. consider feedback effects from climate change policies on non-policy assumptions (see discussion above).

2.3 Estimating future revenues and costs at market prices under different policy sets

With the base case and alternative policy scenarios established it is possible to begin measuring the possible impact of climate related policies on the economic value of natural resources and on future infrastructure investment costs. This step will provide insights into the impact of a particular policy mix on the economy as a whole, but will not determine whether any loss of revenue or additional investment will fall on the government budget, or will be borne by consumers or commercial enterprises. Splitting the value among these groups is covered in sections 2.4 and 2.5. One key factor to take into consideration is that products and services that are sold in local markets should be treated differently from those that are driven by global prices.

Products and services traded on local markets

Chart 2 shows how government revenues and costs can be measured for products and services that trade on local markets. The first left-hand column indicates how much economic value the resource creates when revenues are measured at world market prices, and after operating and capital costs are recovered. As will be discussed in subsequent sections, for many services, especially in the infrastructure space, there is no effective world market price. In these cases, the government or regulator decides, given policy and political considerations, how much it will charge for services. In some cases, such as roads or mass transit, the government may charge less than full cost or even provide the service for free in order to achieve other economic or social objectives.

In the example illustrated in Chart 2, the government has chosen not to charge domestic customers full global market prices for the commodity or service in question (that is, the government has provided a consumer subsidy), but has recovered more than the full costs. Thus, as the second column shows, the value retained by the asset owners and producers is smaller than it would have been had this asset or commodity been sold on the open market. In this case, the government has also decided to bring in private enterprises to develop, build and operate the asset. These developers have shared risks with the government and therefore are entitled to incentives. In the third column, “government take” represents the final net positive impact on the government budget. Note that, in many instances, services are provided or production is carried out by wholly state-owned enterprises. In such cases, the government keeps the producer incentive and the risk associated with it as well.

To understand the impact of policy sets or scenarios on government revenues in cases where there is no effective world market price, one needs to compare costs and revenues under various scenarios:

- For services that are offered for free, the only impact on government budgets is if the cost or volume of services provided changes.
- For services for which prices are regulated, governments must also consider changes to costs and volume. However, they will also have to choose how they would like to adjust regulated revenues. If the government has a policy of full cost recovery, or if the services offered are provided entirely by commercial enterprises that take all of the risk, there will be no net direct impact on government budgets.

Products and services traded on global markets

For products and services traded on global markets, such as crude oil and some coal and gas, the picture becomes somewhat more complicated, as shown in Chart 3.

In this example, global market prices for a commodity have declined; this could be due to, for example, coordinated international policies designed to reduce demand. The first left-hand column reflects the decline in revenues and economic value due to pricing, where the national government has chosen to provide the commodity to its own domestic

[13] The analysis presented in the next chapter follows this approach.

Chart 2: Measuring the government take from products and services priced for local markets

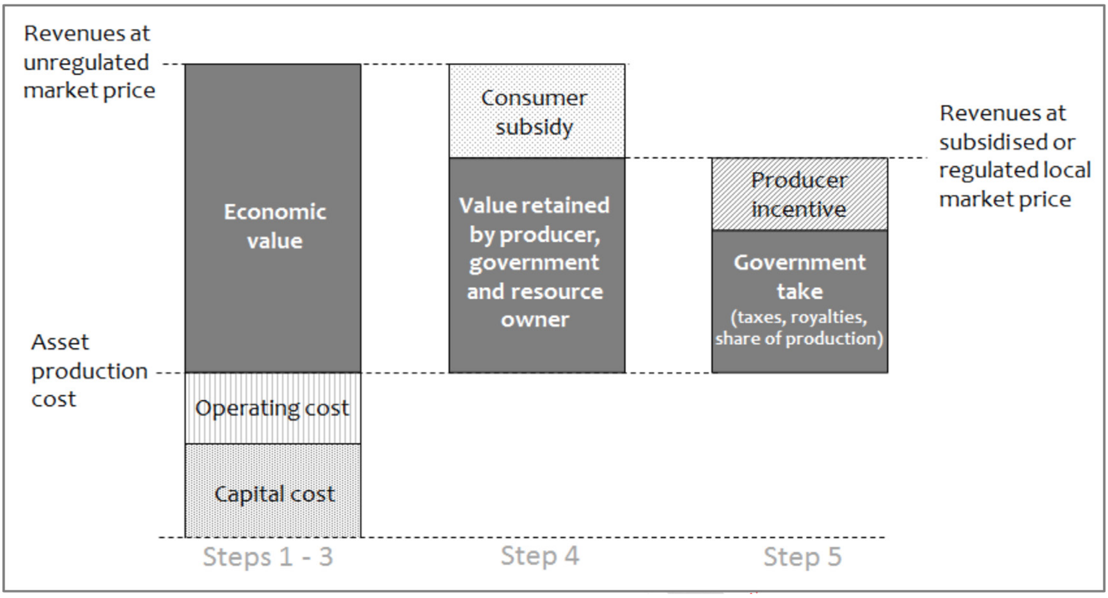


Chart 3: Measuring the government take from products and services priced for global markets

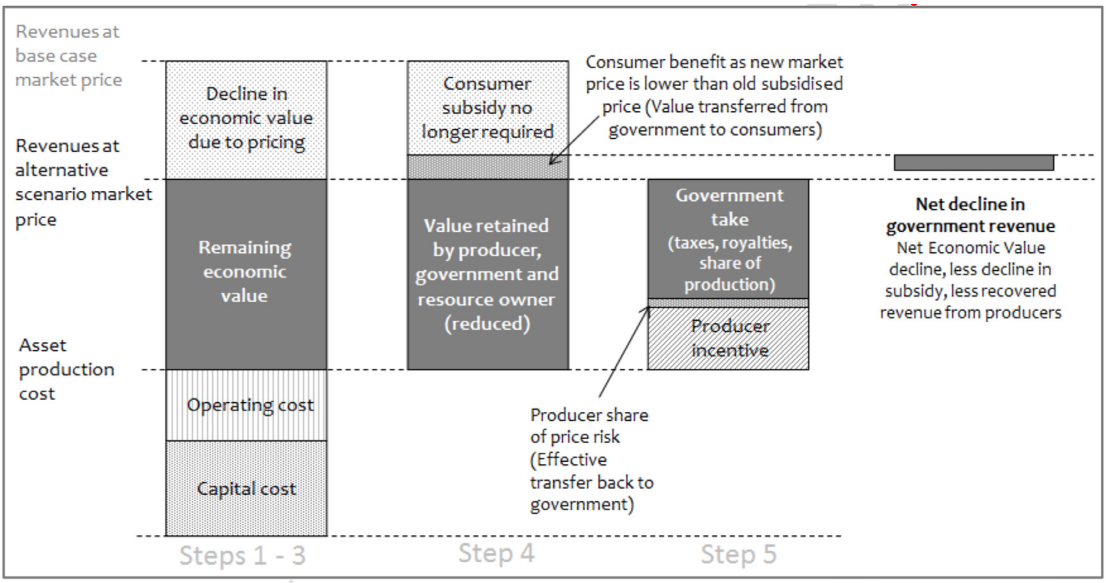


Table 5: Impact of policies by market

Market in which asset/ service competes	Impact of policies on production	Impact of policies on price	Focus of policy analysis
Global	Production will largely depend upon the global supply curve and the position of the asset in that global supply curve. Production from higher-cost resources could fall if international policies and technology development lead to lower demand for the product, reducing the need for higher-cost production. Production levels for competitive, low-cost resources are likely to remain unchanged, although local tax or royalty policies may need to adapt in some cases.	Market prices will fall if global demand falls, and most production, whether high-cost or low-cost, will experience a decline in revenues as a result of falling prices.	International policies have the greatest impact on the value of resources traded on a global market. Local policies can also have an effect, but this is likely to be adjusted in the face of global supply and demand.
Globally influenced ("netback to global") [14]	As with globally traded assets, high-cost assets may no longer be produced if they are not competitive (subject to energy security or other policy concerns), while lower-cost resources are likely to continue producing. However, since there is often a difference between the cost to local markets and the netback price, local policies, for example on energy conservation, could have an impact as well.	The impact here is similar to global markets, but with an increasing impact from local policies. Often there is more than one competing netback price. For example, captive gas supplies could compete with imported gas or oil, local biomass or energy conservation. Thus, the direct link to global supply curves can be broken.	International policies, as reflected in global supply and demand curves, set a constraint, but local policies will have an important effect within that constraint.
Local or captive	How much a country invests in local infrastructure and services such as roads, rail and even ports, will largely rest on domestic policy decisions. However, international policy could affect the value proposition presented by these assets and encourage or discourage new investment. The same is true for certain resources that only trade locally, such as lignite (brown coal).	Most of the services and products for infrastructure and resources that compete only in local markets are natural monopolies where the service is either given to consumers for free (for example, many roads) or is under price regulation (for example, electricity distribution). Under these circumstances, the impact of prices on government budgets becomes less relevant, and there is greater emphasis on costs and therefore production/ build levels.	National and local development plans are the most important policy set. These need to be evaluated in terms of how the country will respond to outside stimuli (such as changing commodity prices) and in terms of the country's own policy adjustment to meet climate change goals.

[14] "Netback" prices represent the effective price to the producer of a natural resource at a particular location and incorporate all the costs incurred by bringing the resource to the market. For example, the netback price for an oil producer would equal the price of a globally traded barrel of crude less transportation costs (pipeline or tanker) in addition to other factors, resulting in a netback price that is less than the market price.

consumers at prices below world market prices, effectively subsidising domestic consumers.

The second column demonstrates that consumers still benefit, despite the continuing global market price fall, as the government has decided to eliminate the subsidy and let local prices reflect global market prices.

The government could equally have chosen to leave prices at their previous level, effectively converting the subsidy into a tax. In this event, for that portion of the production that was consumed in domestic markets, neither consumers nor the government and producers would be affected. Furthermore, if the product was produced by state-owned enterprises, then the government budget would be unaffected. For exported products, however, the government does not have such an option.

The third column shows the effect of private involvement. While most of the incentive is in place to transfer cost and production volume risk back to the private operator, the contract and pricing mechanism agreed between the government and the producer has left some price risk with the producer. As a result, the government has been able to recover some of the revenue declines by reducing payments to the private operator. The total government budget impact is shown in the fourth column.

Policy effects are dependent on the market in which assets and services compete

As Table 5 shows, the impact on both production and prices of different policy sets will depend upon the market into which the product or service is sold. Generally, the more global the market in which a product or service competes, the more sensitive that good is to global and international policies. For instance, the price of crude oil, which is exported and traded on international markets, is much more likely to be influenced by the combined impact of international policy, technology changes and markets than it is by local policy. Conversely, the level of new road construction in a particular municipality is much more strongly influenced by local factors, and the price (whether free or a toll road) will be set by local authorities rather than by market forces.

Many markets are somewhere in between global and local. For example, transport costs often make low-quality coal or lignite uneconomic to export. However, the electricity produced from a power plant locally may compete with electricity generated by another plant using imported coal. To the extent that the locally produced electricity from lignite is cheaper than electricity from imported coal, the government, regulator or market structure will determine whether that value – the difference between local costs and the netback to global markets – is kept by the generator in the form of profits, garnered by the government in the form of taxes, or passed on to consumers in the form of lower electricity prices. This allocation is discussed in more detail in sections 2.4 and 2.5.

Setting aside, for a moment, resources that fall in between global and local, determining the economic impact of policy follows distinct patterns for global and local assets. Below, we set out a high-level methodology for impact analysis.

Global natural-resource assets: estimating production and revenues at global prices, minus costs

1. Develop global supply and demand curves for the alternative scenarios to be tested for each of the years under study.

2. Estimate the maximum production level/ infrastructure build that the asset could achieve. In most cases, this estimate will be the same as the production levels estimated in the base case.

3. Estimate the cost of production that is delivered to global markets, making this production consistent with the benchmark used for the global supply curves. This estimate should focus on incremental costs in addition to those already spent or that form part of the initial investment in the asset. Total costs (including depreciation and return on investments that have already been made) will also be important for further analyses outside the scope of this methodology, such as those regarding residual asset values.

4. If the incremental cost of production delivered from the asset is below the market clearing prices, we can assume that the resource will be produced as planned. In this case:

   a. Revenues will fall in accordance with changing global prices.

   b. Costs will remain relatively unchanged (see above for discussion).

   c. Allocation to government of costs and the remaining revenues may change, which will be discussed in sections 2.4 and 2.5.

   d. By virtue of having lower incremental costs, most assets currently under production are likely to fall into this group, whereas assets that are yet to be developed may have incremental delivered costs above (step 4) or below (step 5) the market clearing price, depending upon development costs.

5. If the incremental cost of an asset is above the market-clearing price, determine when the asset will fall below the estimated market-clearing price – if ever – and adjust the investment and production schedule under the new scenario. In this case:

   a. Revenues will fall and/or be delayed in accordance with both global prices and revised estimated production schedules.

   b. Some costs (such as operating costs tied to production levels) will be delayed, and others (for example, fixed costs tied to operations such as lease payments and annual charges on equipment) will not.

Local/captive assets – estimating production and revenues at local prices, minus costs

1. Develop estimates of new infrastructure build requirements for the alternative scenarios to be tested for each of the years under study and estimate the captive resources that will be needed as inputs for the infrastructure build in each scenario (for example, lignite for power generation).

   a. For local assets pricing is unimportant – only production schedules and costs will differ between the scenarios.

   b. Production or development schedules will be determined by national and local policies, which may adapt to changing circumstances.

2.4 Evaluating the economic value split between consumer and industry (government/ private sector)

The analysis in section 2.3 assumes that the oil, coal, rail transport and potable water produced by a government or by private companies is offered to consumers at market prices. However, consumers often do not pay the market price for a commodity or infrastructure service, even if that price is clear. Consumer taxes and subsidies, and schemes regulating prices paid by consumers can all distort the prices paid for assets. How these consumer-side taxes and subsidies influence the impact of policy changes on the national budget depends on whether the commodity is exported, consumed domestically, or, as with many infrastructure projects, does not have a market price.

Exports

It is unlikely that a country would price resources that are produced domestically and then exported at anything other than the market price. Pricing higher than the market price would cause buyers to go elsewhere, reducing revenues, while pricing below market prices would also reduce revenues. Therefore, we can assume that all resource exports are priced at market prices and the full value calculated in section 2.3 is split between the resource owner (typically the government),[15] and the producer (either the government or a private company). In this case, we can skip to section 2.5.

Global commodities consumed domestically

For resources produced and consumed domestically, governments often offer prices below global market prices. Sometimes they do so out of perceived fairness; that is, the mineral resources belong to a country's citizens and should therefore be shared by all, often at prices near the production cost. Lower prices are also seen as a way to spur economic growth; and sometimes low prices are used to help win votes or maintain political stability. Whatever the reason, the end result is less revenue collected by the government or by a private producer. Where this decline in revenue is borne by the government, as is usually the case (see section 2.5), it must be compensated for by either greater taxation, reduced services, or lower national investment and savings. Often, lower prices also lead to higher consumption, which itself has an impact on asset valuations.

Conversely, sometimes governments tax resources either to raise revenues or to pursue other policy agenda, such as energy conservation, energy security, or to improve their balance of payments

between imports and exports. Consumer taxes above market prices are more common in countries that are net importers of a given commodity, but this is not exclusively the case.

Infrastructure and other public goods without a market price

Many goods and services that may be affected by climate change and climate policies, particularly those related to infrastructure, do not have an effective market price, or are produced by state monopolies. These include, among others, roads, water, electricity distribution and waste. Local and national governments may choose not to charge consumers at all, may charge a flat fee, or collect revenue from other tax sources to cover the costs of these services. Roads, for example, are often available for free in order to promote economic growth, while electricity distribution is often charged at or near cost.

For these goods and services, the impact of climate change policy on government budgets depends on pricing policies, rather than on any intrinsic value. If the pricing policy implies full cost recovery from consumers, then, at a first-order approximation,

[15] Governments own more than half of all global fossil-fuel production and control as much as 70 per cent of oil and gas production through companies that are wholly or substantially owned by governments. For coal production and coal-fired power plants the figure is closer to 60 per cent, while it is lower for gas-fired power plants. These figures include government-owned companies that have private investors, who are listed as minority shareholders on stock exchanges. Climate Policy Initiative (2014), *Moving to a low-carbon economy: the impact of policy pathways on fossil-fuel asset values.*

government budgets will be unaffected by increases or decreases in investment due to climate change policies. The impact depends upon how far prices deviate from costs, and how those costs will change.

Exports are the most difficult to control of the three market segments mentioned above (exports, global commodities consumed domestically, and goods and services without a market price). As explained, the risk to export values depends on the global policy mix, rather than on national policy. Outside of exports, however, government policy can significantly offset, or compound, the risk to the national budget. For those goods and services where the full cost is passed on to consumers, there is no risk to the budget. Meanwhile, a shift away from assets that are currently subsidised can reduce the negative impact of these subsidies on a government's budget and reduce the impact of any global decline in commodity prices that may result from concerted climate action.

The best way to assess the impact of these subsidies or taxes is to consider the profits, costs or value of the resources used to furnish a country's consumers with a product or a service simply as methods to raise or spend money. Spending money on reducing the cost of gasoline to consumers is, in essence, no different from spending money on more roads or additional police services. By the same token, collecting revenue from domestic consumers on the profit on oil sales to those consumers is no different from collecting money via income tax or excise duties. The only major difference is that collecting the revenue from one resource and spending it on another will have differing impacts on individual segments of the economy. In other words, revenue collection and spending will produce both winners and losers among consumers and producers. Furthermore, the shape of the economy as a whole could shift. However, any government can balance these effects through offsetting taxes and policies. For domestic consumption, therefore, governments can use policies and subsidies as they see fit in order to allocate the costs and benefits of a transition to consumers and the government.

Producer and consumer subsidies

In many cases, producer subsidies,[16] including tax incentives, are merely an easier way to adjust the terms of tax, royalty and concession arrangements in order to maximise government take by prolonging production. In such cases, calculating the budgetary impact is relatively easy. However, in cases where subsidies are delivered for policy reasons, such as energy security, industrial policy or employment policy, the budgetary impact becomes less clear, as the value of the competing policy must also be judged. Producer subsidies are primarily relevant to the discussion in section 2.5 about the split in economic value between governments and the private sector.

On the consumer subsidy side, governments often choose to control or to change the price that consumers pay for their energy.[17] This is for a variety of policy reasons. In some cases, governments tax energy in order to pay for related infrastructure, to encourage energy conservation or to raise revenue. In other instances, they keep prices below market levels in order to share the value of a country's natural resources, to maintain price stability, incentivise industrialisation and reduce fuel poverty.

All consumer subsidies reduce incentives to invest in energy efficiency and alternative energy, or otherwise to reduce energy consumption; they thereby increase fossil-fuel consumption and greenhouse gas emissions. Consumer subsidies' impact on greenhouse gas emissions is actually much greater than that of producer subsidies, as producer subsidies will only cause the domestic source of oil, gas or coal to crowd out other sources, unless the subsidies are high enough to flood the export market with additional supply and thus reduce global prices and increase global demand. Conversely, consumer subsidies directly increase demand, which in turn drives increased production.

Following this discussion, evaluating the split between consumers and the owners and producers of products and services should follow the following steps:

[16] The narrowest interpretation of producer subsidies includes only direct government expenditures through cash payments, but in practice these are less common than other direct support measures, such as tax breaks and loan guarantees. Most internationally accepted definitions take a broad view and include these and other forms of indirect support, such as price controls, domestic purchase requirements and trade restrictions designed to benefit national firms.

[17] Fuels derived from oil are particularly heavily subsidised. Removing fuel subsidies is a politically difficult task because governments fear unrest caused by price increases. However, the current low oil price offers an opportunity for governments to relax subsidies at a time when consumers can more easily absorb price increases. The IMF has described this, and similar situations, as "fiscal space" – room in a government´s budget that allows it to provide resources for a desired purpose without jeopardising the sustainability of its financial position or the stability of the economy. Source: Heller, P. (2005), "Back to basics", *Finance and Development,* Vol. 42, No. 2, IMF, www.imf.org/external/pubs/ft/fandd/2005/06/basics.htm

1. For export commodities, we can assume that no value is allocated to consumers and that all value remains with the owners and producers.

2. For global commodities priced domestically:

   a. Calculate and forecast domestic consumption.

   b. Forecast base-case and alternative scenarios for domestic pricing. These can be based on domestic pricing schemes and can include scenarios that offer fixed prices, fixed discounts to market prices, or fixed percentage discounts to market prices. These scenarios can also be modified to phase out subsidies where that is realistic, or where market prices are forecast to fall below subsidised prices.

   c. Calculate the effective allocation of value to domestic consumers and deduct this from the full value to the economy. This leaves an estimate of value to government and private sector participants.

3. For products and services without a market price (many infrastructure projects):

   a. Determine what share of the full cost is borne by consumers and how that might change under different build-out scenarios.

   b. Estimate costs and investment requirements.

   c. Calculate the government and private-sector shares of costs and investment and the impact of different scenarios.

2.5 Evaluating the government/private-sector split of economic value

Allocating the value of an asset between government and private-sector actors requires knowing who owns the asset and how it is financed. Although governments own or control a majority share of assets globally, there is a combination of public and private funding behind many projects. This mix of financing defines how the economic value from a project will be split, and ultimately the impact of policy change on national budgets.

For commodities and infrastructure alike, when a government is the sole asset owner, any change in the economic value of that asset will directly affect the national budget. As shown in Table 6, for all other ownership arrangements, the private sector is involved to some extent – either through ownership of commercial entities or through a non-controlling interest in a state-controlled entity.

Ownership of natural resources
For natural resources, with a few exceptions,[18] national governments retain ownership of all

[18] The major exception being in the United States, where private landowners retain ownership rights in most cases. However, even here there are instances where private landowners own only the land, while the government holds subsurface rights, in so-called "split estate" arrangements. US Department of the Interior – Bureau of Land Management (no date) Available at: http://www.blm.gov/ wo/st/en/prog/energy/oil_and_gas/best_management_practices/split_estate.html (last accessed 1 September 2015).

