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Financing clean power: a risk-based approach to choosing ownership models and policy/finance instruments

Working Paper

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A CPI Report

Acknowledgements

This working paper is part of a program of work for the Advisory Finance Group (AFG). We would like to thank AFG members, and other investment/development finance professionals, for their valuable contributions and insights.

We thank CPI staff members Felicity Carus, Brendan Pierpont and David Posner for their editorial and analytic contributions to this study.

We are grateful for funding for this work provided by the Hewlett Foundation and the Rockefeller Brothers Fund. The findings of the report are those of the authors, and do not necessarily reflect the views of these foundations.

Descriptors

Sector	Power generation, Electricity	
Region	Global	
Keywords	Risk, public finance, electricity generation	
Related CPI Reports	Flexibility: the path to low-carbon, low-cost electricity grids Overcoming barriers to institutional investments in renewables European Renewable Energy Policy and Investment	
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About CPI

Climate Policy Initiative works to improve the most important energy and land use policies around the world, with a particular focus on finance. An independent organization supported in part by a grant from the Open Society Foundations, CPI works in places that provide the most potential for policy impact including Brazil, China, Europe, India, Indonesia, and the United States.

Our work helps nations grow while addressing increasingly scarce resources and climate risk. This is a complex challenge in which policy plays a crucial role.

Executive Summary

The case for public versus private finance of power investments can be highly political, but behind the politics lie real costs and benefits to each model that suggest the choice should be tailored to each specific set of circumstances. We argue this debate is not simply about choosing between public or private finance. Rather policy-makers and investors should ensure each different investment risk (eg, construction, price) is allocated according to whether private investors, public entities or consumers are best placed to manage, understand and bear it. This allocation of risks can be achieved through a blend of ownership models, policy, regulation and specific finance instruments.

This report is the first step in establishing a framework for choosing the right ownership models and policy/finance instruments which has "risk allocation" at its core. It is aimed at policy-makers (eg, energy and finance ministries, regulators) and development banks, who play an active role in setting policies and deploying public finance. It is also aimed at private investors with an interest in where public finance and policy should (and shouldn't) play a role in transferring some of the risks for their investments. We show how for different energy technologies and country contexts we can:

- assess the ideal allocation of each risk; and
- choose a blend of ownership models and finance/policy instruments to achieve this allocation.

The following is a short summary of this project, which is part of a program of work for the Advisory Finance Group (AFG)[1].

There is a growing trend towards private finance. But not all risks are best left with private investors…

Over the last three decades, there has been a general trend towards privatization of the energy sector, particularly in developed countries (see Table 1). This trend has brought a corresponding transfer of risks towards private investors, particularly in parts of the market where competition is possible such as electricity generation. At present, state-owned entities own just under half of global installed electricity generation capacity. In general, the level of state-ownership is greater in less developed countries.

The growing preference for private investment is understandable given large pressures on public sector budgets, and evidence that competitive private markets can deliver cost efficiencies. But some risks are still better managed by governments or development banks, or transferred to consumers. If we ask private investors to manage risks they are not well-placed to manage or understand, the investment may only be financeable at a high cost of capital, or may not happen at all. Ultimately, this higher cost of capital increases customer bills and/or drags on public budgets.

So what is the right way to think about public versus private finance of energy?

Allocating risks correctly is fundamental to lowering the costs of the low-carbon energy transition…

The approach we are developing at CPI Energy Finance is to consider the right allocation of *each specific risk* for a power generation project. These risks include those around costs (eg, construction, operational) and revenues (eg, price, currency). For each risk we need to determine who can bear the risk at the lowest cost. That is, can the risk be managed at a lower cost by private investors, public entities (and ultimately taxpayers) or by passing-through the risk to consumers via their bills?

By ensuring each risk is allocated to who is best placed to manage, understand and bear it, the overall risk of an investment can be reduced along with the cost of financing it. Which in turn minimizes the overall costs of a given investment (operating costs, capital costs and financing costs).