Table 6: Categories of asset owners

State-owned enterprises (SOEs)	SOEs are wholly owned and operated by national governments. Any change in the economic value of assets owned by SOEs will directly impact government budgets (less the impact on management costs).
State-controlled entities (ListCos)	A government is considered to have a controlling interest in a firm when the state owns more than 50 per cent of shares. Majority ownership ensures that the government maintains control of company decision-making. Shares not owned by the government are typically floated on a public exchange.
Commercial entities	These are either privately held or publicly traded (with a non-controlling government interest) firms. Commercial entities can own assets outright or are involved in project development and operation. Contractual arrangements and taxes determine what share of economic value they receive.
Joint ventures (JVs)	Composed of multiple companies, JVs are usually formed for a specific project. They are often a mix of state-owned and commercial entities, but can be purely private or public as well. Technically or administratively complex projects are often developed by a consortium of companies structured as a JV.

subsoil mineral resources in their territories (such as oil and gas fields, coal deposits, and metals). Many countries have created wholly state-owned enterprises (SOEs) to develop and extract these assets. In cases where SOEs do not exist, or where SOEs lack the technological sophistication or capital to exploit certain assets, governments must bring in commercial partners with expertise (typically foreign firms) to realise natural-resource wealth.

In order to encourage these private partners to enter into a project, governments must provide an incentive. Usually this incentive comes in the form of part ownership of the asset or a share of the revenues or output from the project. As we mention below, and discuss in more detail in the natural resources section of the appendix, the revenue-sharing arrangements between government and commercial partners are often complex.

Ownership of infrastructure assets

For infrastructure, governments have an interest in maintaining and expanding assets that are essential to social welfare and economic growth. For example, having a robust electric grid to power industry and a network of roads and ports to transport goods for exporting supports economic growth and increases tax revenues. However, as in the case of natural resources, governments are not always fully capable of developing and operating infrastructure projects alone – particularly as the scale and complexity of such projects increase.

Governments seek private-sector involvement in these projects for a number of reasons:

- Commercial partners with specialised expertise can provide the **technical capabilities** that SOEs do not have.
- By **attracting innovation** in terms of technology and management processes, SOEs can benefit from partnerships with private corporate entities through transfer of knowledge and adoption of best practices.
- **Private sector management,** according to some, reduces costs and increases efficiency better than public sector management.
- **Sharing risk** during the development, construction and operation of assets shields governments from calamitous losses and offers a more attractive risk-return profile.
- **Fiscal concerns,** such as reducing government balance-sheet exposure, can be mitigated by drawing in capital from private sources.

The structure of each public-private project will depend on what trade-offs the government is looking to make between capturing economic value and mitigating project risk. Different structures have different levels of budgetary exposure to asset value change, as Table 7 shows.

Table 7: Public-private asset ownership structures and budgetary impact

Structures used to split economic value	Private role[19]	Public role	Budgetary exposure to asset value
Infrastructure			
Service/ Operation and Maintenance (O&M) contracts	Takes on O&M risk for short terms (2-5 years). Receives fixed fee to cover staffing and expenses. Often included in other contracts.	Takes ownership of all project-related risk except management for term. Remains employer of personnel.	Highest
Lease contracts	Receives fixed lease fee from the state and takes on collection risk and O&M risk. Medium-length term (8-15 years).	Takes ownership risk and financing risk. Gives assurances that tariff levels will rise over term (political risk). Transfers employees to lease operator.	Higher
Design Build Operate (DBO) projects	Takes on construction risk and O&M risk. Obtains revenue through a fee from the state rather than consumers.	Takes on ownership and financing risk.	High
Build Operate Transfer (BOT) projects	Takes on construction risk, O&M risk, and financing risk. Usually for a discrete, new asset, not a system. Raises revenue from state fees, not user tariffs.	Post-contract the asset is transferred to the state. For long-lived assets the state bears valuation changes.	Low
Concessions	Takes on construction risk, O&M risk, and financing risk for extended term (20-30 years). Covers an entire infrastructure system. Obtains revenue directly from consumer tariffs to (often) cover regulated rate of return.	Maintains ownership of assets and is typically responsible for replacing large assets.	Lower
Full divestiture / privatisation	All, or substantially all, the interests in a utility asset or a sector are transferred. Private purchaser may be unwilling to accept all liabilities, which are absorbed by the state.	Sells assets directly or through shares of an operating company. Assumes regulatory role; retains indirect control.	Lowest
Commodities			
Production Sharing Agreements (PSAs)	Costs of exploration and production are covered but profit sharing strongly favours the host government.	Takes most of the upside from production gains and price increases (on top of royalties) through contract terms.	Higher
Royalties regime only (production taxes)	Takes production risk but retains asset upside by only paying the state royalties on production.	All project-related risk is with producer, but will still realise lower tax revenues as commodity prices fluctuate.	Lower

As well as through these contracts, the private sector transfers additional economic value to the state through taxation – primarily corporate income taxes, but also value-added taxes and income taxes from employees. Land leases and concessions are significant during the exploration and production of commodities as well. Production Sharing Agreements (PSAs)[20] often have unique terms, creating project-specific tax regimes and compensation splits that will be significant for large assets.

In summary, evaluating the split between governments and private-sector players – the investors that own assets and provide services – should follow these steps:

1. Identify the entities that own and control natural resources and infrastructure assets.

2. Estimate the share of economic value from natural resources that is allocated to the government based on effective contracts and the tax/royalty structures in place.

    a. Identify all the relevant PSA contracts in place, as many projects will have unique contracts that stipulate different production splits and tax rates.

3. Estimate the share of investments and operating costs related to captive assets (primarily infrastructure) that are allocated to the government.

    a. Determine how the ownership of captive assets is structured along a continuum between public and private investors, identifying sectors where public-private partnerships (PPPs) dominate.

    b. Examine the contractual arrangements and regulatory structures for privately owned assets (or partially privately owned assets) that determine how value is allocated between public and private investors.

    c. Identify for how long the contracts governing PPPs are in place, and what types of adjustments governments could make to respond to new investment needs (for example, are all sectors already privatised or under concessions, or could private-sector investors be drawn in by regulating the industries differently?).

4. Estimate the extent to which private players will have to be compensated for the loss of value of existing infrastructure assets caused by industry restructuring.

    a. Base this estimate on asset ownership, local regulatory policy and contractual arrangements between the government and private investors, as identified in steps 1 to 3.

    b. To the extent that there is private-sector involvement in these assets, governments or taxpayers may be forced to pay investors that own regulated assets if local policies make these assets redundant.

[20] A more detailed discussion of PSAs is included in section 1 of the appendix.

Chapter 3

Examples of methodology applied to the fossil-fuel and power sectors in selected EBRD countries of operations

1. Introductory remarks

The methodology described in chapter 2 has been designed as a tool to help policy-makers understand how climate change policies impact national budgets. The current chapter shows through examples how that methodology can be applied to individual sectors and countries in order to estimate the impact of climate related policies on governments' budgets. The examples are drawn from four industries that are particularly susceptible to the effects of climate related policies (coal, oil, gas and power) and from EBRD countries of operations where these four industries are nationally significant.

Table 8. Selected countries and industries for evaluation

Coal	Oil	Gas	Power plants
Russia	Russia	Russia	Turkey
Kazakhstan	Kazakhstan	Kazakhstan	
Ukraine	Azerbaijan	Azerbaijan	
Poland	Egypt	Turkmenistan	

To capture fully the effects that climate change policies have on national budgets one would need to look beyond individual sectors and estimate impacts across the entire economy, including second-order effects on employment and any potential new revenue streams from "clean technology" (cleantech) assets. However, for resource-rich countries that rely on extractive industries for the majority of their income, looking only at the effect climate policies have on the fossil-fuel industries tells a good part of the story.

The structure of this chapter follows the steps from the methodology presented in chapter 1. Section 2.1 below discusses the process of selecting scenarios for evaluation, and section 2.2 covers the specification of models used to calculate the change in economic value of fossil fuels and the change in infrastructure build-out. Section 3 discusses the effect on national budgets of moving to the low-carbon scenario from the base case for those countries and industries detailed in Table 8.

2. Scenario selection and model specification

Climate change policies will change production costs and demand levels, which, in turn, will change the value of natural resources and infrastructure assets owned by investors, including governments. Estimating the change in value associated with a set of climate change policies requires that production costs and demand levels across two scenarios are compared, as follows:

Table 9: Definitions and objectives of the *WEO 2014* scenarios

	Current policies scenario (BAU)	450ppm scenario (low-carbon)
Definitions	Government policies that had been enacted or adopted by mid-2014 continue unchanged.	Policies are adopted that put the world on a pathway that is consistent with having around a 50 per cent chance of limiting the global increase in average temperature to 2° Celsius in the long term, compared with preindustrial levels.
Objectives	To provide a baseline that shows how energy markets would evolve if underlying trends in energy demand and supply are not changed.	To demonstrate a plausible path to achieving the climate target.

Source: IEA World Energy Model Documentation (see footnote 23).

- **The base case, or business-as-usual (BAU) scenario,** which assumes a growth trajectory for costs and demand levels that is in line with historical trends and reflects a future without significant policy action to mitigate climate change impacts.

- **The low-carbon scenario,** which reflects the best estimate of a feasible path to a low-carbon economy and adopts a set of climate change policies that alter the projected costs and demand levels for resources and infrastructure assets.

Once the cases for comparison have been identified, the next step is to evaluate the impact on economic value from moving from the BAU scenario to the low-carbon scenario:

- **For natural resources,** specify models that capture the nature of the asset in question. Commodities that trade in global markets will be impacted by shifts in global demand and prices, while other commodities are priced locally (such as lignite coal).

- **For infrastructure,** develop build-out projections that incorporate in the low-carbon scenario increasing levels of investment in cleantech, reflecting the changes in demand for natural resources.

2.1 Establishing the BAU and low-carbon scenarios

This modelling exercise bases the estimates for BAU and low-carbon scenario cost and demand levels on coherent scenarios developed by credible analytical organisations, such as the International Energy Agency (IEA) and the US Energy Information Agency (EIA).[21] The two key sets of projections used in the modelling presented here come from the *IEA's World Energy Outlook 2014 (WEO)* and *World Energy Investment Outlook 2013 (WEIO).*[22]

While there are many potential ways to reduce fossil-fuel consumption and achieve a lower-carbon economy, this model uses the IEA projections as an example of consistent scenarios in order to scale the potential magnitude of shifts in value. Thus, the BAU and 2DS/450ppm scenarios are used not as definitive numbers, but rather as guides to the quantitative evaluations of the potential impact of climate change policies, to understanding how valuation changes could be distributed, and to identifying the potential implications for policy-makers. Actual outcomes will be affected by policy, technology and economic development, as well as by the timing and ambition of global energy and climate action.

Because the projections used for these models are drawn from pre-existing scenarios developed by the IEA, as defined in Table 9, the same assumptions about macroeconomic trends and effective

[21] Many commercial and publicly available data sources have been used to specify the model and verify IEA projections, including data from EIA, BP Statistical Review of World Energy, Rystad, Wood Mackenzie, Platts, BGR, and The World Bank, among others, some of which are detailed in later sections.

[22] This model uses the WEO 2014 BAU scenario and 450ppm scenario (the low-carbon case reflecting emissions below 450 parts per million CO2). It also uses the WEO 2013 BAU scenario and the 2DS scenario (the low-carbon case, reflecting a global temperature rise limited to two degrees Celsius). The 450ppm and 2DS scenarios are closely related but not exactly equivalent.

policy sets used to develop the IEA projections apply here.[23]

2.2 Specifying global pricing and local build-out models

Assessing the impact that climate change policies will have on the national budgets demands different treatments for natural resources and for infrastructure assets. Fossil fuels, to varying extents, are traded and priced globally, and therefore require a global market pricing analysis. Manufactured assets, such as power plants, which are influenced almost exclusively by domestic policy and demand levels, require a local build and investment analysis.

Natural resources

Coal, oil and gas are traded internationally, and, as a result, changes in demand and prices for any fossil fuel in one part of the world can potentially impact demand and price levels for the others. Therefore, the supply and demand models used to estimate the change in value of fossil fuels must adopt a global perspective.

The oil, coal and gas models are based on five basic inputs: price, quantity, production cost, ownership and taxes.

- For the **price and quantity** of coal, gas and oil production, we have developed our own supply and demand modelling to forecast which production would be curtailed and how prices in commodity markets would react to falling demand under a low-carbon transition scenario, since operating under different scenarios is costly.

- **Production cost, ownership and taxes** are allocated based on commercially available data sources, such as the Rystad database of 66,000 global oil and gas fields, and various other cost and ownership data sources.

These supply models are based on aggregations of costs from the same data sources, adjusted to account for the impact of sunk costs, transport costs, investment returns and, in the case of gas, the inter-relationship between oil and gas supplies.

The gas model breaks down supply and demand into separate modules for production for domestic consumption, for pipeline gas and for LNG, and captures the constraints placed on natural gas exports by pipeline capacity and LNG liquefaction infrastructure. The oil demand model is based on IMF forecasts for individual country GDP growth, and on historical multipliers for the relationship between GDP and oil consumption in the absence of price changes. Then, based on a number of studies of oil sensitivity to price changes, demand changes for any given future price expectation are forecast. The next section discusses in more detail the particular issues to consider when modelling oil and gas.

Demand for coal, oil and gas under the low-carbon scenarios is based directly on the IEA's low-carbon scenarios, and comparison of these demand estimates with the supply curves generated by the supply models provide estimates of the market price and production assets needed in a given year. With this in hand, deducting cost from price provides the value achieved per unit of production. This can then be multiplied by quantity or output to define yearly profit. We then discount annual profits over the study period – from 2015 to 2035 – to estimate the value for any given asset. We use a discount rate of 8 per cent to represent the return in the general market that the re-invested revenues from these assets could support. Higher or lower discount rates affect the headline number, but do not materially alter the relative impact and insight that this analysis offers.

Infrastructure

Power differs from the other fossil-fuel markets in two important respects. First, it is the most local market, with global transport being physically nearly impossible. Thus all power markets are local or regional, with some price relationships flowing through coal, gas and equipment prices. Second, most of the value of coal, gas and oil are in the actual natural resources, rather than the equipment used to extract and refine the resources. Power has no natural resources and consists only of the conversion equipment.

Climate change policies will have an impact on government budgets through infrastructure assets

[23] Some additional work was required to isolate individual country projections for the analysis presented here. Although projections for the largest countries, including Russia, are broken out in the IEA figures, all of the other countries of interest (such as Azerbaijan, Poland and Egypt) were included in regional groupings. Constructing country-level demand projections for the various fossil fuels required cross-checking other data sources and imposing additional assumptions, primarily regarding demand growth. For a full description of the assumptions used to construct the IEA demand projections see: http://www.worldenergy outlook.org/media/weowebsite/2014/WEM_Documentation_WEO2014.pdf (last accessed 1 September 2015)

by requiring new investments, increasing capital expenditures, or by requiring that some assets are retired early or utilised less frequently, potentially exposing governments or consumers to economic value loss on fully regulated assets.

Unlike natural resources, infrastructure assets typically differ from country to country. There are significant variations within infrastructure classes in terms of technology, and even within technology types. For example, the feasibility of changing the way power plants are utilised in an electricity system depends not just on their age, fuel supply and location, but also on a host of technical specifications for plant components, and these determine the plants' operational limits. In addition, unlike fossil fuels, infrastructure assets face limited pressure from global forces. National policies play the largest role in determining the amount of infrastructure investment required; these policies include the regulatory regimes that determine whether the investment is financed by consumers or investors. For these reasons, evaluating the impact of climate change policies on infrastructure requires detailed country-level modelling.

The power-plant analysis conducted for Turkey in the following section is built around three main inputs:

- **Electricity demand** is taken from historical BP *Statistical Review 2015* data and Bloomberg New Energy Finance data.

- **Generation capacity** by technology type is drawn from Platts data (which also provides detailed plant data on ownership and operational characteristics) and reports from the Turkish government's 10th *Development plan and official plan for the electricity sector.*

- **Operational and capital expenditure costs,** including fuel costs, are taken from several publicly available databases and CPI modelling.

Evaluating the net impact of new-build infrastructure costs under various scenarios requires a comparison of the following:

1. Depreciation and amortisation of total capital costs

2. Operating costs

3. Financing costs

4. Assets that lose economic value because they are retired early or utilised less frequently.

Projected capacity additions required to meet electricity demand in the BAU and low-carbon scenarios are estimated using electricity demand estimates and assumptions about plant utilisation rates. The projected capacity figures and capital-cost assumptions for various technologies are then used to estimate the investment costs associated with

Box 2: Estimating the impacts on consumers and taxpayers

Assets do not increase or decrease in value spontaneously. They become stranded when a shift in policy causes asset values to diverge from previous expectations. In the case of fossil-fuel assets, the risk of stranding hinges on what steps governments take to address climate change.

To illustrate the significant role policy plays in driving asset stranding, we use the oil industry – where nearly three-quarters of fossil-fuel stranding risk lies –as an example. The risk is high partly because oil reserves are relatively large and the value of oil is relatively high compared with other fossil fuels. The most important reason, however, relates to the global nature of the oil market compared to other fossil fuels, and the relative sensitivity of oil prices to demand.

Supply and demand for oil until 2035 is modelled as a function of the oil price. When oil demand falls, the most expensive new production is no longer needed and the remaining producers compete to sell oil into an oversupplied market. Prices fall as a result. To assess the stranding risk, the producer price for oil that would be consistent with output at the low-carbon scenario levels is forecast. This is then compared with the forecast of oil demand and supply.

In one scenario, demand is brought down to levels consistent with the low-carbon scenario using only price instruments and existing technologies. In the other, demand adjusts to low-carbon-scenario levels without the use of price instruments – for example, through customers switching to an innovative substitute – and oil prices fall as a result.

For both these solutions, the impact on the economy and on investment extends beyond just the stranding loss faced by producers. With taxes, governments will benefit from tax receipts, while consumers will suffer from higher prices, although governments could lower other taxes to compensate consumers for these higher costs. In the case of innovation, consumers will benefit from lower fuel prices, as, even in the low-carbon scenario, oil demand would continue at around 80 per cent of today's level.

The analysis for oil in this section, which highlights the costs associated with innovation and tax policies, provides a range of estimated policy costs, not two stark policy choices. In practice governments are likely to implement a combination of these two types of policies, so we expect the true cost or benefits to fall somewhere between. The results presented for coal and gas only consider the costs and benefits associated with innovation policies.

future plant additions. Depreciation and amortisation expenses, financing costs and operating expenses until 2035 are calculated using estimates specific to the region and technology types.

For assets that are retired early or utilised less frequently under a low-carbon transition scenario, the infrastructure analysis utilises a simple wholesale electricity market model at the country-level to estimate the expected market clearing price, which is used to calculate avoided generator profit according to how much less a particular generator is called on. In fully regulated markets, it is assumed that the asset owner recovers all costs and the loss is borne by rate-payers.

3. Evaluation of climate policy impacts on selected industries and national budgets

The physical and financial characteristics of demand and supply in each fossil-fuel market determine the impact of policy and other forces on national budgets. In this section, industry-specific considerations are discussed for each of the four sectors analysed, followed by an evaluation of the budgetary impact on each country of interest.

3.1 Oil

Crude oil is a heterogeneous resource that needs to be separated and refined into oil products such as gasoline and diesel for cars and trucks, aviation fuel, bunker fuel for cargo ships, heating oil, or tar and asphalt for roads. Heavier crudes produce less gasoline and aviation fuel and thus require more refining to enhance their value. Yet, despite this heterogeneity, global markets work relatively well to give refiners and oil producers incentives to maximise the value of their production, directing the heavier, lower-value barrels to better equipped refineries.

The prices of oil products, such as gasoline, reflect this trading of crude between producers and refiners, while the price of crude oil reflects the highest value, given its location and the potential production mix. As a result, despite the heterogeneity of crude oil, the relationship between crude prices is well established and is typically driven by a series of "benchmark" crude prices. The price of most crude, regardless of its quality and location, is affected by the global crude market. Thus, the value of any particular crude production can be estimated by using a benchmark oil price estimate and differentials accounting for transport and crude quality.

Another important point about oil is the steepness of its supply curve. That is, to meet demand the cost of producing the most expensive oil can be up to several times more than average production costs. In sharp contrast, to meet demand, the most expensive coal production is only 30 per cent higher than average production costs. As Chart 4 shows, a 10 per cent reduction in demand for oil has a much larger impact on oil producer profits than demand for coal does on coal producers. Since the price is set by the marginal production cost (that is, the most expensive production needed to meet demand), falling demand has a much lower impact on coal prices than on oil prices. As a result, changes in coal demand have a much smaller impact on prices and economic value than in the case of oil. This dynamic between oil supply and demand explains the significant reductions in economic value that accrue to oil producers under the low-carbon scenario evaluated in this report.

Production ownership and consumption

Governments control as much as 70 per cent of oil production globally. While this holds true for Russia, where state control is exerted through its majority shareholding in several publicly traded companies (for example, Gazprom and Rosneft), the level of state control in Kazakhstan, Azerbaijan and Egypt is considerably less.

Kazakhstan, Azerbaijan and Egypt own only small amounts of national oil production directly through the participation of state-owned enterprises (such as SOCAR in Azerbaijan and Kazmunaigaz

Chart 4: Illustrative oil and coal supply curves based on forecasts for year 2013 facing a 10% demand reduction

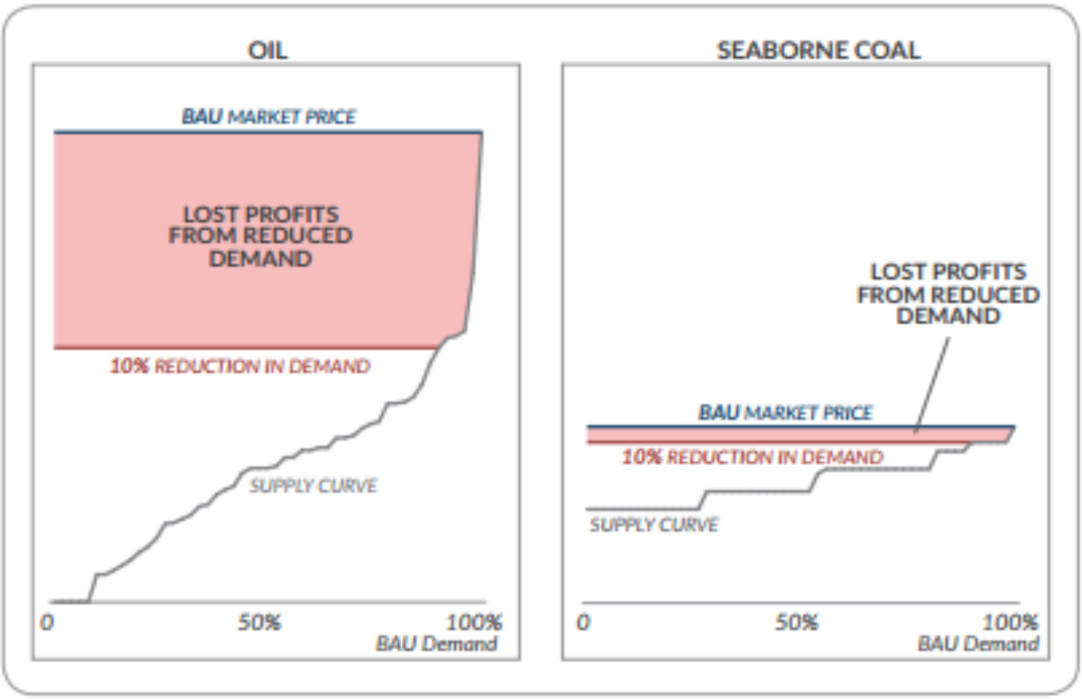
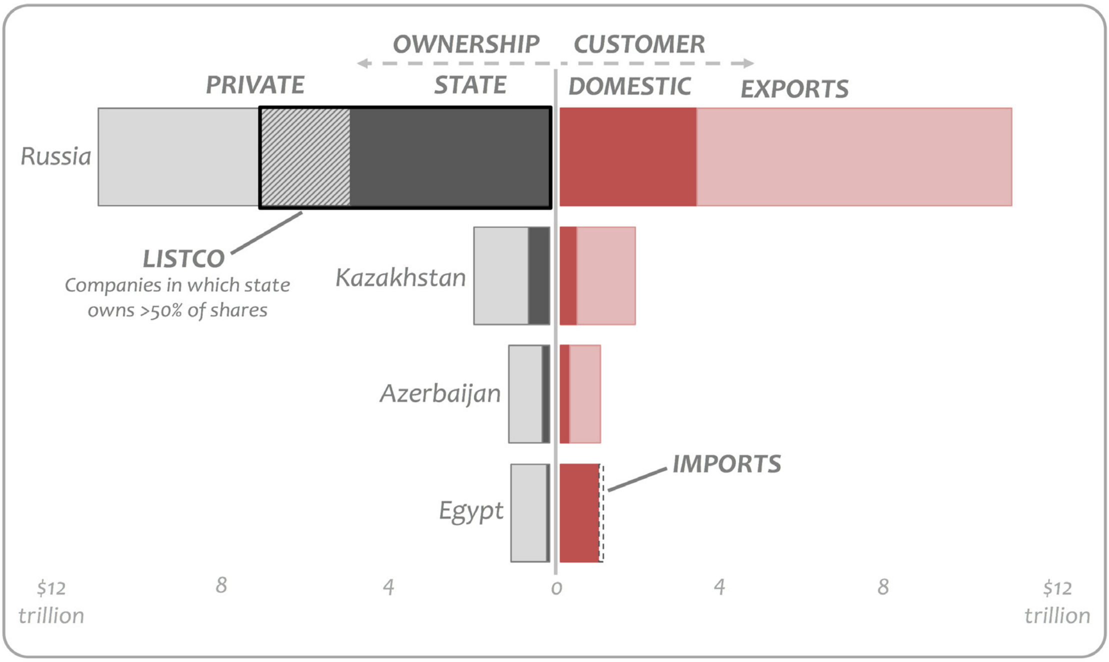


Chart 5: Oil production value by owner and customer



in Kazakhstan) in joint ventures; these countries' governments primarily extract economic value from the oil and gas sectors through tax and royalty regimes. Azerbaijan and Egypt primarily employ PSAs, with 83 per cent and 92 per cent of production, respectively, covered by such structures in 2013. In Kazakhstan, only 20 per cent of oil extracted in 2013 was produced under a PSA, but this share is expected to rise rapidly from 2020, when the supergiant Kashagan field in the Caspian Sea comes online.

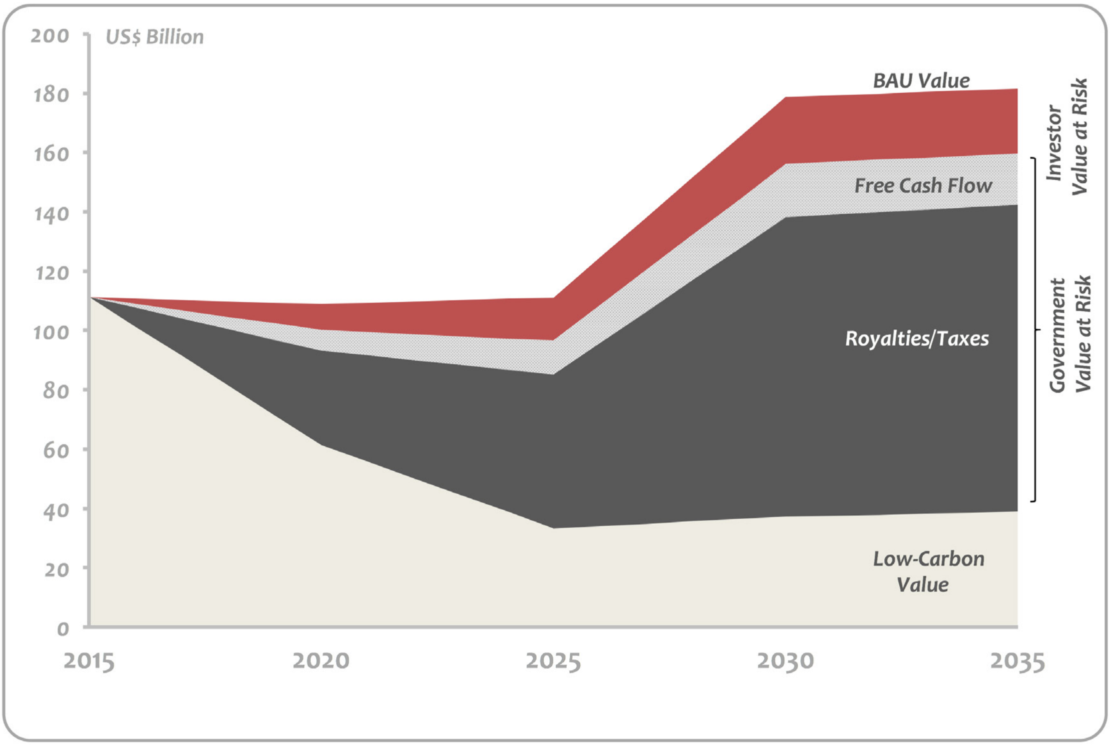
Egypt, which imported 10 per cent of the oil it consumed in 2013, is the only net importer among the four countries evaluated in this report. Russia, Kazakhstan and Azerbaijan export 71-88 per cent of their total oil production. The main destination for Russian crude is Europe. The oil is transported through a vast pipeline network controlled by state-owned enterprises (this carries the majority of Kazakh and Azeri production to the market as well). Considerable volumes from both Russia and Kazakhstan are also exported to China, and a number of pipeline projects that will increase exports in the region in the short term are under way.

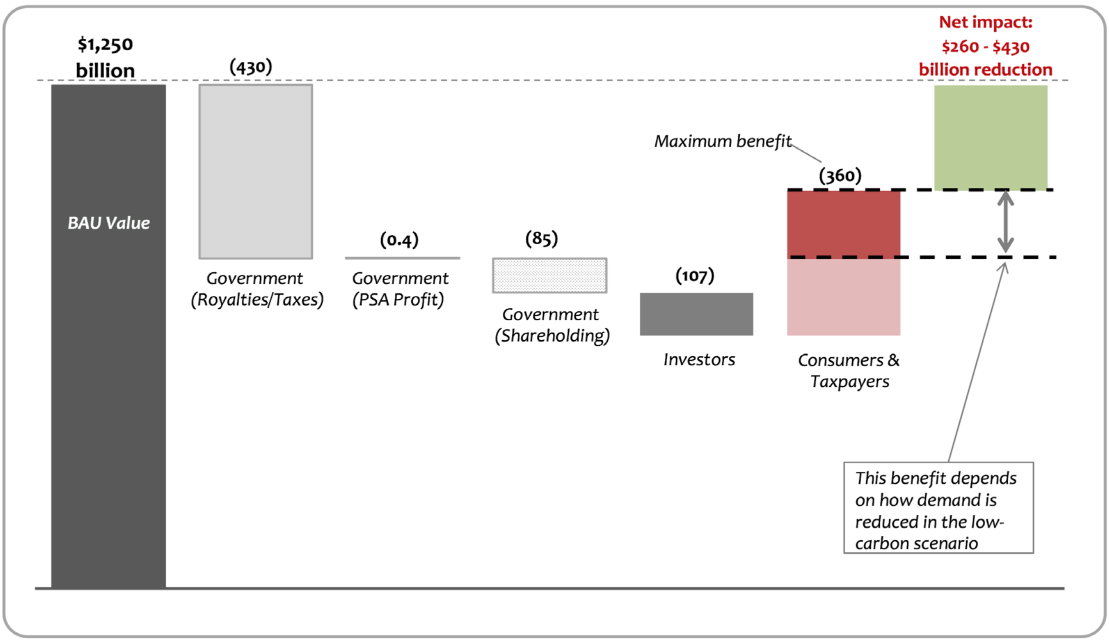
Russia

Under the low-carbon scenario, the economic value of Russian oil to producers declines from US$ 1.25 trillion to US$ 630 billion. Of this, the Russian government is at risk for US$ 515 billion, with investors at risk for the remaining US$ 107 billion under the modelled scenario. The range of benefits for consumers is US$ 190-360 billion, resulting in a total cost to Russia of US$ 260-430 billion, to be split between the government, consumers and taxpayers.

As Chart 6 shows, the biggest loss of value is projected after 2025 as climate change measures take hold and global demand contracts as a result. One challenge facing Russian production is the location of its remaining hydrocarbon reserves, as many are located in remote areas with harsh conditions (such as the Arctic and eastern Siberia). The technical challenges extracting these reserves pose means exploration and operating costs for many oil players in Russia through to 2035 are comparatively high.

Chart 6: Russia oil: change in projected economic value from BAU to low-carbon scenario

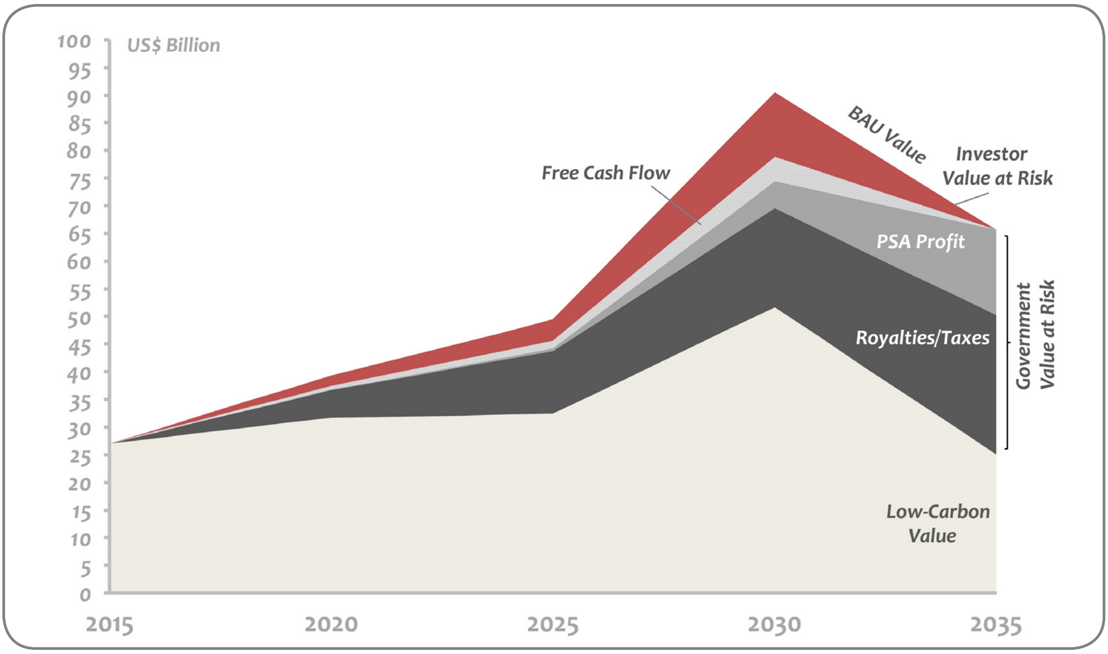




Kazakhstan

The shape of projected producer value reductions in Kazakhstan, as seen in the left pane of Chart 7, can be explained in large part by the timing of fields entering production. Kashagan, the supergiant field in the Caspian Sea, is expected to come online around 2020 and reach full production by 2030. The large decline in free cash flows to investors can be attributed to cost recovery for the Kashagan field as per the terms of the PSA in place for Kashagan. As discussed at length in the appendix, PSAs are structured so that the operator of the field, in this case a consortium including the state-owned Kazmunaigaz, reclaims development expenses in the initial years of the field's operation. During the period 2025-30, a proportionally higher share of oil revenues is essentially promised to commercial entities.

Chart 7: Kazakhstan oil: change in projected economic value from BAU to low-carbon scenario



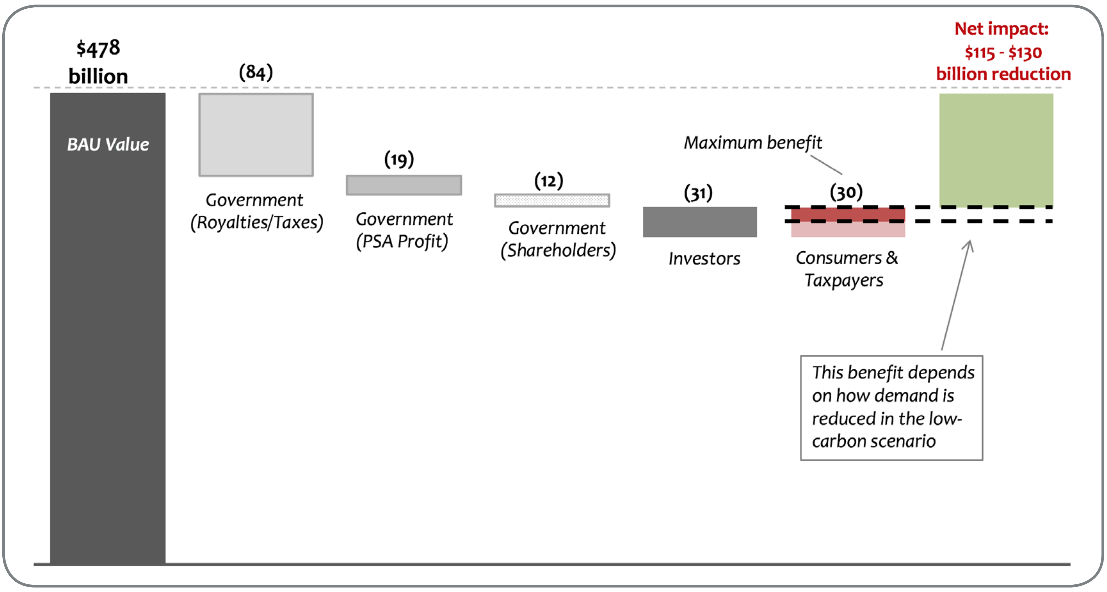
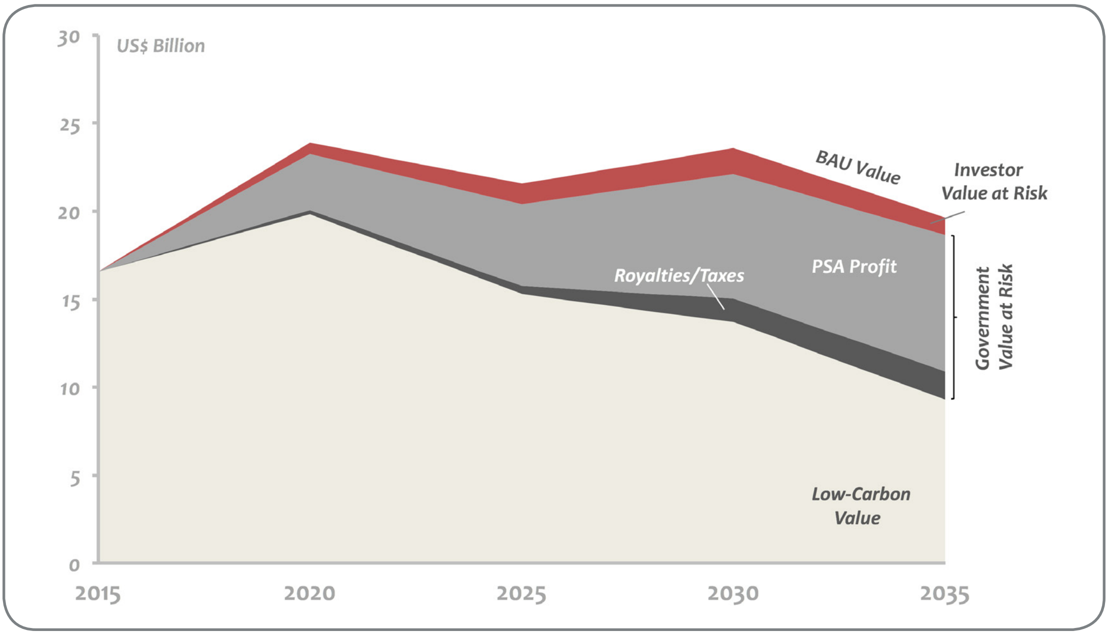
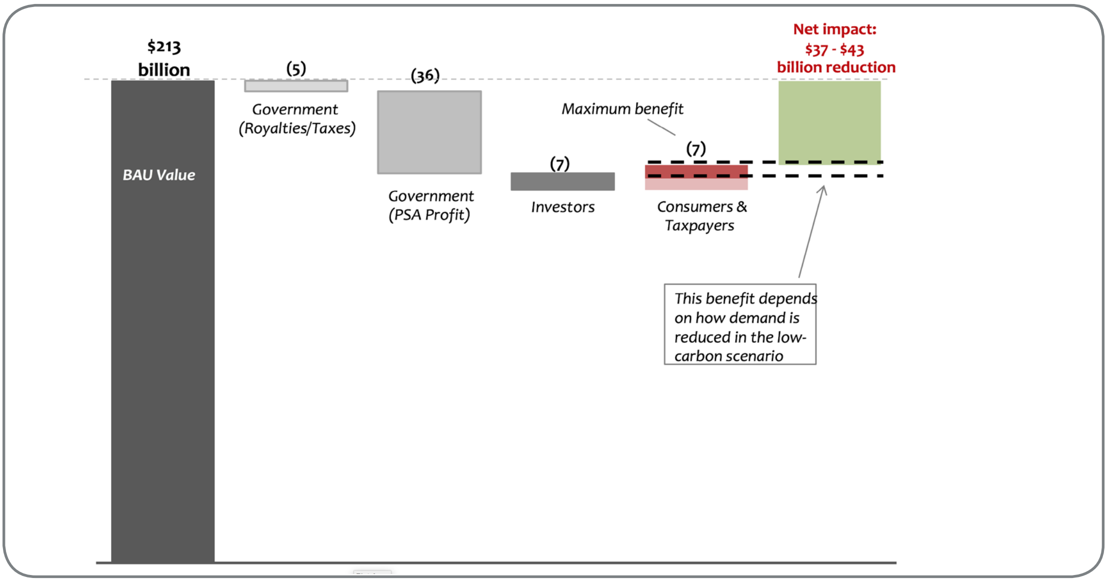


Chart 8: Azerbaijan oil: change in projected economic value from BAU to low-carbon scenario