The right allocation of a given risk varies depending on the nature of the investment, in particular:

- **Technology type**. The differing nature of power generation technologies means their owners have differing abilities to manage risks. For example, there is a strong case for private owners of flexible generation types (such as CCGTs) bearing price and curtailment risk, as this encourages them to dispatch flexibly to meet demand. Price risk also encourages fuel based generators to optimize their fuel purchase and contract strategy, as well as plant efficiency, to remain

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[1] The Advisory Finance Group (AFG) is a network of individuals who have served as senior level officials in both the public and private sectors, and is designed to analyse and shape policy and investment choices presented by climate risk. The AFG is designing and publicizing research that explores the productivity effects of efficient public investment in new technologies to facilitate systemic transitions in the energy, transportation, and agriculture sectors.

competitive and reduce risk. But there is less to gain from exposing private onshore wind investors to price and curtailment risk. They can only generate when the wind blows and they have no fuel cost or contracts. So exposing them to price and curtailment risk does little to promote efficient dispatch and operating efficiencies, once the siting decision is made. But it does raise the cost of capital.

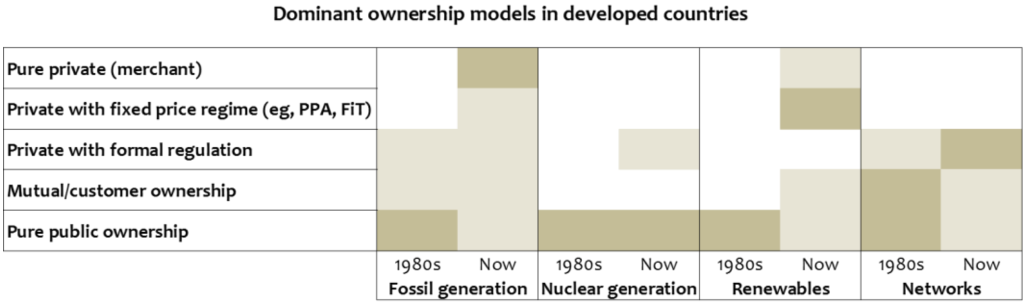
- **Country context**. The relative ability of private and public entities to manage different risks varies across countries. For example, some countries such as India, land acquisition can be difficult for private investors to manage due to bureaucratic and politicized planning rules, while grid connection can be subject to unpredictable delays. In these contexts, public entities may be better placed to navigate these issues, reducing delays, costs and risks. This is one of the reasons why state financed "solar parks", such as those in Gujarat, are starting to sprout[2].

The first step is the assess the ideal allocation of each risk given the technology and country context (Section 2 explains this process in detail). The next step is to assess how to achieve this ideal allocation.

The choice of ownership model (eg, state, PPP, private merchant) gives a basic allocation of risks…

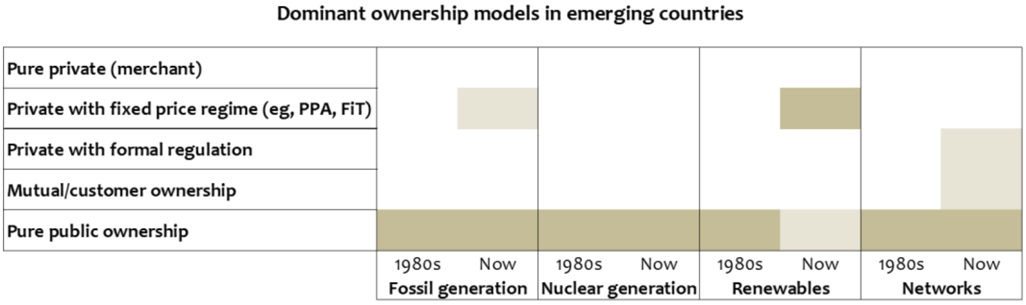
The choice of ownership model has a major bearing on how risks are allocated. There is a spectrum of different ownership models that can be used for infrastructure investments (see Table 1).