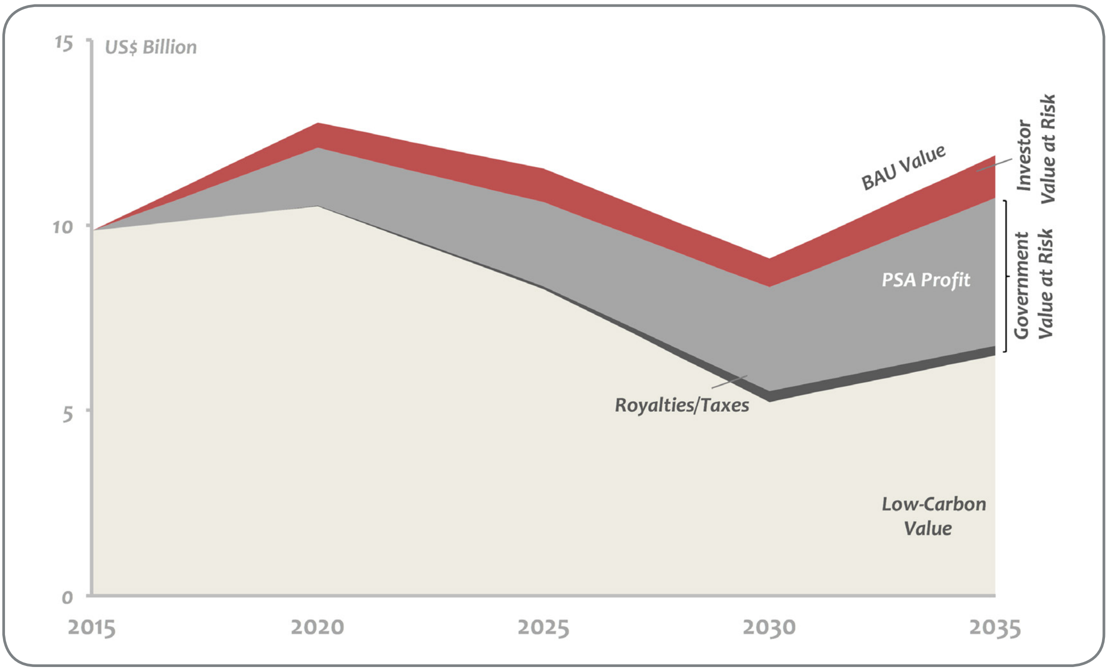


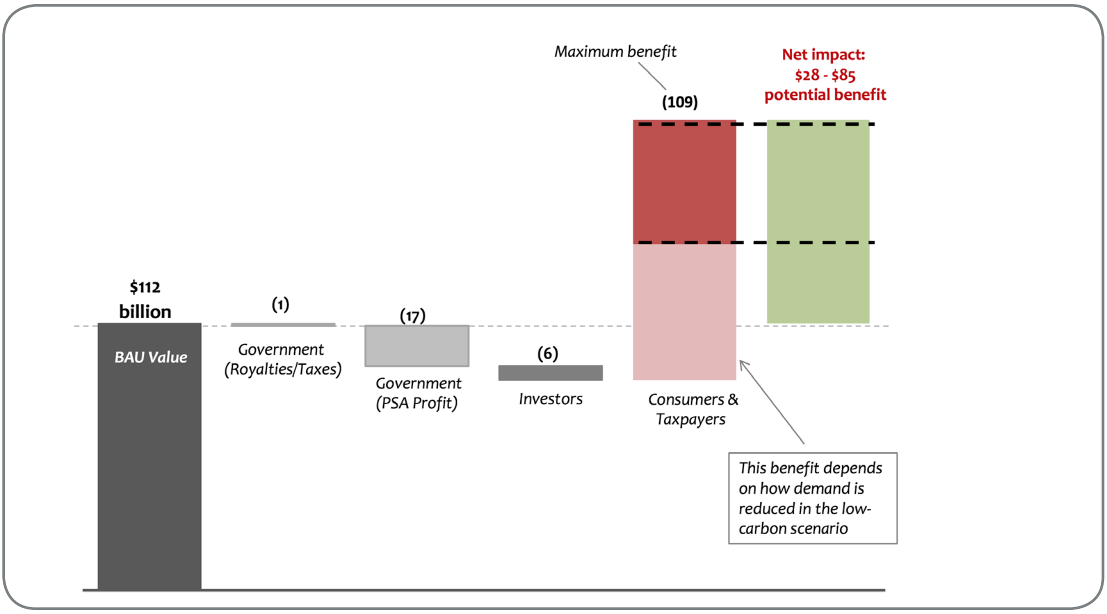
Under the low-carbon scenario, the government of Kazakhstan sees oil revenues declining by US$ 115 billion, primarily due to the disappearance of royalties and taxes from the ageing Tengiz field, which are not replaced by other production because of reduced demand globally (see Chart 7). The range of benefits for consumers is US$ 15-30 billion, resulting in a total cost to Kazakhstan of US$ 115-130 billion to be split between the government, consumers and taxpayers.

Azerbaijan

Revenues from production in the oil sector under the low-carbon scenario fall by 23 per cent compared to the BAU case, from US$ 213 billion to US$ 165 billion. Depending on the policies used to reduce demand to levels consistent with the low-carbon scenario, consumers and taxpayers will experience a benefit of US$ 5-11 billion, resulting in a total cost to the economy of US$ 37-43 billion, to be split between the government, consumers and taxpayers.

Chart 9: Egypt oil: change in projected economic value from BAU to low-carbon scenario





Roughly 75 per cent of Azerbaijani oil production comes from the Azeri-Chirag-Gunashli offshore field, which is contracted under a PSA. Thus, the major drop in government revenues comes from profit gas (that is, the gross revenue remaining after deducting royalties, taxes and costs) associated with that field. As PSAs are not as easy for governments to adjust as laws surrounding the tax and royalty regime, the government of Azerbaijan, in contrast to those of Kazakhstan and Russia, will have less manoeuvrability in terms of shifting some of that loss of economic value on to investors.

However, even if PSAs could be negotiated, it is unlikely that governments could shift the loss of economic value to investors in a meaningful way since they capture such a small share of the economic value from oil under either scenario (approximately 20 per cent). Going back to the discussion on the oil supply curve, the level of global demand reductions for oil under the low-carbon scenario is sufficiently large to reduce government revenues dramatically even if the government could shift as much value as possible back to commercial producers (through, for instance, higher taxes and royalties, or more favourable PSA terms).

Egypt

Egypt faces a similar situation in terms of the share of production under PSAs as is Azerbaijan, with 28 per cent of BAU revenues being lost just in the state share of PSA profit oil (that is: the amount of production, after deducting the cost of oil production allocated to costs and expenses, that will be divided between the participating parties and the host government under the production sharing contract). In total, the value of oil production in Egypt falls from US$ 112 billion in the BAU scenario to US$ 88 billion in the low-carbon scenario as a result of climate change policies and reduced global demand, with the government bearing US$ 18 billion of the value at risk. The sharp drop in value, even in the BAU scenario around 2030, is related to capital expenditure assumptions for proven undeveloped fields in the Rystad cost data.

The Egyptian government may not easily be able to renegotiate its concessions and PSAs with commercial oil companies, but it is not without options to manage, at least partially, the reduction in oil revenues under the low-carbon scenario. For instance, Egyptians receive one of the world's most generous energy subsidies: the US$ 30 billion the Egyptians spent on subsidies in 2013 was the sixth-highest figure in the world, behind China and Indonesia and equalling more than 5 per cent of the global total.[24] If the Egyptian government were to continue its efforts to steadily eliminate the subsidy as oil prices fall in the low-carbon scenario, the reduced expense would partially offset declining oil revenues, which would also be falling with oil prices.[25]

In fact, Egyptians, who consume a large amount of oil per capita as a result of the subsidies, would benefit more than most countries from the falling demand and price levels associated with a low-carbon scenario. The range of benefits for consumers is between US$ 57 billion and US$ 109 billion, resulting in a total potential benefit to Egypt of US$ 28-85 billion.

3.2. Coal

Like oil, coal is a heterogeneous product. However, there is less scope to refine or blend coal into distinct products.

Primarily, coal can be grouped into two main products:

- **Coking or metallurgical coal,** which comprised approximately 13 per cent of global coal production in 2012,[26] and more than 25 per cent of production in Russia and the former countries of the Soviet Union,[27] is used mainly as a source of carbon in primary steel production.

- **Steam or thermal coal** (including hard coal and lignite), which is used to produce electricity, heat, and steam for industrial and residential use.

The main effects from climate change policies will fall on thermal coal, which represents the largest share of energy-related carbon emissions and has many potential low-carbon substitutes.

Coking coal, which may be a good candidate for carbon capture and storage (CCS), is more difficult to replace. First, it is a smaller and more self-contained market than thermal coal (meaning that there is less competitive pressure to keep prices down). Second, the gas produced at steel mills has a higher concentration of than the gas emitted from power plants, so a steel mill could capture the same amount of CO_2 with a smaller (and, therefore, less expensive) CCS facility than would be required at a coal-fired power plant. Very little, if any, of the coking coal produced by Russia, Poland, Kazakhstan and Ukraine will experience economic value loss under the low-carbon scenario. This is good news for proportionally large coking coal producers such as Russia and Ukraine, where coking coal comprises 21 per cent and 41 per cent of production, respectively, as Chart 10 shows.

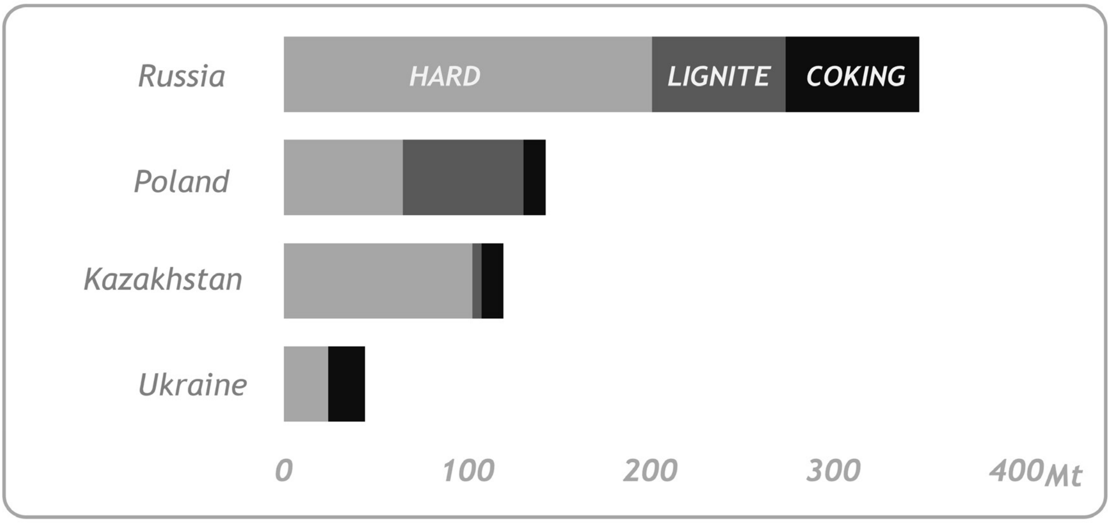
[24] Energy subsidies are defined as government expenditures on oil, electricity, natural gas and coal consumption. IEA (2015); http://www.worldenergyoutlook.org/resources/energysubsidies/fossilfuelsubsidydatabase/

[25] Eliminating subsidies would also help to diminish the country's high budget deficit and help the state-owned oil company pay off the billions of dollars in debt to foreign operators that is slowing down its exploration and production. EIA (2015); http://www.eia.gov/beta/international/analysis.cfm?iso=EGY

[26] International Energy Agency (2013), Coal Information 2013, Table II.1

[27] Climate Policy Initiative (2014), Moving to a low-carbon economy: the impacts of policy pathways on fossil-fuel asset values. Available at: http://climatepolicyinitiative.org/publication/moving-to-a-low-carbon-economy/.

Chart 10: Coal production by type



Within thermal coal, the energy, sulphur and moisture content, and the location of coal mines create other sub-markets. For instance, lignite, which represents approximately 12 per cent of global coal production, has lower energy content per tonne, resulting in higher transport costs per unit of energy. Consequently, it is more efficient to locate a power plant on or near a coal mine rather than transporting the coal. For example, in Poland, a large proportion of the country's power is generated by "mine-mouth" power plants that run on lignite, while 5-10 per cent of its exports are of steam coal, which is used to fuel power plants in Europe and eastern Ukraine.

Beyond lignite, there are other coal types that are not linked into national or global coal markets, either because of their low energy content, the cost of transport, or a lack of infrastructure to transport the coal to global markets. To evaluate the change in economic value of coal assets, the model identifies four types of market:

- **"Mine-mouth" resources:** For these coal resources, the quality of coal and the location make transport expensive relative to the energy value of the coal. In this case, power plants and other demand are located next to the mine, since the cost of transporting the electricity is usually lower than the cost of shipping the coal. With this arrangement the mine is a captive supplier of the power plant, so coal prices are usually set on a regulated or cost pass-through basis under contract. "Mine-mouth" resources are thus not exposed to any price effects as a result of policy and demand changes, but only face volume risk. Since many "mine-mouth" resources are relatively low cost and provide local energy security, they also tend to face lower volume reductions than international coal.

- **Isolated regional markets:** Some markets are reasonably self-sufficient in terms of coal production. In addition, imported coal is often unable to compete with local sources due to high transport costs or a lack of transport facilities. Such markets are either regulated (and, thus, are effectively "mine-mouth" markets) or price coal according to their own internal supply-and-demand dynamics.

- **Regional markets with international price pressures:** Regions such as China, Europe or India produce large amounts of coal, but because they have well-established infrastructure and relatively low-cost import potential, international prices can influence local prices.[28] In China, for instance, much domestic production is delivered to ports, where it is put on cargo ships to deliver to seaports along the coast, which feed demand in eastern China. Thus, logistically, Chinese coal is on the same footing as imported coal, because both domestic and imported coal is arriving at the same ports.

- **Internationally traded coal:** Approximately one-sixth of global coal is traded on international

[28] Climate Policy Initiative (2014), *Moving to a low-carbon economy: the impacts of policy pathways on fossil-fuel asset value.*

markets – either placed on bulk carriers if seaborne, or on rail (primarily transported from Russia to Europe and China). International coal is a heavily traded commodity that is priced, like oil, through a complex system in which traders balance shipping costs and coal differentials to set prices at different locations for different coal qualities. As with oil, changes in one region can have an impact on the price of coal traded globally. However, global coal prices would see a less dramatic difference than oil prices under the low-carbon scenario, to the extent that coal has lower marginal production costs and profit margins.

Chart 11 summarises the global share of coal that the model indicates would not be produced during the low-carbon transition. This applies to internationally traded coal and domestic coal (including regional markets with and without international price pressures).

Ownership and production

Internationally traded coal, which is at greater risk of stranding, is also more heavily investor-owned than domestic coal. Investors own approximately 80 per cent of internationally traded coal value at risk but own less than half of the value at risk for domestic coal. Compared with the oil market, where governments own or control the vast majority of assets and revenues at risk, coal stranding risk globally is more evenly balanced between investors and governments.

However, as Chart 11 shows, the majority of production in Russia, Poland and Kazakhstan is owned either by the government or by private industry. Only in Ukraine, where state-owned entities produce the majority of thermal coal and private producers control coking-coal production, is there a clear balance between state and private ownership.

Russia is a major exporter, and serves the European and Chinese markets equally. Kazakhstan exports almost all of its coal to Russia, mainly from the eastern part of the country into western Siberia, where Kazakh coal powers several Russian power stations. In Russia and Kazakhstan, the majority of coking coal is consumed domestically. In Kazakhstan, ArcelorMittal has become one of the country's largest coal miners, supporting its own metallurgical plants.

Poland

The Polish government controls the entire coal production sector in Poland and, therefore, all the value at risk, which is estimated at US$ 11 billion. In total, the value of the Polish coal sector is predicted to fall from US$ 76 billion to US$ 71 billion under the

Chart 11: Coal production value by owner and customer

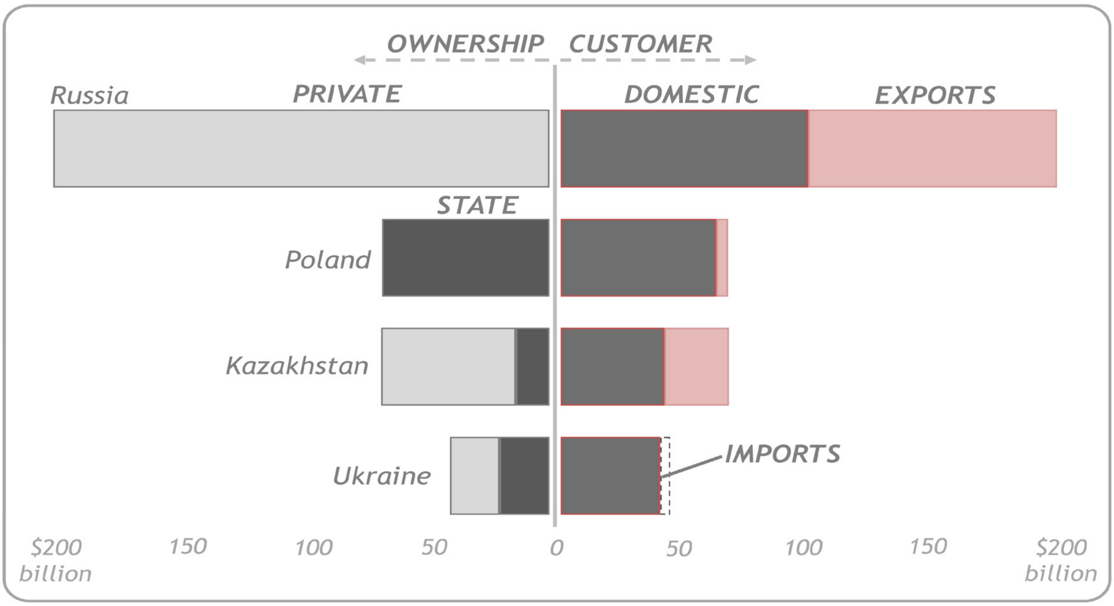
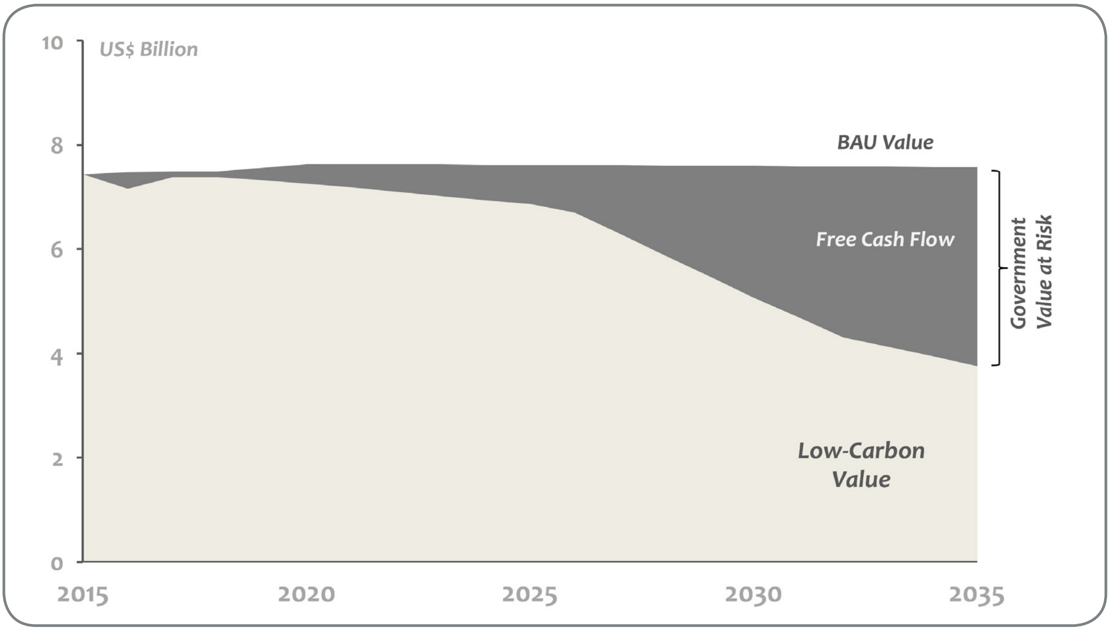
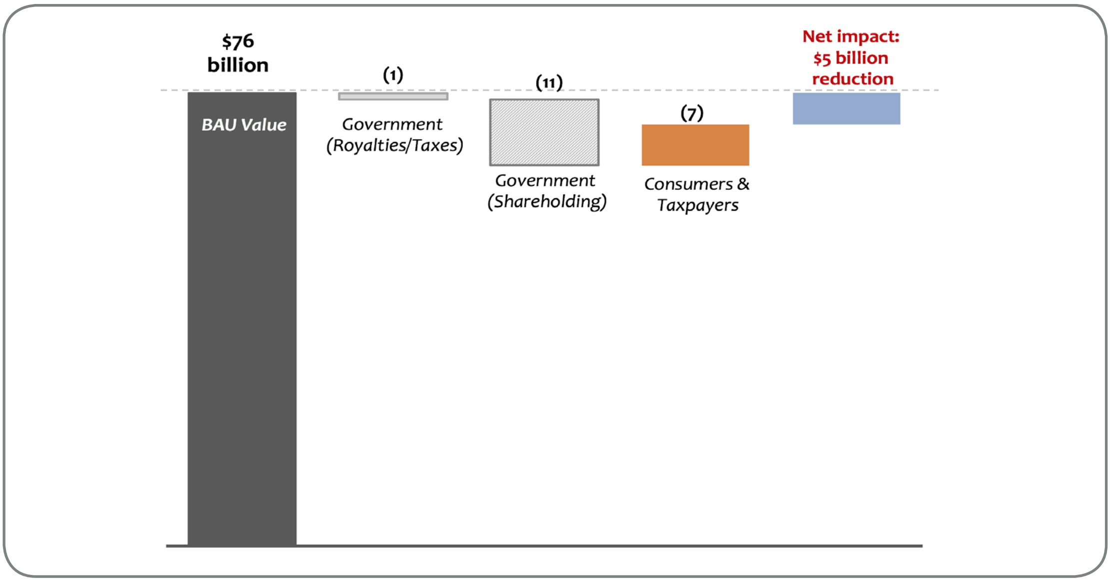


Chart 12: Poland coal: change in projected economic value from BAU to low-carbon scenario





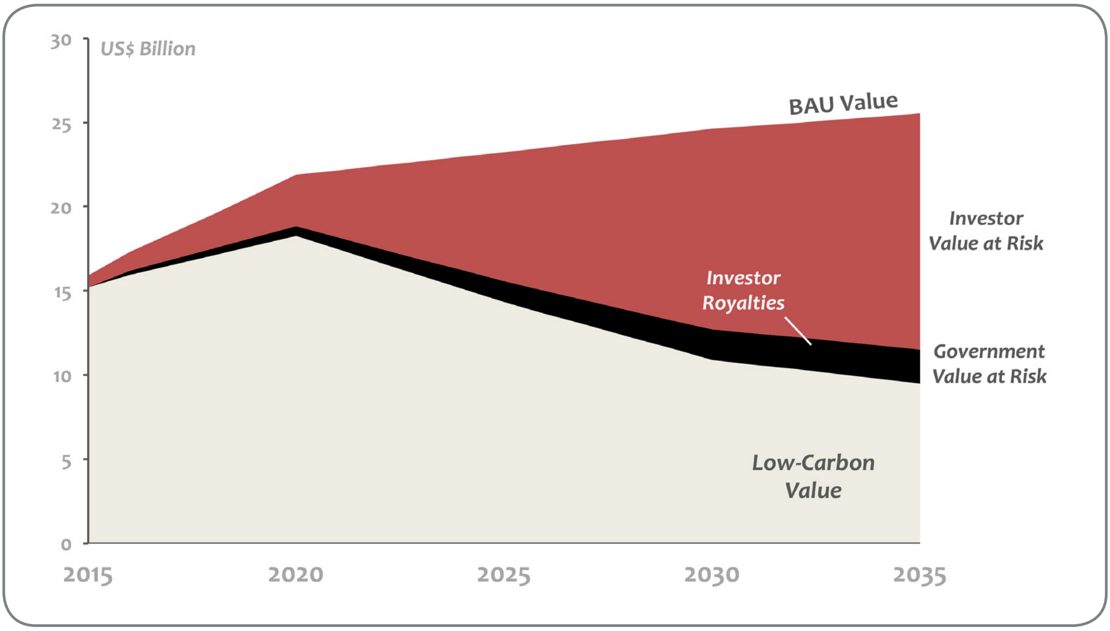
low-carbon scenario, factoring in the US$ 7 billion expected benefit that accrues to consumers through reduced demand and price levels (see Chart 12).

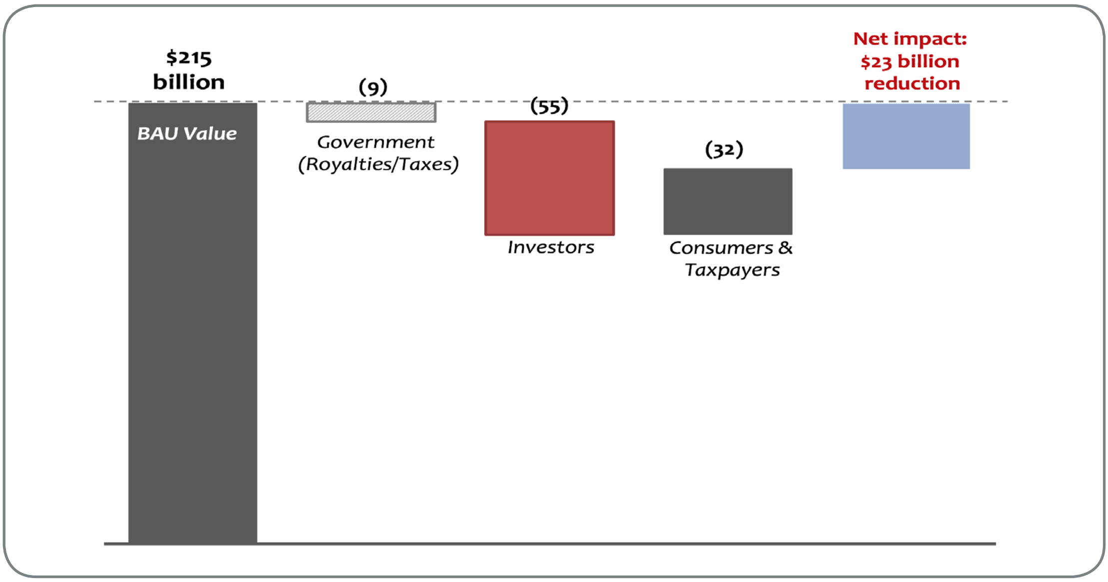
Although, in the low-carbon scenario, coal use across the globe will be to a large extent reduced, in many areas production for domestic consumption will continue unabated. Coal is the most significant fossil-fuel resource with which Poland is endowed and the country views the continued production and utilisation of coal as an energy-security issue. Poland exports only small amounts of its annual production, which greatly reduces the value at risk from demand fluctuations in export markets.

Russia

In contrast to Poland, Russia is one of the world's largest coal exporters by volume and by share of production. Thus, the Russian coal industry as a whole is exposed to heavy losses from falling exports in the

Chart 13: Russia coal: change in projected economic value from BAU to low-carbon scenario

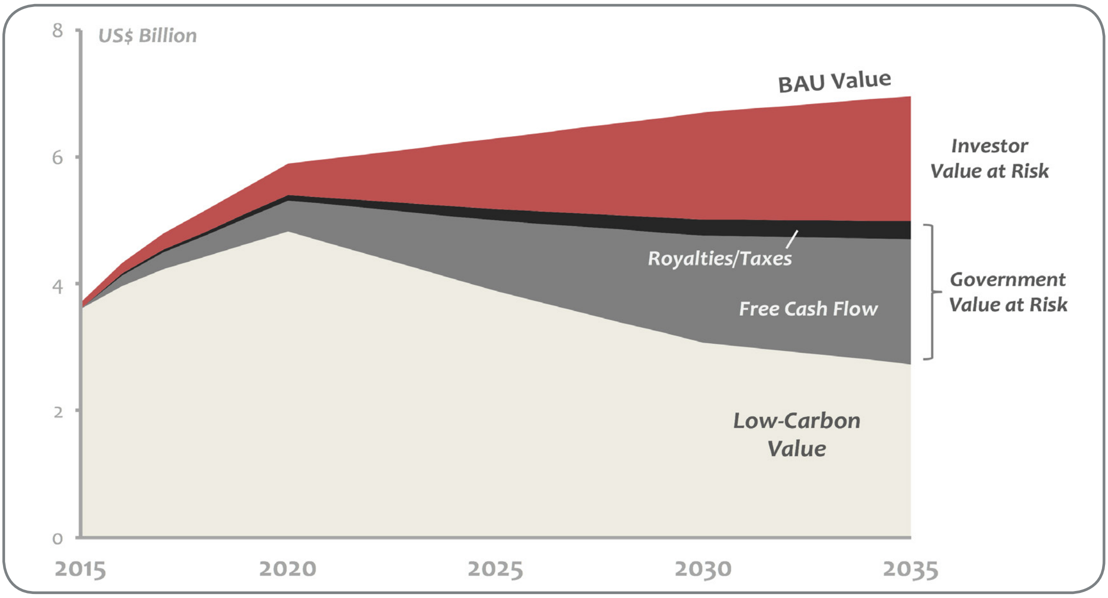


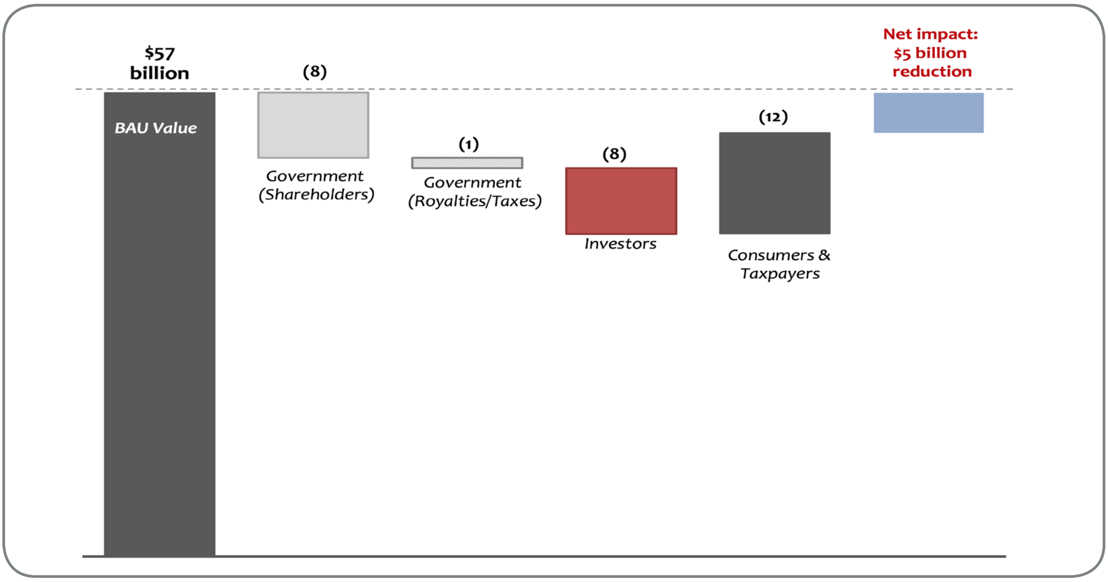


low-carbon scenario. As Chart 13 shows, the value of Russian coal production falls by US$ 64 billion, from US$ 215 billion to US$ 151 billion through to 2035. Most of this decline can be attributed to demand reductions in Europe and, to a lesser extent, in China.

However, it is not the government, but investors that are exposed to most of this risk. Although the government does see revenues falling by US$ 9 billion as a result of falling royalty payments, because the industry has been completely privatised, the state is insulated from the largest consequences of a reduction in the economic value of coal production. In addition, the second-order effects of curtailed operations, such as unemployment, may have negative implications for the national budget if social payments increase. Consumers are expected to receive a benefit of US$ 32 billion and the estimated total cost to the Russian economy is US$ 23 billion.

Chart 14: Ukraine coal: change in projected economic value from BAU to low-carbon scenario



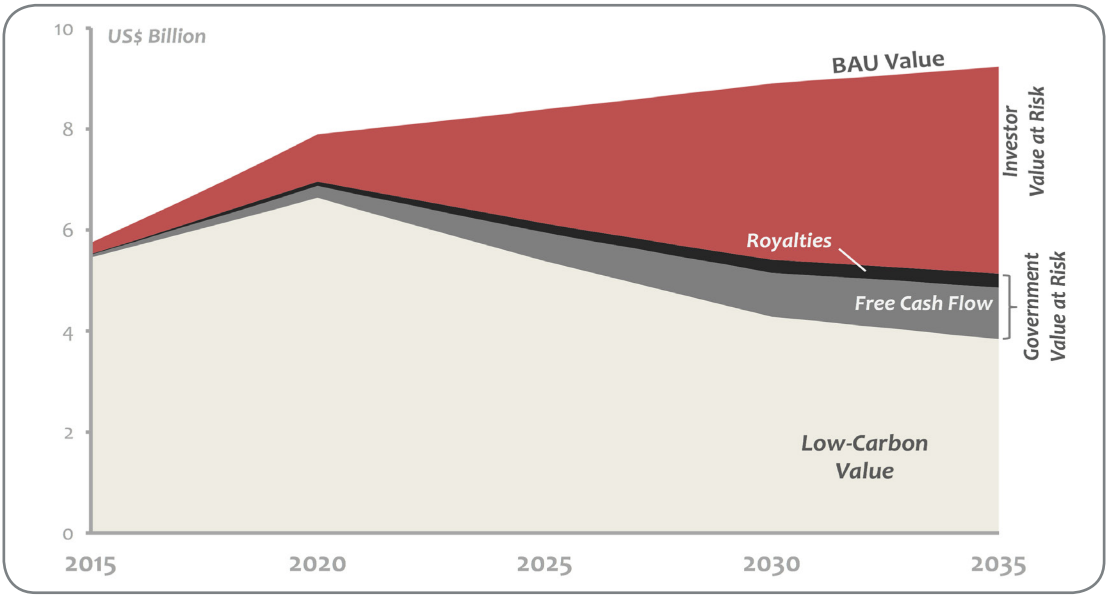


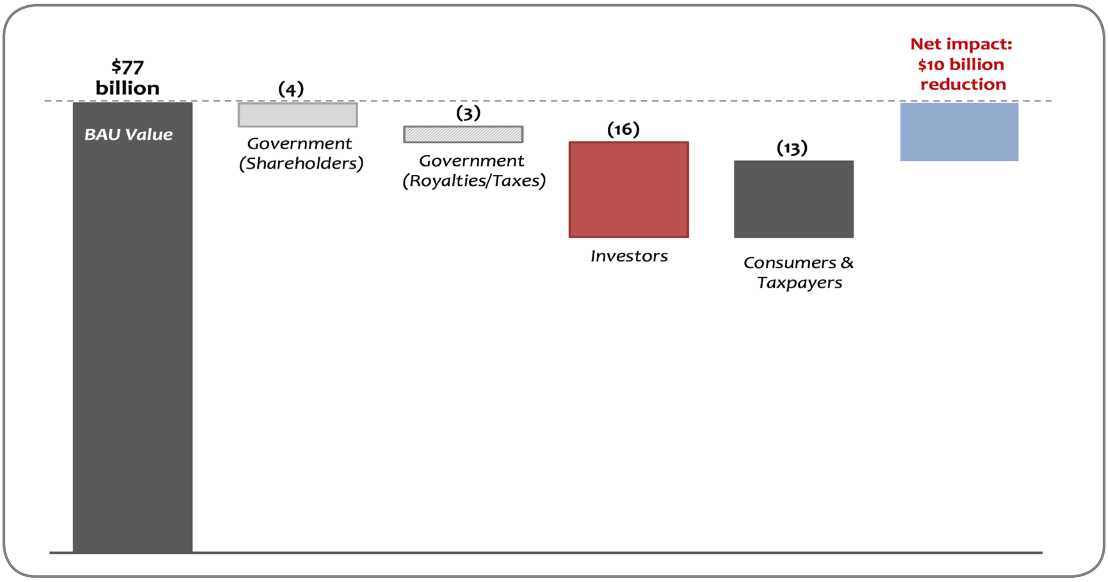
Ukraine

The economic value of coal production in Ukraine falls by 30 per cent (equivalent to US$ 17 billion) from BAU levels in the low-carbon scenario. Due to the effect of royalties, the government's value at risk is slightly above its 50 per cent direct-ownership share of the industry – with revenues reduced by US$ 9 billion compared with US$ 8 billion for investors, as Chart 14 shows. An estimated US$ 12 billion benefit to consumers results in a net US$ 5 billion cost to Ukraine, to be split between the government, consumers and taxpayers.

Ukraine, like Poland, has not historically been a major coal exporter, typically exporting limited amounts of coking coal. Since the ongoing conflict in Ukraine began in 2013, a sharp fall in coal production has resulted in the country becoming a net importer. The primary coal-producing area is in eastern Ukraine, where the fighting has been concentrated and continues to disrupt industrial activity. All the

Chart 15: Kazakhstan coal: change in projected economic value from BAU to low-carbon scenario



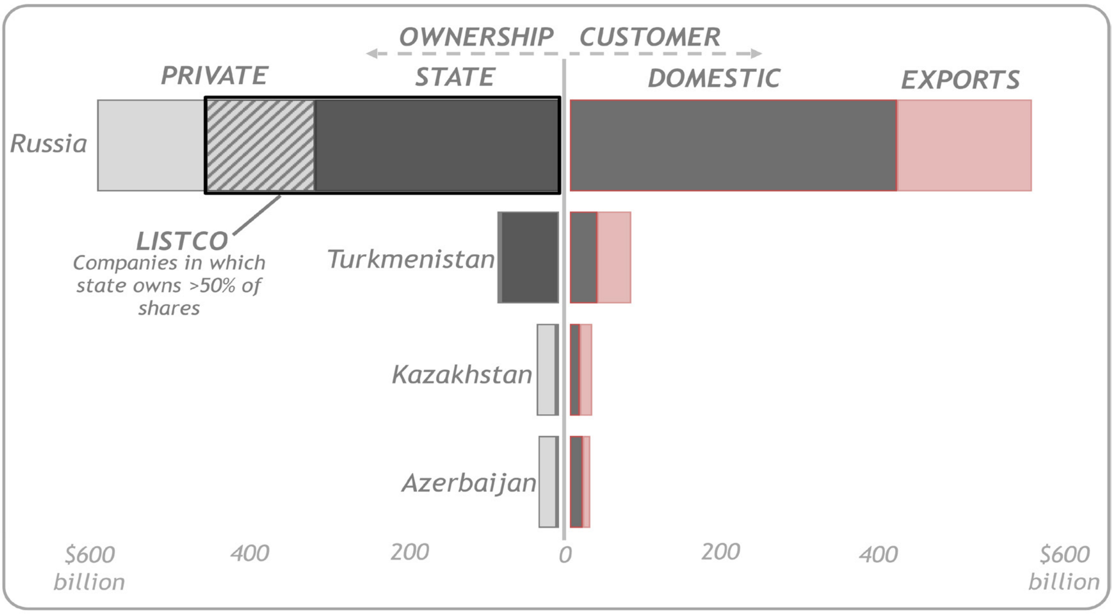


estimates presented in this report assume that production levels will recover to pre-2013 levels in two to three years, but if disruptions continue these estimates may not be appropriate, particularly in terms of private investors (such as DTeK), since they dominate production in eastern Ukraine.

Kazakhstan

Shortly after gaining independence in 1991, Kazakhstan began the process of privatising its coal industry in response to a sharp decrease in productivity from the coal sector, which was under full state control. Today, 80 per cent of the coal sector is privatised, with the government retaining direct involvement through a 50 per cent ownership interest in Bogatyr Access Komir (through the state-owned electricity producer Samruk Energo), which produces 40 per cent of the country's coal. The residual involvement of the state through Samruk Energo is primarily due to the strategic importance of coal to the power sector, where coal power supplies 80 per cent of electricity demand.

Chart 16: Gas production value by owner and customer



Under the low-carbon scenario, government revenues fall by US$ 7 billion through a combination of reduced royalties from private producers and falling revenues from Samruk Energo's shareholdings. With Russia being the main export destination for Kazakh coal, there will be pressure on Kazakh coal exports in the low-carbon scenario, as more Russian production is stranded and potentially redirected towards domestic consumers that take coal deliveries from Kazakhstan.

3.3 Gas

While natural-gas resources are as diverse as oil resources, once the gas is processed and the impurities and liquid hydrocarbons removed, natural gas is much more homogeneous. The complications for gas arise from the difficulty in transporting a gas rather than a solid or liquid. Gas can be transported either through pipelines, or by compressing it into a liquid and shipping it. Either way, transport can be very expensive; thus, like coal, gas falls into either local markets, where pipeline gas dominates, or markets where liquefied natural gas (LNG) enters and can help set the price. For instance, whereas North America is a regional market dependent upon local prices, Asia is mostly an LNG market. Europe, in contrast, is a combination of both, where local and long-distance gas from Russia competes with LNG. Approximately 10 per cent of global gas is transported as LNG, but a further 15-25 per cent of gas is delivered to markets where LNG affects the price. Since the cost of liquefaction is high, significant price differentials can exist between markets where LNG sets the price and those where internal dynamics set the price. For instance, in the United States, gas prices are currently 77 per cent and 84 per cent below the respective European and Asian LNG prices. As with coal, local producers benefit from the higher cost of imported (LNG) gas and are also less likely to be affected in a low-carbon scenario.

One of the most important issues with gas is that it lies at the intersection of several fossil fuels. Gas can be used in power generation and heating, and therefore is a major competitor to coal. In fact, in the medium term, in many markets gas demand could grow under a low-carbon scenario, replacing coal in markets such as China and India and, due to its lower carbon content, helping to reduce carbon emissions. Gas also competes with oil in heating, power generation and transport, while gas and oil reserves are often contained within the same reservoirs and are exploited by the same companies.

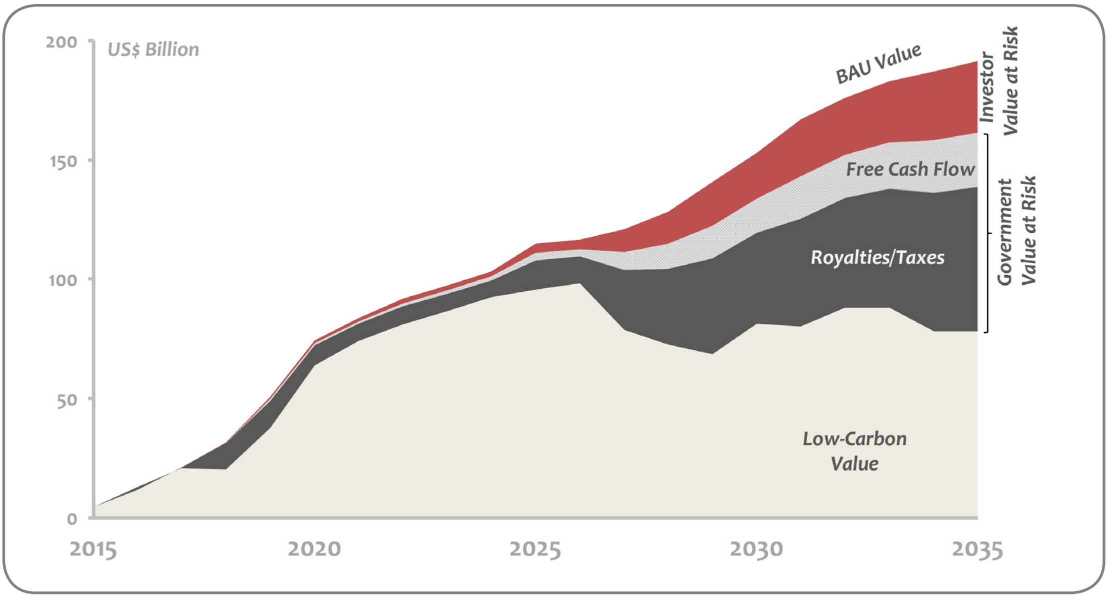
High transportation costs mean that local markets are somewhat insulated from international market dynamics. Two-thirds of gas is consumed in local markets, but LNG and long-distance pipelines can influence costs. This configuration means that gas markets are segmented into three major price zones (the Asian LNG market, the North American gas market, and the Continental European/ UK gas market), which are unlikely to converge because of transportation costs and infrastructure limitations. The pre-existence of gas export/import infrastructures (pipelines and/or LNG liquefaction plants and regasification terminals), and related long-term gas supply contracts, limit the impact of stranding on exporting countries by ensuring that some of the demand is locked in and that costs are passed on to consumers. The hedge is still imperfect as LNG contracts are typically rather short-term, because long-term supply contracts can be renegotiated, and because gas transport infrastructure can become stranded as well.