Table 1. Ownership models for power generation and network investments



Dominant ownership models in developed countries

	Fossil generation		Nuclear generation		Renewables		Networks	
	1980s	Now	1980s	Now	1980s	Now	1980s	Now
Pure private (merchant)		▓				░		
Private with fixed price regime (eg, PPA, FiT)		░				▓		
Private with formal regulation	░	░		░			░	▓
Mutual/customer ownership	░	░				░	▓	░
Pure public ownership	▓	░	▓	▓	▓	░	▓	░



Dominant ownership models in emerging countries

	Fossil generation		Nuclear generation		Renewables		Networks	
	1980s	Now	1980s	Now	1980s	Now	1980s	Now
Pure private (merchant)								
Private with fixed price regime (eg, PPA, FiT)		░				▓		
Private with formal regulation								░
Mutual/customer ownership								░
Pure public ownership	▓	▓	▓	▓	▓	░	▓	▓

These ownership models vary in the extent to which risks are transferred to taxpayers or consumers. Through a *pure private ownership* model we can privatise most of the risks (eg, construction, operational). While through *direct public ownership* most risks can be transferred to taxpayers (and consumers). Then there are many intermediate options. For example, *economic regulation* offers a wide range of options for sharing different cost risks between private investors and customers. Models with private finance but under *a fixed price regime* (eg, FiTs or fixed price PPAs) typically transfer price risks away from the private investors, but leave them bearing most of the cost risks.

To the extent policy makers have a choice on the ownership model for a technology (often the prevailing market structure will restrict the options) we need to pick one which most closely matches our ideal risk allocation. However, these generic ownership models will often leave "gaps" between the actual and the ideal allocation of risks.

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[2] Sites in these parks, with planning permission and grid connection already secured, are then sold to different private developers who do not need to bear the development risks.

Specific policy & finance instruments can then "fine tune" to the ideal pattern of risk allocation…

Specific policy and finance instruments can be used to plug these "gaps" and transfer specific risks. Instruments can be broadly categorized into four groups:

- **Public finance instruments** include grants, equity co-finance, insurance and guarantees provided by governments and development banks. These are justified where one or a number of risks are best managed and understood by the public sector (and taxpayers). For example, policy risks are typically best understood and managed by public entities and can be transferred away from private investors through policy risk insurance and guarantees.
- **Government contracts** can shift and share risks between private investors and taxpayers . Again, shifting risk away from private investors is justified where a risk is best managed and understood by public entities.
- **Regulatory instruments** can also work to allocate risks in different ways between private investors and customers. These are justified where private investors are not well-placed to bear a risk (eg, if the risk drivers are outside of their control). In particular, where generation or networks are subject to economic regulation, the incentives and revenue allowances can be set up so that some or all of the cost changes private investors experience can be passed through to consumers in their tariffs.
- **Policy mechanisms**. Many policy mechanisms also have the effect of transferring risks away from private investors and, again, are justified where these investors are not well-placed to manage, understand and bear the risk.. In particular, price risks can be transferred through mandated fixed-price Feed-in Tariffs (FiTs), with the costs of these recovered from customer tariffs.

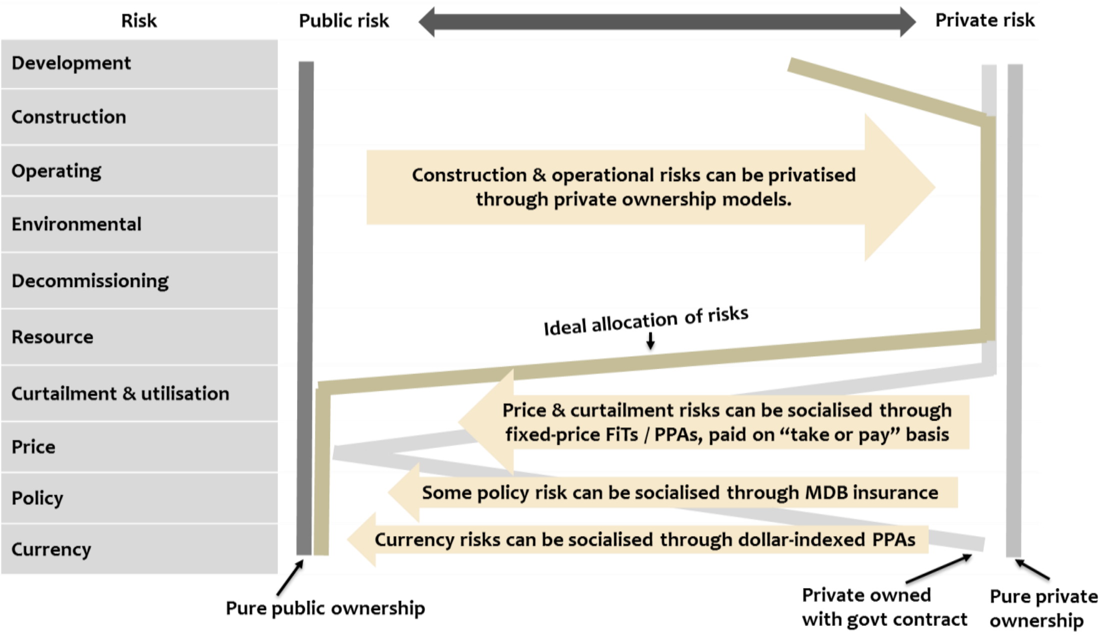
There is a very broad menu of instruments to plug the risk "gaps". We can identify the most appropriate instruments from this menu and then evaluate the impacts before selecting them.

We have developed a framework to help finance/energy ministries and development finance institutions (DFIs) evaluate the right blend of ownership models and finance/policy instruments…

Putting the above process together, we have developed a simple four-step framework for choosing ownership models and finance/policy instruments for energy investments:

1. **Identify the key risks** and their impact, given technology type and country context. The left hand column of Figure 1 below shows the key risks for a solar investment in an emerging country.
2. **Assess how the risks should be allocated** between private investors, taxpayers and consumers (the beige line in the figure below). This assessment should be based on analysis of who is best placed to manage, understand and bear the risk and (ideally) a quantification of the impacts of different allocations on financing costs, cost/operational efficiency and transaction costs.
3. **Choose the most appropriate ownership model** (grey lines). This should be based on which ownership model provide the closest match to the ideal risk allocation.
4. **Identify and select finance and policy instruments** to "fine tune" the desired risk allocation (yellow arrows. This is based on analysis of where risks remain "misallocated" and impact assessments of instruments to "correct" these allocations.

Figure 1. Illustration of achieving the 'ideal' risk allocation for a solar investment in an emerging country



A strategic approach to selecting which risks are financed by the private sector versus the public sector could lead to large savings in the overall costs of the energy transition. In two case studies we analyzed, we found that cost savings of 10-40% could be achieved. In particular, we found that significant savings could be achieved from reallocating development, price, offtake and curtailment risks. This suggests that these risks, and the instruments that can be used to transfer them, should be a focus for future work.

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1. Introduction

Energy is expected to account for around US$25 trillion of investment between 2015 and 2030, with US$8.5 trillion of this in electricity generation and $4.0 trillion in electricity transmission and distribution[3]. This paper considers who is based placed to make these investments, and more specifically, how the different risks associated with these are best allocated between private investors, taxpayers and consumers.

1.1 The changing investment environment for energy

At present, state-owned entities own almost half of global installed electricity generation capacity. In general, the level of state-ownership is greater in less developed countries: in India the ratio is two-thirds and in China 60% compared with 45% in the EU, 25% in Japan and 20% in the United States. The level of state-ownership is greater for fossil, nuclear and hydro generation (50%) compared with non-hydro renewables (30%)[4].

Over the last three decades, there has been a general trend towards privatization of the energy sector, particularly in developed countries. This trend has brought a corresponding transfer of risks towards private investors, particularly in parts of the market where competition is possible such as electricity generation. This trend towards private ownership is continuing, in particular through the proliferation of auctions for renewables contracts around the world. These auctions provide a route for private investors to enter markets dominated by state-owned incumbents.

This trend towards private investment is understandable given governments' desire to promote competitive markets and the large pressures on public sector budgets. Moreover, in many cases, private investors have proved better at driving cost efficiencies than state investors. However, some risks are still likely to be better managed by governments or development banks. If we ask private investors to manage risks they are not well-placed to manage or understand, the investment may only be financeable at a high cost of capital (or may not happen at all). Ultimately, this higher cost of capital increases customer bills and drags on public budgets.