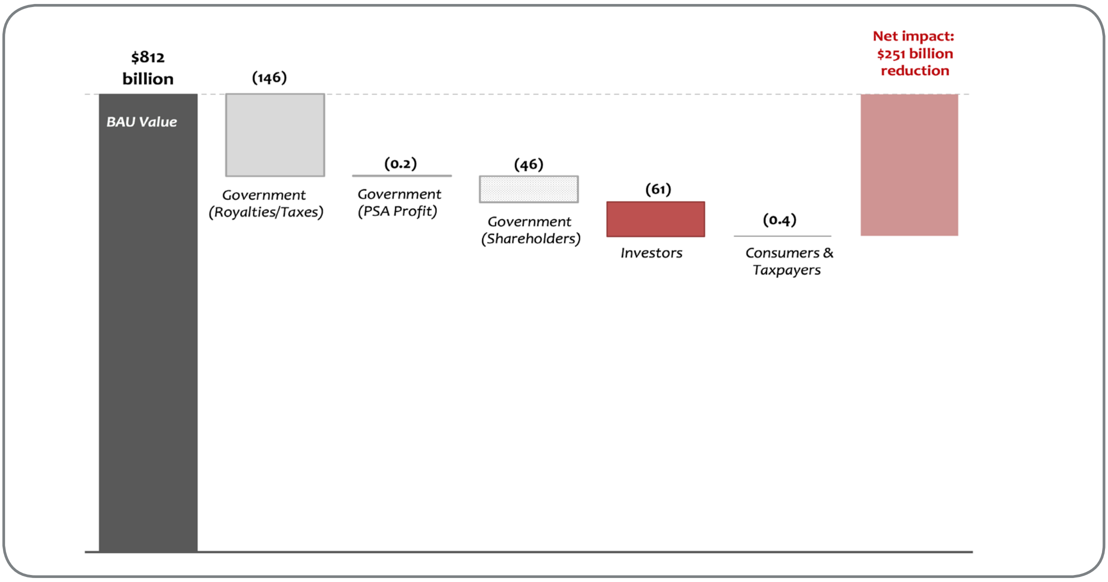
Ownership and production

As is the case with oil, Russian gas production is dominated by publicly traded companies in which the government holds a majority interest. For example, just through the state's shareholding in Gazprom (which produced 73 per cent of the country's gas in 2013), the government has a direct ownership interest in 37 per cent of total natural gas production. Private companies, predominantly foreign oil and gas majors such as Total and Shell, are involved primarily through joint ventures in large projects, such as Sakhalin in the Okhotsk Sea in Russia's Far East and Yamal in northern Russia.

In Turkmenistan, most of the gas fields are onshore and relatively straightforward to operate from a technical perspective. This has allowed the government to retain tight control of gas production in the country through the state-owned Turkmenneftgaz, as foreign expertise is less critical to successful hydrocarbon extraction. China has signed several deals in recent years with Turkmenistan to secure gas supplies, investing in pipeline development and even taking a limited ownership stake through a PSA in some onshore development. The PSA Turkmenistan signed with the state-owned China National Petroleum Corporation for the Bagtyiarlyk field is the first example of foreign ownership allowed by the Turkmen government.

Chart 17: Russia natural gas: change in projected economic value from BAU to low-carbon scenario



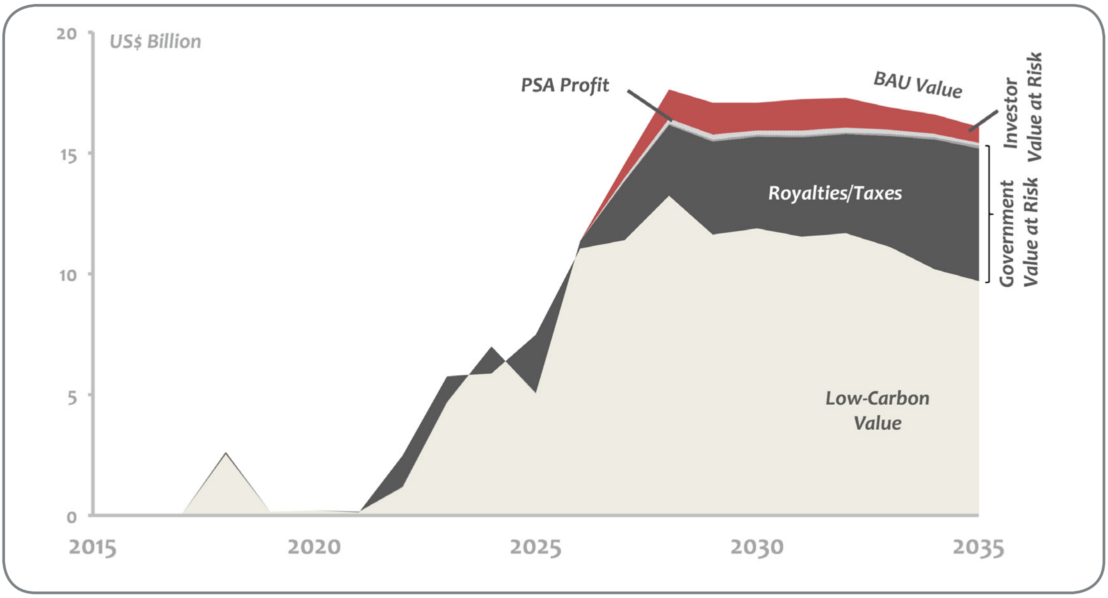


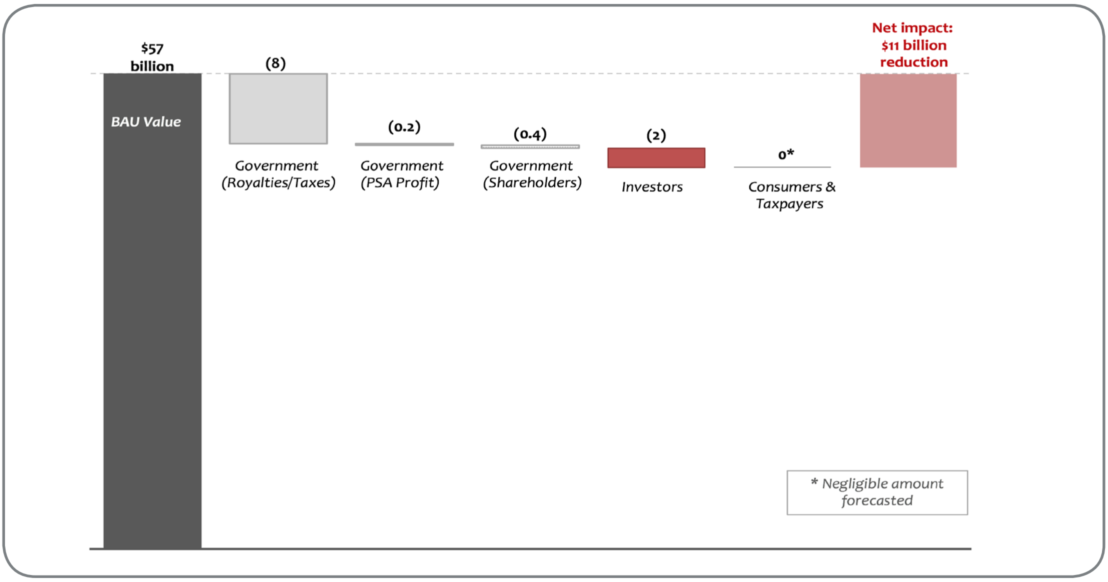
Russia

In the low-carbon scenario, Russian gas production will decline in value, primarily because of falling exports to Europe as well as reduced domestic demand. Although China will become an increasingly important destination for Russian gas in the future as pipeline capacity is built out, today Russian exports are largely directed toward Europe. Russian producers are set to suffer the most as European demand for gas softens post-2025 in the low-carbon scenario.

The Russian government, rather than investors, would be hit hardest in the low-carbon scenario, since the largest Russian gas producers are state-owned and because tax revenues collected by the state would fall with production. According to this modelling, government revenues fall 30 per cent from US$ 650 billion to US$ 458 billion. The benefit to Russian consumers, as is the case with all countries, is expected to be small, since domestic demand will remain constant under both scenarios until at least 2030. The expected net cost to Russia is US$ 251 billion.

Chart 18: Kazakhstan natural gas: change in projected economic value from BAU to low-carbon scenario



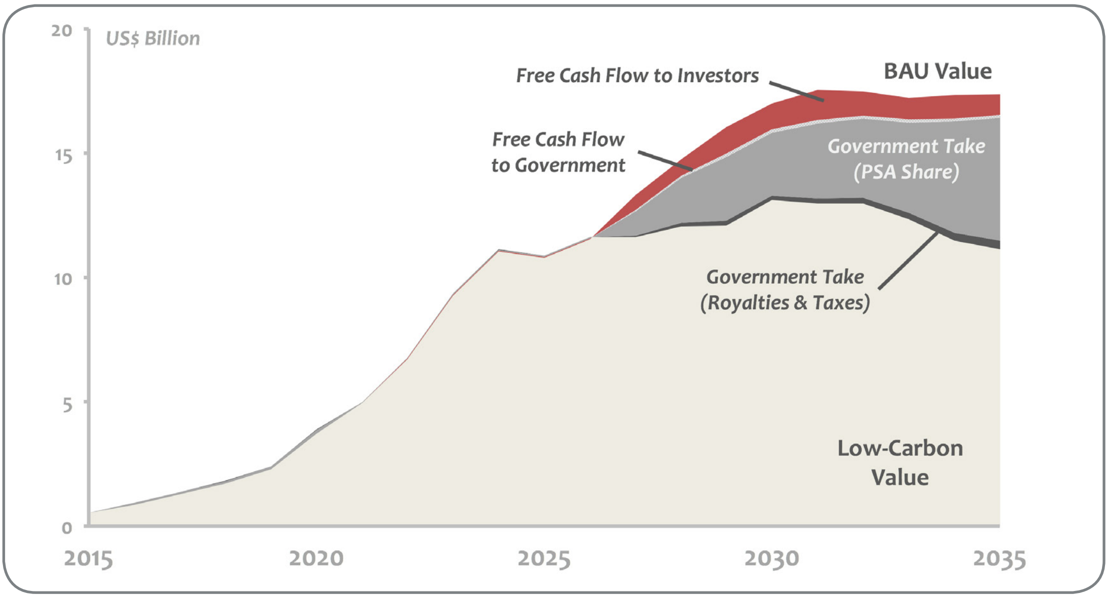


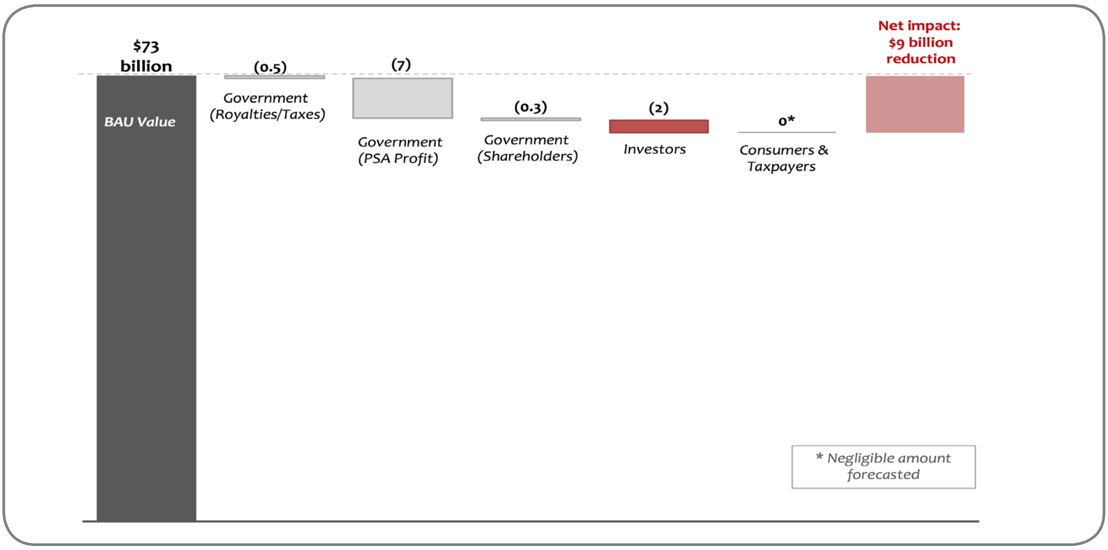
Kazakhstan

A notable contrast between gas and oil in this analysis is how little total economic value differs between the BAU and low-carbon scenarios for gas in all countries. Demand for natural gas remains strong in the IEA's low-carbon scenario until 2025, after which it flattens out through to 2035. The curves for economic value in Kazakhstan's gas sector, as shown in Chart 18, are particularly lumpy from 2015 to 2025 in both scenarios, because significant capital investments are required to bring the Kashagan field fully online in this timeframe. The capital expenses borne by investors[29] in the period are large enough to cancel out the government take from a net economic value perspective. This dynamic is reflected in the net present value amounts in Chart 18, which show government revenues declining by US$ 8.6 billion to US$ 36 billion in 2035.

[29] These are primarily private investors, but the government is also exposed to these costs through Kazmunaigaz's joint venture interests.

Chart 19: Azerbaijan natural gas: change in projected economic value from BAU to low-carbon scenario





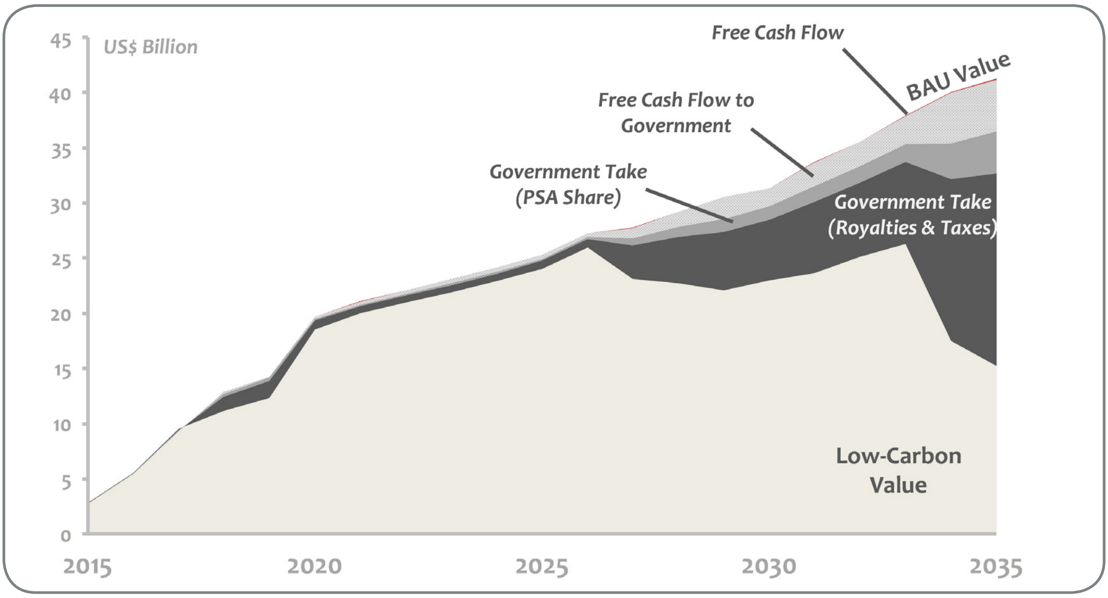
Kazakhstan exports the majority of its gas to Russia through the extensive pipeline network in the west of the country. Over the past decade, several pipeline deals have been struck with China, and the share of Kazakh gas flowing east will continue to rise for several years as construction is ongoing. Although significant volumes of gas have been produced onshore near the Caspian Sea for decades, domestic gas infrastructure from fields in the west to population centres in the east is not adequately developed, so most of the electricity in the country is generated by coal-fired power plants.

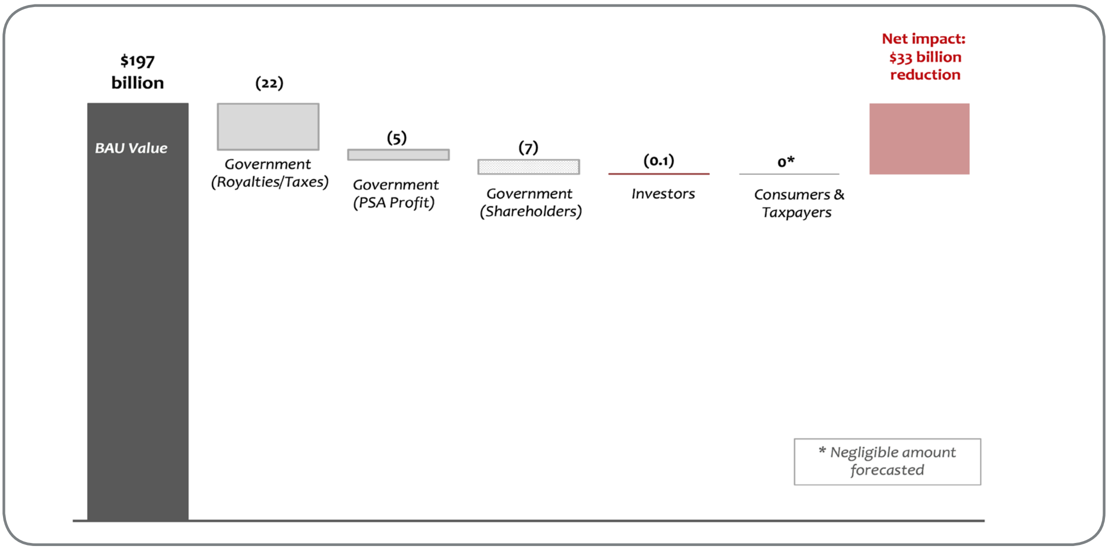
Azerbaijan

Outside of corporate income taxes, which go straight into the central budget, revenues raised from oil and gas extraction in Azerbaijan reach the government through the State Oil Fund of the Republic of Kazakhstan (SOFAZ)[30] via its full-ownership of the State Oil Company of the Azerbaijan Republic (SOCAR). SOCAR

[30] A similar arrangement exists in Kazakhstan, where another national welfare fund, Samruk-Kazyna, controls all state-owned interests in the oil and gas sectors, as well as in many other industries.

Chart 20: Turkmenistan natural gas: change in projected economic value from BAU to low-carbon scenario





raises revenue from producing oil at its own onshore and shallow-water fields, from exports and sales, and its joint-venture interests in the country's large offshore fields. It is also the state's representative in PSAs. Thus, SOCAR pays taxes and royalties on its own fields and transfers gas profits from PSAs into SOFAZ.

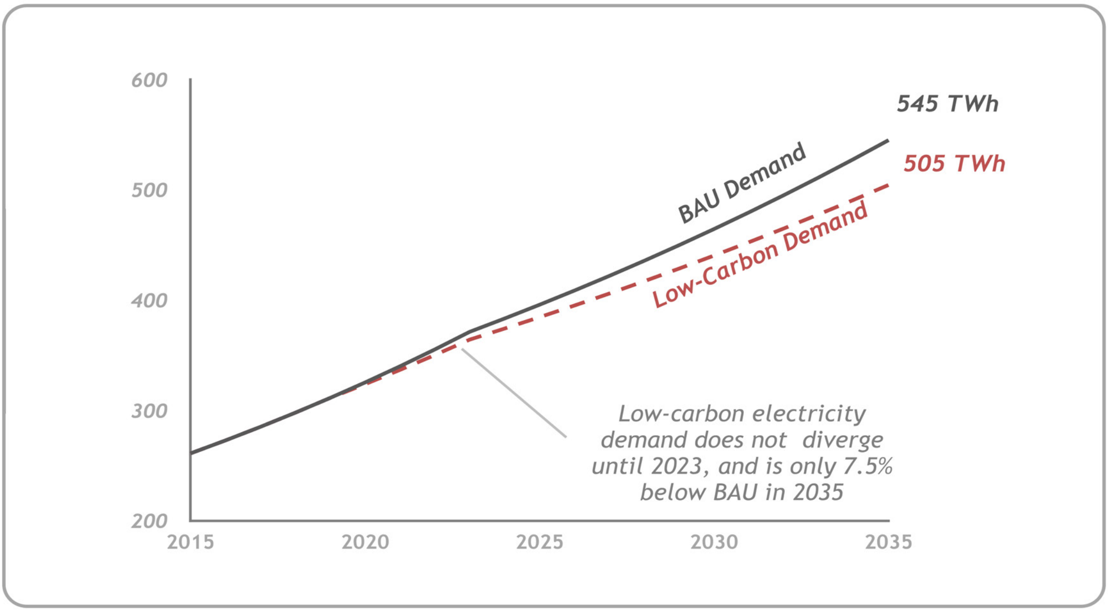
Chart 19 shows the exponential growth in economic value from 2015 to 2025 due to the expansion of the Shah Deniz field. Already responsible for most of Azerbaijan's production, the second phase of Shah Deniz is expected to nearly triple the current output from the field once it reaches its full production in 2018.[31]

Turkmenistan

Gas reserves in Turkmenistan are largely found onshore and are exploited by state-owned enterprises, with the exception of some Chinese

[31] The second phase of Shah Deniz (representing the greatest part of Azerbaijan's exports) is being sold to European utilities under long-term contracts and will be transported via new pipeline projects through Turkey and into southern Europe.

Chart 21: Total electricity demand under BAU and low-carbon scenarios



involvement. Therefore, under the current state of ownership, the government will absorb all of the reduction in economic value under a low-carbon transition scenario. Several major discoveries have been made in recent years, including the discovery in 2006 of the world's second-largest field (Galkynysh), and production capacity will grow rapidly from 2015 to 2035 as new prospects come online.

Today, nearly all Turkmen gas is exported to China through a growing pipeline network (in cooperation with the governments of Kazakhstan, Uzbekistan and China), but from 2020 the exports are expected to expand to Europe[32] and possibly Afghanistan and Pakistan.[33] According to our modelling, the sharp decline in economic value under the low-carbon scenario shown from 2033 can be attributed to a reduction in exports to Europe as a result of falling European demand and more competitive gas suppliers with lower transportation costs than Turkmen gas piped through Russia. This analysis finds government revenues from the gas sector falling by 17 per cent from BAU levels in the low-carbon scenario.

3.4 Power

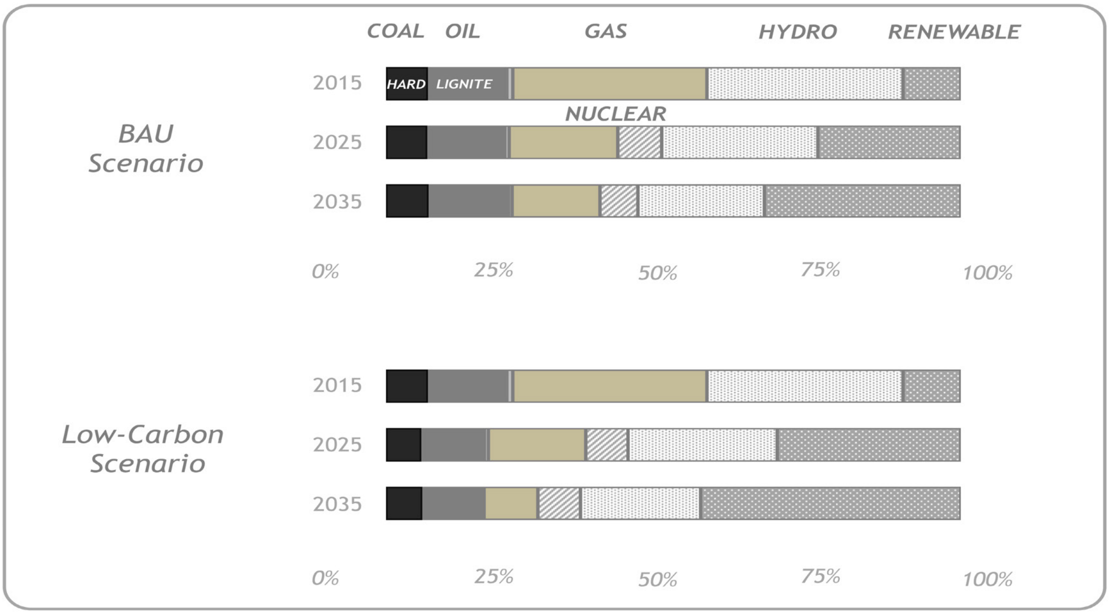
Power plants present very different dynamics from those of commodities discussed in the preceding sections. As manufacturing assets, rather than natural resources, their lives are limited more by age and economics than recoverable reserves. Plants need occasional upgrades and retrofits to extend their lives and maintain their efficiency and competitiveness.

Given the need for natural-gas plants to replace much of the generation from retiring coal plants in the low-carbon scenario, there will likely be no stranding of natural-gas power plants globally through to 2030. However, if natural-gas plants are relied on exclusively to replace coal-plant capacity in the short term instead of as a bridge to a balanced generation mix consisting of a significant share of low-carbon generation technologies, then the valuations of gas plants may be at risk. Conversely, in Turkey, where most electricity is generated from imported natural gas, the government is planning to phase natural gas out of the power sector and develop coal-fired generation in its place, for energy security reasons.[34]

[32] Turkmen gas can currently enter Europe through the pipeline network stretching north into Kazakhstan and Russia, but investors are also exploring options for a subsea pipeline through the Caspian Sea to Azerbaijan and for the pipelines being constructed for the European market (TAP & TANAP).

[33] Gas may reach Afghanistan and Pakistan through the proposed Trans-Afghanistan Pipeline (TAP) (not to be confused with another pipeline project with the same acronym, the Trans-Anatolian Pipeline, being constructed in Turkey).

Chart 22: Turkey power: installed generation capacity under BAU and low-carbon scenarios



Gas prices are expected to converge globally over the next decade as producers begin exporting large quantities of LNG. As LNG becomes more of an international market, like oil is today, foreign demand will have a stronger impact on domestic prices. An unbalanced build-out of natural-gas plant capacity in the short term, both in the developed and developing worlds, could increase demand from the power sector to a point at which gas plants would become less competitive depending on the level of price increases realised. This is a compelling reason for countries with growing electricity demand to diversify away from gas generation in the medium term; although moving to coal generation instead is not desirable from an emissions perspective.

Turkish power

Just as the global market pricing analysis for fossil fuels begins with two alternative demand scenarios, the local market build analysis for Turkish infrastructure requires that a BAU demand case be compared with a low-carbon scenario. The projection for BAU electricity demand is adapted from Bloomberg New Energy Finance (BNEF)[35] data and the low-carbon demand scenario is created from a combination of data from BNEF and official Turkish projections.[36]

Turkish power demand has grown rapidly since 1990 (at a CAGR of 6.4 per cent), in line with an expanding population and strong industrial production. However, BNEF predicts that growth will slow to 3.9 per cent through to 2030 in the BAU case and the estimates adopted in the analysis here are generally in line with that projection.

The modelling does not assume a significant reduction in demand from the BAU to low-carbon scenario, as Chart 22 shows. Even under a hypothetical global agreement on climate change it is unlikely that middle-income growth economies such as Turkey would be expected to make dramatic cuts in demand. In the low-carbon scenario, demand is only 7.5 per cent below the BAU in 2035, and the two scenarios do not diverge until 2023. Instead, the assumption is made that the composition of installed capacity shifts more aggressively toward low-carbon generation in the low-carbon scenario.

[34] Since 2013, the Turkish government has been moving to diversify its power supply away from gas (primarily imported from Russia) towards coal, due to a lack of "alternative stable suppliers and rising concern about the impact of gas costs on the current account deficit". BNE Intellinews (2013), Turkey dumps pricey gas power generation. Available at: http://www.bne.eu/content/story/turkey-dumps-pricey-gas-power-generation

[35] Bloomberg New Energy Finance (2014), Turkey's changing power markets. Available at: http://about.bnef.com/white-papers/turkeys-changing-power-markets/ (subscription required)

[36] Republic of Turkey – Ministry of Development (2014), The tenth development plan (2014-2018).Available at: http://www.mod.gov.tr/Lists/RecentPublications/Attachments/75/The%20Tenth%20Development%20Plan%20(2014-2018).pdf

Chart 23: Turkey power: installed generation capacity by ownership (2014)

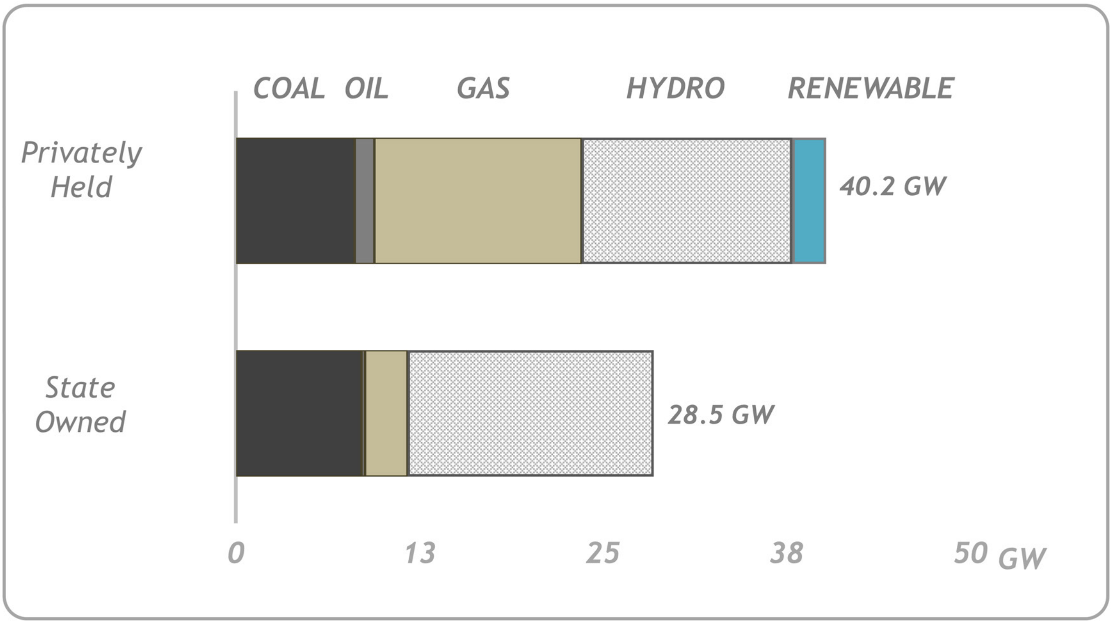
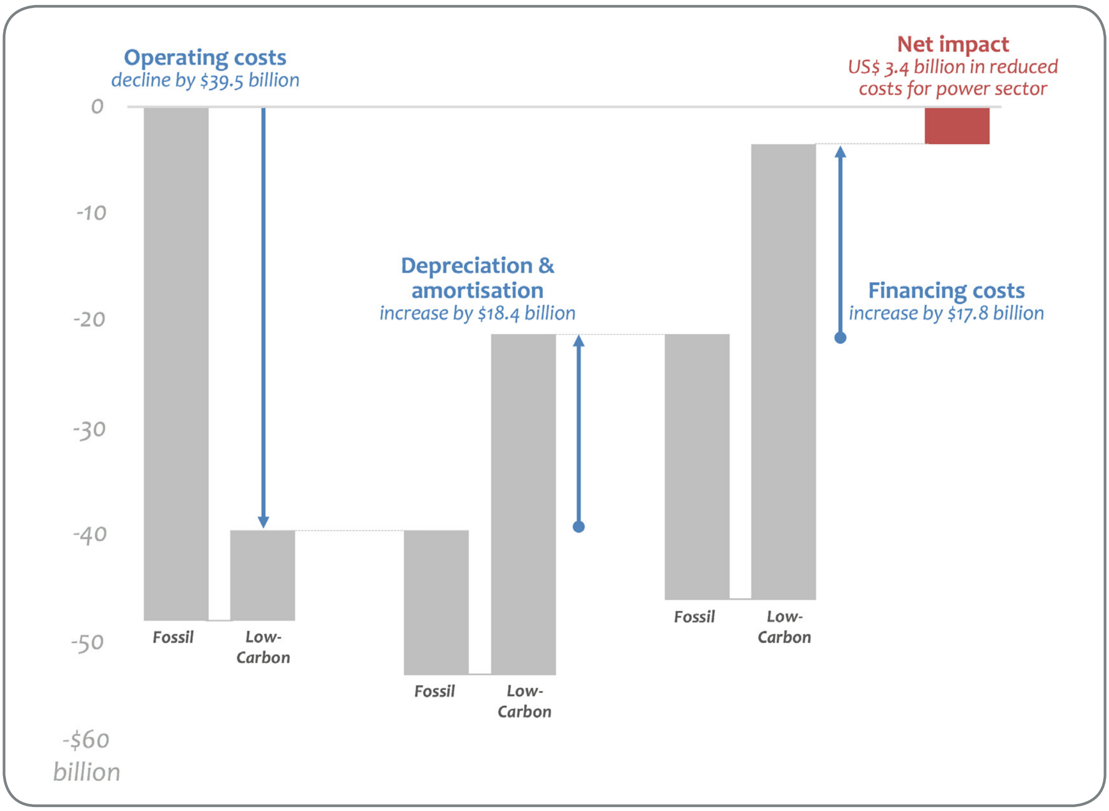


Chart 24: Turkey power: new-build infrastructure costs under a low-carbon transition



There are two key elements that guide the estimation of a transition in low-carbon generation: the Turkish government's policy to increase the share of coal production in the power industry; and equivalent contributions from both nuclear and hydro power in both scenarios. Generally, the generation stack in the low-carbon scenario differs from the BAU case by the share of renewables, and by the balance of coal and natural gas in the share of generation attributable to fossil fuels.

Turkey imports nearly all of the gas it consumes but it does have significant coal reserves. Thus, the government is motivated to move away from gas-fired plants towards coal-fired generation, primarily to increase its energy security through guaranteed fuel supplies and because the coal, particularly the lignite, has limited export value. In the low-carbon scenario, the shift away from natural gas, which is expected to facilitate renewable rather than coal generation, accelerates after 2030. Given the government's stated policy aim to increase reliance on coal generation, the model only assumes a reduction in coal's share of generation of 8 per cent by 2035 under the low-carbon scenario, with 60 per cent of that reduction coming from lignite. To compensate for the decline in gas and coal generation, the low-carbon scenario assumes that non-hydro renewables capture the generation share avoided by fossil fuels.

The state owns 41 per cent of installed capacity, much of which is hydroelectric and coal-fired, but only generates 30 per cent of the country's electricity. Since 2001, the Turkish government has been steadily privatising the power sector and the process is ongoing. EUAS, the state-owned electricity generator, is slowly selling off plants but the government intends to retain control of a number of plants it deems strategically important, such as large hydroelectric facilities. Most of the new power infrastructure in the country is being built by private investors and there is no reason to believe the government will change its policy for the electricity sector by increasing the share of installed capacity it owns through EUAS. Therefore, there will be no direct capital expense required of the government towards funding infrastructure development in the power sector, and over the short term the government is likely to raise additional revenue through the sale of state-owned generation assets. Furthermore, there will be no plants that must be closed early or utilised

less under the low-carbon scenario, considering the assumed demand trajectories and, thus, there is no risk of stranding for the government or private investors in the Turkish power sector between 2015 and 2035.

The low-carbon scenario will entail significant capital investments from the private sector, however; when the reduction in operating costs that comes with the low-carbon transition are factored in, the net impact is a cost saving of US$ 1 billion, as illustrated in Chart 24. These savings will accrue entirely to private investors under the assumption that the government will not be providing capital to the power sector over the study period.

Chapter 4

Conclusions and recommendations for policy-makers

Climate and energy policies enacted at both domestic and international levels as part of the transition to a low-carbon economy can have a pronounced impact on government budgets. Although the value of coal, oil and gas assets, and associated infrastructure, may suffer from reduced valuations as society moves away from these fuels, opportunities will be created around clean technologies and new industries that capture market share in a less carbon-intensive economy. For governments to make the most of this transition and optimise the impacts it has on their national budgets, they must plan carefully around future policy scenarios and put strategies in place that address their key industries and exposures.

1. Careful planning and analysis around low-carbon transition is essential

Policy pathways will affect national budgets differently depending on individual countries' unique circumstances and how they respond to specific assets. Net importers of fossil-fuel assets will be affected very differently from net exporters, and countries with a large share of captive assets will be affected differently from those with greater exposure to global market prices. Therefore, governments must take into account the various strengths and weaknesses of their positions in the market when planning for their transition to a low-carbon economy.

For fossil-fuel producing countries, falling prices may cause substantial declines in budget revenues as global demand for oil, gas and coal softens. These declines can be somewhat ameliorated through effective domestic policy design and planning (for instance, by reducing fuel subsidies and encouraging local cleantech expansion).[37]

Generally, governments should avoid making costly long-term investments in projects that may limit their ability to respond to future policy changes. Most infrastructure assets will remain in use for decades at significant upfront capital costs; avoiding the risk associated with locking in a particular technology or set of assets can save governments over the long term. Private-sector involvement, through ownership stakes or through cooperation in public-private partnerships, and international financial institutions, through lending and advisory services, are useful partners that can help governments manage the transition.

2. Governments need to develop strategies to manage the impact of a transition on natural resources, infrastructure and finance

The analysis, methodology and models developed in this project suggest several strategies that governments can adopt in order to capitalise on the low-carbon transition.

[37] Climate Policy Initiative (2014), *Moving to a low-carbon economy: the impacts of policy pathways on fossil-fuel asset value.*

For oil and gas assets, governments should:

- Commit less capital upfront so that they have more flexibility when responding to policy changes (for instance, structuring production-sharing contracts)
- Evaluate the long- and short-term cost positions of assets and how they might fit into future supply/demand scenarios
- Develop more flexible PSCs, and adapt royalty and taxation regimes to optimise revenues over assets' lives, given the uncertainty around future demand levels. These could include more fixed fees for licences or faster cost recovery, and so on
- Stage investments to adapt to changing mitigation patterns; potentially reduce exploration expenditures where they cost the national budget, or change relationships with commercial explorers in order to reduce government risk
- Manage maintenance capital expenditures in accordance with the changing expected life of facilities
- Position the economy to benefit from lower long-term energy prices
- Reduce long-term reliance on revenues, using proceeds to build alternatives (for example, many countries, such as United Arab Emirates and Saudi Arabia, that have relied on fossil fuels to generate national wealth are hedging their exposure to commodity prices by investing in solar)
- Address the home market: adjust tax regimes to reduce the energy intensity of the domestic economy and use these revenues (from reduced subsidies or higher taxes) to build replacement infrastructure and energy sources
- Seek global agreements that create an organised and transparent withdrawal from fossil-fuel use that will enable more robust planning of investment and maintenance expenditures and timing.

For power, coal and infrastructure assets, governments should:

- Plan a phase-out and decommissioning strategy carefully
- Reduce maintenance capital expenditure to correspond to appropriate asset life
- Identify shifts in value and act accordingly; that is, use resources where they provide the most value

in a transition. The use of coal-fired power plants to provide back-up generation when renewable production is low is a prime example of where carbon emissions can be reduced (by decreasing coal burning each year) while maintaining value (by producing electricity and using coal only in the hours when the non-renewable generation is most needed and most valuable)

- Develop flexibility and transmission resources that facilitate the adaptation of energy systems to lower-carbon generation sources

- For countries where energy demand is growing, develop alternative, low-carbon energy supplies as a matter of priority. Use carbon taxes and other fiscal mechanisms to redirect investment to the new supplies (while encouraging greater energy efficiency).

On the financing front governments should:

- Investigate policy mechanisms and financing schemes with which to access financing in currencies that offer lower interest costs and are currently the source of low-cost financing for international oil and gas

- Seek royalty/taxation schemes (including carbon taxes and resource royalties re-invested by sovereign wealth funds) that facilitate lower-cost financing of alternative energy sources and position the economy to benefit from lower long-term energy prices and strengthen its resilience to increasing power and infrastructure costs.

3. International finance institutions will play an important role

Institutions such as the EBRD have an important role to play in supporting governments to understand, manage and optimise the impact of climate change policies on their budgets. This can be reached through a combination of targeted investments in key sectors and advice regarding the enactment of appropriate policies and regulations.

Finance a diversified, climate resilient portfolio of projects and infrastructure

International financial institutions (IFIs) should promote investments that help economies shift to an environmentally sustainable path, particularly where funding is scarce or significantly more expensive than alternatives. Where the beneficiary is the public sector, the impact on budgets will be immediate; where the beneficiary is the private sector, the impact will come indirectly through a change in the economic structure, which is equally important. Energy efficiency, renewable energy, climate change adaptation, water and wastewater, smart grids, urban transport, regeneration projects and many others would fall into this category.

Promote private-sector participation; support the highest levels of environmental and social conduct

IFIs fund a number of municipal, regional and national infrastructure projects, whose selection should be based, among other factors, on a full assessment of their resilience under a number of climate change policy scenarios. The delivery of “bankable” and financially sustainable projects is of paramount importance if budget shortfalls are to be avoided, and the participation of the private sector in ways that are mutually beneficial to it and to governments can at least partially mitigate governments’ exposure. IFIs can help public authorities, notably the smaller ones, to strengthen contractual relationships, build capacity to attract private-sector agents, adapt concession frameworks and develop new ways to do business, such as performance-based contracts, public-private partnerships or privatisation.

Terms and conditions applied to funding can provide further incentives for firms and governments to improve management standards, raise efficiency, find innovative ways to compete and undertake transparent and environmentally sound procurement processes, all of which help build resilience.

Provide appropriate advice; support an ambitious policy-reform agenda

Promoting the internalisation of environmental externalities and market failures into economies is one effective way to make countries – and government accounts – more resilient, by accruing the true costs of benefits of various economic activities. The EBRD has done significant work to achieve cost-reflective tariffs that also account for environmental costs and benefits, and in promoting carbon markets. Likewise, IFIs have a role to play in helping governments understand the links between economic activity and a low-carbon economy, including fiscal impacts.

Appendix
Special methodological issues

1. Natural resources

Whereas only the captive (or local) market is relevant for infrastructure assets, when evaluating the effect that climate policies have on natural-resource assets, governments must understand the implications of each relevant market – be it global, hybrid or captive. For commodities that trade on global markets, the dynamics between supply and demand that establish commodity pricing is at the core of the methodology for quantifying changes in value under alternative low-carbon scenarios driven by climate change policies. For assets that trade in hybrid and local markets, evaluating the shift in asset value and government allocations is made more complicated by issues such as netback pricing.

Commodity pricing

Changes in policies that affect demand will have an impact not only on the resources that are not produced as a result of the policy changes, but also on prices for the resources that continue to be produced.

In a market, the value of a commodity is determined by supply and demand. An efficient commodity market would rank potential supply sources from the cheapest to the most expensive (including the cost of delivering the product to the consumer). This ranking becomes a supply curve, as shown in Chart 25. For any level of demand, the most efficient market would only take the least expensive products to produce.

Conversely, in commodity markets, the market price is determined by the intersection of the supply and demand curves. The value of a production asset, on the other hand, depends upon its production cost relative to the market price. Thus, by virtue of having lower production costs, the value of asset A in Chart 25 is correspondingly higher per unit of production than that of asset B.

Chart 26 shows the change in asset values concurrently to falling demand. In other words, lower demand would drive down prices to a new market price. Consequently, the most expensive assets (those in the yellow oval on the right side of the figure) would no longer be economically efficient to produce and that implies that they would lose all of their value. Other assets that are less expensive to produce may continue at the same output level, but will likely see a fall in the market price they receive for their output.

The change in commodity prices between scenarios will be determined by the market the assets are sold into. As export commodities are exposed to either global or regional market prices, global policies (or the aggregate effect from all international policies) will have a significant impact on asset valuations for export markets.

Netback[38] pricing and captive assets

We have seen that some assets compete in global markets while others are restricted to local markets – oil markets are the most global, while infrastructure assets are the least. Thus, policy, technology and economic changes in one region tend to affect oil prices across the world, and, through prices, production. On the other hand, infrastructure is mostly affected by regional, national or even sub-national policy. Coal, natural gas and other commodities, such as metals and lumber, fall in between.

For global assets such as oil there is a global netback price; that is, a single price at which producers in every country compete. A single country may have

[38] "Netback" prices represent the effective price to the producer of a natural resource at a particular location; these prices incorporate all the costs of bringing the resource to the market (see note 14).

Chart 25: Asset value dependence on production costs and market price

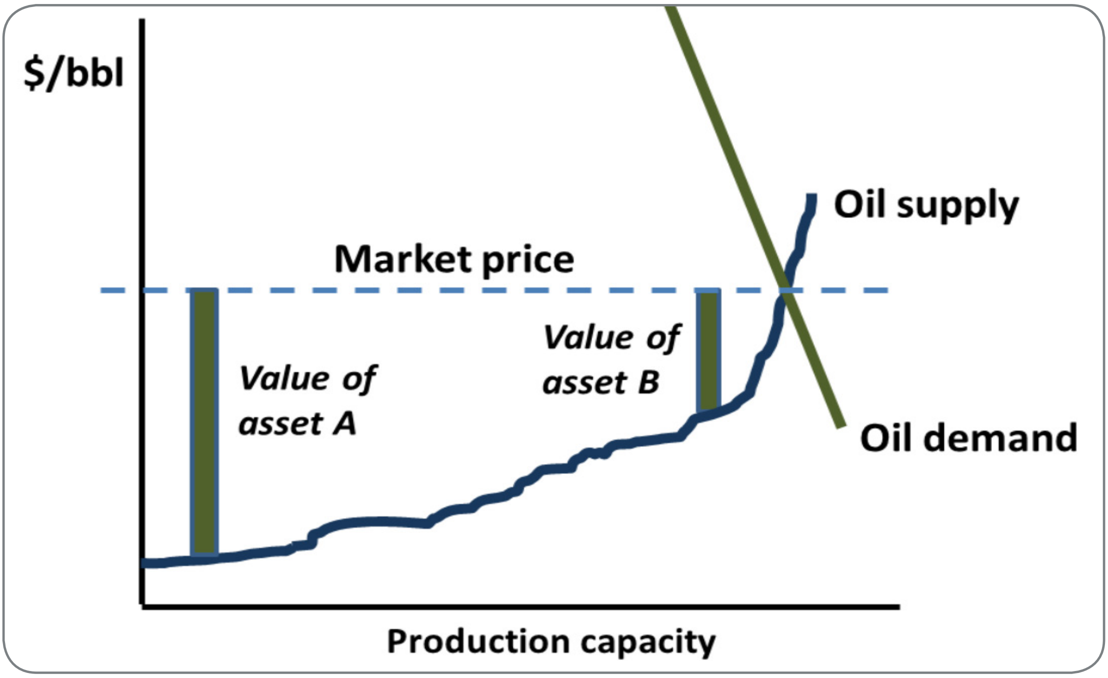


Chart 26: Assets stranded by lower demand and lower prices

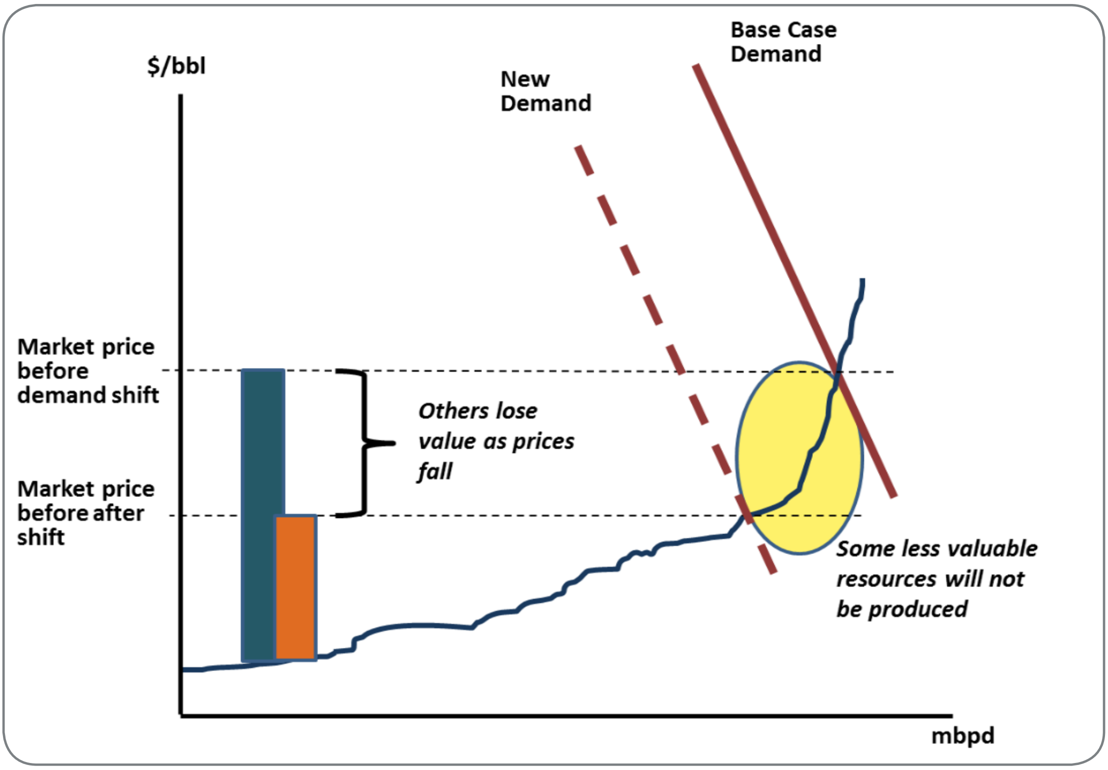
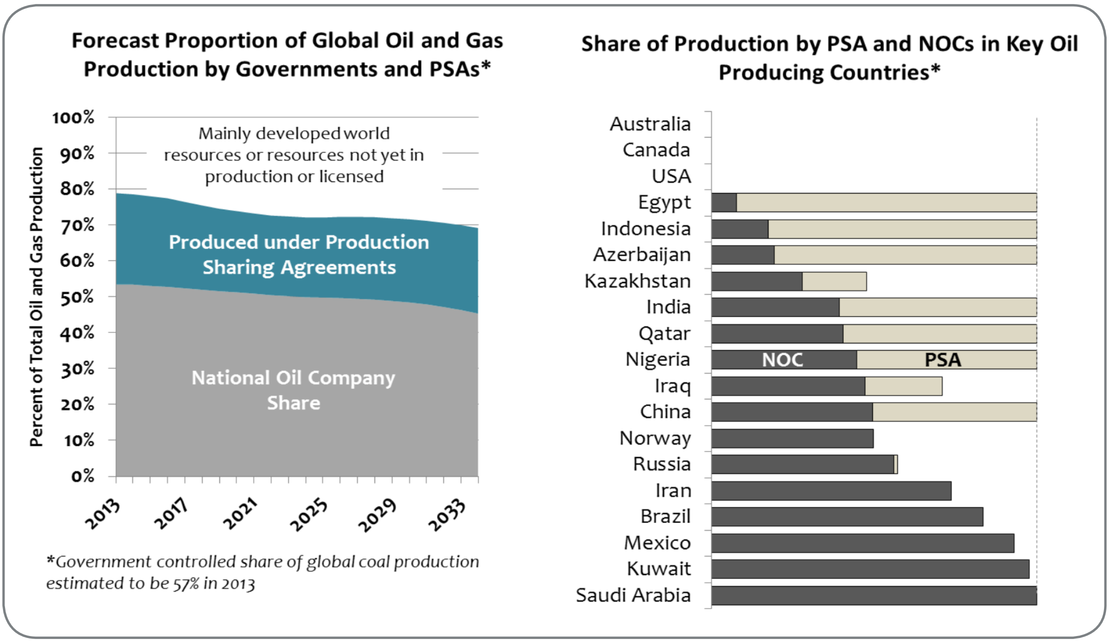


Chart 27: Share of hydrocarbon production under PSAs



to consider several netbacks for one type of asset, such as natural gas sold domestically, that sold internationally through pipelines, and that sold internationally as LNG. Furthermore, the netback may depend on the final use of the asset, such as domestic gas, for which the netback competes with that of imported gas for fuel consumption, and with the electricity price if it is being used in the power market.

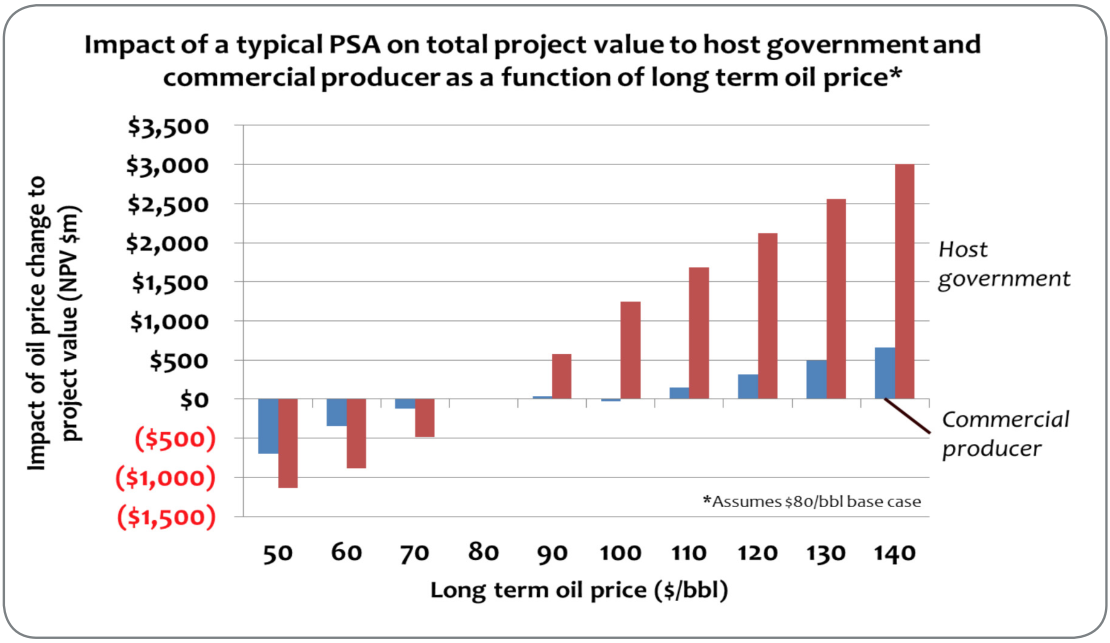
Captive assets, such as power plants, domestic gas and lignite coal, are responsive to domestic and local policies almost exclusively. Therefore, governments have flexibility to manage these assets as valuations change; flexibility they would not have over assets that are driven by global or regional prices. For example, if there is a “mine-mouth” coal power plant that produces power at US$ 20/MWh with no cost recovery (it is not under regulation) in a power market where the netback electricity price is US$ 60/MWh, the government can tax the lignite (producers) or electricity (consumers). The options available to governments to allocate value for captive assets should be considered in steps 4 and 5 of the methodology (as laid down in sections 2.4 and 2.5 of chapter 2), when value is being split between the government, private investors and consumers.

Production Sharing Agreements (PSAs)

For energy resources developed by the private sector, most governments seek to minimise the leakage of value from the government to the private sector. Governments have become very good at developing regulation, contracting, licensing, royalty and taxation regimes that keep most of the value of energy resources for the government. To keep private-sector returns and financing costs at a relatively low level, these regimes typically provide some revenue certainty to private investors, with the result that governments bear a much larger share of the risk of higher or lower energy prices, or higher or lower production volumes. Typical examples include oil and gas production sharing contracts, and power generation built under a regulatory system that provides a fixed return on investment.

Under PSAs, hydrocarbon production is typically split between “cost hydrocarbons” and “profit hydrocarbons”. The first tranche of production is typically allocated to “cost hydrocarbons”, until the producer’s costs have been covered. Any resource that is left (that is, the “profit hydrocarbons”) is then split between the producer and the host government, with the host typically receiving a much larger share. The producer will receive a greater share of the

Chart 28: PSA impacts under varying oil prices



oil production if oil or gas prices fall, or costs rise (including taxes), because costs must be covered first. PSAs de-risk the enterprise for investors and give governments all the upside and risk. Around a quarter of overall global oil and gas production is produced under PSAs, as shown in Chart 27.

The advantage to the overall project is that, since the producer bears less price risk, it will require lower returns, resulting in lower project development costs. In contrast to the producer, the government bears more of the price risk (see Chart 28). Our modelling of typical PSAs shows that, for moderate changes in oil prices, 80-100 per cent of the price and volume risk falls to government budgets rather than commercial enterprises. Of course, this risk is applicable only to PSAs currently in force. Governments face 100 per cent of the value risk for PSAs for assets yet to be developed, as the conditions will reflect the market at that time.

2. Infrastructure

Future climate policy pathways that pursue decarbonisation more aggressively compared with the BAU scenario will demand a different set of future infrastructure investments. The difference in costs between the two alternative sets of future infrastructure assets will have the largest impact on national budgets, but it is not the only transition cost. Existing assets that are not entirely owned by the state may need to be retired early or utilised far less, and the private investors that own those existing assets may be contractually guaranteed certain returns.

As Table 10 shows, the costs associated with constructing new assets or compensating owners of unneeded existing assets ultimately accrues to governments or taxpayers. Although financing for infrastructure projects may come from the private sector, as is the case with build-operate-transfer projects or concessions, these investors are typically protected by contracts that ensure a stream of payments to cover their costs through government or user fees. When investments made prior to a shift in market structure – brought on by utility restructuring or privatisation – lose value as a result of that shift, those investments are said to be “stranded costs”.

In the electricity sector, the issue of stranded costs has come up repeatedly where markets have opened to supply-side competition. Prior to market liberalisation, countries attracted investment in the power sector by offering long-term power purchase

Table 10: Calculating transition costs for new and existing infrastructure

Asset type	Quantify change	Allocate cost
New assets	Calculate the net difference between future infrastructure investment costs in the low-carbon scenario versus the BAU scenario.	Allocate impact between government budget and user fees from taxpayers.
Existing assets	Stranded costs payments may be legally/contractually due to private investors of assets not fully owned by the state (such as regulated assets).	The state can absorb stranded costs or pass them on to consumers through higher tariffs and access costs.

Table 11. Issue identification for infrastructure under a low-carbon transition

Infrastructure class	Issues under low-carbon transition
Power, transmission and distribution	Transmission and distribution networks will need to be upgraded and expanded into new areas to cope with distributed generation and renewable energy far from demand centres. Fossil power will still be central in the developing world until costs of renewables fall further.
Pipelines	Pipeline flows (and royalties) will move with demand for oil and gas, and utilisation rates will fall in some areas. On the other hand, construction of natural-gas pipelines will accelerate in the short term to bring gas to new markets and to established markets in need of new supply to replace coal.
Transport	Investments in a low-carbon scenario may involve infrastructure for alternative vehicles (biofuels, fuel cells, electric) or moves toward mass transit build-outs (such as rail).
Water and sanitation	The issues for water should be similar in BAU and low-carbon scenarios: power generation (even low-carbon) and fuel production is water-intensive, and, as demand for electricity and fuels increase globally, investments will be needed in water recycling and reuse technologies.
Industrial manufacturing (cement and steel)	These industries are heavy emitters through their use of energy and their production processes. Operating costs will rise due to climate policies that increase power costs and the costs of emissions in the production process.

agreements (PPAs) to generators for delivering power to state-owned distribution utilities. The PPAs were structured so that the investors would receive a regulated rate of return that covered their costs and provided for a set level of profit. However, when markets were deregulated, some PPAs were abolished and many of the existing assets previously under contract were too inefficient to compete, and the public sector was forced to compensate the generators (primarily through user tariffs) for the costs they could no longer recover in the new market structure.[39] These revenue guarantee arrangements, such as PPAs and tariffs, should be taken into account when calculating infrastructure costs.

Issue identification by sector

Just as the implications of climate change policies differ for new and for old infrastructure assets, there are unique implications for specific infrastructure sectors as well. Understanding the themes that

[39] For example, during the electricity market liberalisation in Portugal at the end of the 1990s, consumers were forced to refund three energy providers (EDP, Tejo Energia and Turbogas) for investments made in inefficient power plants through public compensation payments. European Commission (2004), Commission authorizes public compensation for stranded cost in Portugal. Available at: europa.eu/rapid/press-release_IP-04-1123_en.htm

will play out in each infrastructure class during a low-carbon transition will help shape the alternative scenarios and sensitivities discussed at the beginning of chapter 3. Table 11 presents a high-level view of the issues that may be relevant for each infrastructure class under a low-carbon transition.

3. Climate change related policies

Low-carbon transition is expected to be costly to governments primarily due to rising expenses and subsidy payments to renewable energy as well as increasing capital investment in other new infrastructure projects. In addition, tax revenues from some extractive industries are expected to fall. However, climate change policies will also create opportunities for governments to raise new revenue streams from carbon taxes and emissions trading schemes. For instance, in California, revenues generated from the state's emissions trading programme in 2014 were US$ 969 million – considerably higher than anticipated.[40]

Direct impacts on government spending and income from changing tax regimes and subsidy structures are easy to track, but these effects only reveal part

Table 12: Budgetary considerations for selected climate change policies

Climate change policy	Description	Benefits and drawbacks for national budgets
Carbon tax	A price-based instrument that places a per-unit emissions tax on all carbon-emitting sources.	**Benefit:** Creates a new revenue stream and offers investors (including government) price certainty. **Drawback:** Potentially regressive in terms of energy expense as share of annual income[41] (a tax would cause costs to rise for all consumers equally but has a greater effect on low-income households, depending on how revenues are used). Tax revenue from carbon-intensive industries without access to capital for efficiency improvements may decline.
Emission trading (cap-and-trade) schemes	Schemes that set a cap of allowable emissions for various sectors of the economy and allocate permits for emitting sources.	**Benefit:** Offer flexibility to industry and the lowest abatement costs for a given level of environmental benefit if built correctly. Revenues raised through auctioning emission rights and fining participants for non-compliance. **Drawback:** Require more resources to run than tax schemes due to the complexity involved (hard to ensure fair dealing and proper allocation of permits).
Feed-in Tariffs (FiTs)	Guarantee a price for renewable-energy facilities on long-term contracts to accelerate renewable deployment.	**Benefit:** Attract clean infrastructure investment into the power sector. **Drawback:** They often effectively act as subsidies – particularly if the counterparty (often the government) pays more for power if the FiT is above market prices.
Low-carbon subsidies	Subsidies reduce the cost of low-carbon development and come in many forms (loan guarantees, tax breaks, tradeable energy certificates, etc.)	**Benefit:** Can be directed at specific projects/sectors, and can be used to encourage innovation and foreign investment that may bolster future revenue. **Drawback:** Expenses increase or revenues are avoided in all cases; government share depends on the specific mechanism and industry structure.

[40] *Sacramento Business Journal* (2015), "At nearly $1 billion, cap-and-trade revenues last year blew past predictions". Available at: http://www.bizjournals.com/sacramento/news/2015/03/27/at-nearly-1b-cap-and-trade-revenues-last-year-blew.html

[41] Dinan, Terry, (2012), "Offsetting a carbon tax's costs on low-income households", Congressional Budget Office, Working Paper 2012-16. Available at: https://www.cbo.gov/sites/default/files/cbofiles/attachments/11-13LowIncomeOptions.pdf

Table 12: Budgetary considerations for selected climate change policies (continued from p.62)

Climate change policy	Description	Benefits and drawbacks for national budgets
Fossil-fuel taxes	Consumer taxes aimed at carbon-intensive fuels in order to increase prices and reduce consumption.	**Benefit:** Create new revenue streams in the short term (when prices are inelastic), and change investment patterns in the long run. **Drawback:** Reduced consumption may negatively impact SOEs involved in fossil-fuel production.
Green banking and loan guarantees	A large range of financial mechanisms can be used by governments to create an attractive environment for private investment by lowering investment costs or risk.	**Benefit:** Attract private investment to augment government spending and distribute risk, and create a larger corporate tax base. **Drawback:** There are costs involved in establishing and managing these programmes, and a potential for losses on investments.
Removal of fossil-fuel subsidies	Instruments used widely to reduce consumer costs for fossil fuels. **(Included in this list as an option for governments to eliminate.)**	**Benefit:** Removing subsidies reduces expenses, freeing funds that can be distributed to other economic sectors or back to taxpayers. **Drawback:** Similar to implementing fossil-fuel taxes, SOEs and domestic consumers may be negatively impacted by rising prices.

Sources: International Energy Agency's Addressing Climate Change Policy and Measures
Database: http://www.iea.org /policiesandmeasures (last accessed 1 September 2015); Inter-American Development Bank (2012), *The Role of Green Fiscal Mechanisms in Developing Countries: Lessons Learned*. Available at: https://publications.iadb.org/handle/11319/5433?locale-attribute=en (last accessed 1 September 2015).

of the picture. Many of the impacts that climate related policies may have on national budgets come from second- or third-order effects that require a full general equilibrium model analysis to estimate. For instance, policies that implement financial mechanisms to encourage private-sector investment do not themselves alter government revenues or expenses (ignoring programme management costs), but the investments they foster may expand the tax base and spur job creation, which in turn creates more tax revenue.

As is highlighted in Table 4 (chapter 2), the development of alternative scenarios and sensitivities requires taking into account particular climate change policies, which are further presented in Table 12 in the context of their possible effects on national budgets. Although the methodology developed in this report does not specifically attempt to capture the indirect effects described in Table 12, it is important to identify the issues surrounding these policies for further analysis.

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