This balance between public and private risk is particularly important to consider in the light of the changing nature of investment in the power sector. In particular, low-carbon investments are typically more capital intensive than fossil generation, which means financing costs are much more important driver of costs. In turn, ownership models and instruments which lower financing costs have increasing merit, even if they lower incentives for operational efficiency.

1.2 The aim of this report

Getting the right allocation of risks between private investors, public entities (taxpayers) and consumers is critical to minimizing the costs of the low-carbon energy transition. But often the debate and analysis around the right financing and policy models for power investments is not viewed through this "risk allocation" lens.

This report is the first step in establishing a framework for choosing the right ownership models and policy/finance instruments which has "risk allocation" at its core. It is aimed at policy-makers and development banks, who play an active role in setting policies and deploying public finance instruments. It is also aimed at private investors with an interest in where public finance and policy should (and shouldn't) play a role in transferring some of the risks for their investments.

The framework we are developing aims to answer the following key questions:

- How do we assess what the right allocation of risks is between private investors, taxpayers and consumers for power investments? How does this ideal allocation vary depending on the technology (eg, wind, solar, nuclear) and the country context?

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[3] *The sustainable infrastructure imperative*, New Climate Economy (2016)

[4] *World Energy Investment Outlook*, IEA (2014)

- Given this ideal allocation of risks, what is it the most appropriate ownership model for the investment (eg, pure public/state ownership, private but regulated, private with a government contract, private merchant)?
- Which additional policy and finance instruments are needed to achieve the ideal risk allocation? And how do we evaluate and quantify the impacts of these instruments?

In developing this framework we want to get beyond simply thinking about whether investments should be publicly or privately financed. Instead, we aim to ensure *each specific risk* (eg, development, construction, price) is allocated according to whether private investors, public entities or consumers are best placed to manage, understand and bear it.

This framework is designed to complement decision-making processes used by these institutions, such as the "Cascade" approach currently being implemented by the World Bank[5].

1.3 The structure of this report

This working paper explores the different options for financing clean energy infrastructure, and provides a framework for choosing ownership models and policy/financing instruments**.** It is organized into four sections:

- We begin in **Section 2** by setting out the current pattern of public and private ownership of power sector investments and how this is changing.
- In **Section 3**, we explain why getting the allocation of risks right is fundamental to lowering the lifetime costs of energy investments. We then explain how we can assess what the right allocation of each risk is, for a given investment.
- Then, in **Section 4**, we review the different ownership models that can be used in for energy investments, and show how these allocate risks in different ways.
- In **Section 5**, we show how specific policy and finance instruments (eg, feed-in tariffs, risk guarantees) can then be used to "fine tune" to the ideal pattern of risk allocation.
- Finally, in **Section 6**, we show how optimizing the allocation for risks for investments can lead to large savings in costs.
- We conclude by setting out the next steps for this work.

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[5] The World Bank's "Cascade" approach starts by asking whether the private sector can finance a project. If this isn't possible the next step assesses whether reforms to regulation or policy can get private investment flowing. Then if the project is still not privately financeable, the World Bank will look to deploy risk sharing tools, such as guarantees and insurance. Finally, if these measures are still insufficient to bring in private funding, direct public finance becomes the option of last resort. *Forward look: A vision for the World Bank group in 2030 – progress and challenges*, World Bank (2017).

2. Assessing the ideal allocation of risks for different investments

In this section, we explain why getting the allocation of risks right between private investors, taxpayers and consumers is fundamental to lowering the lifetime costs of energy investments. We then explain how we can assess what the right allocation of each risk is for a given investment.

2.1 Public versus private risk

Risk allocation is fundamental to reducing the costs of clean energy. By ensuring each risk is allocated to who is best placed to manage, understand and bear it, the risk is reduced as is the cost of financing that risk. In this way, correct risk allocation minimizes the overall costs of a given investment (operating costs, capital costs and financing costs).

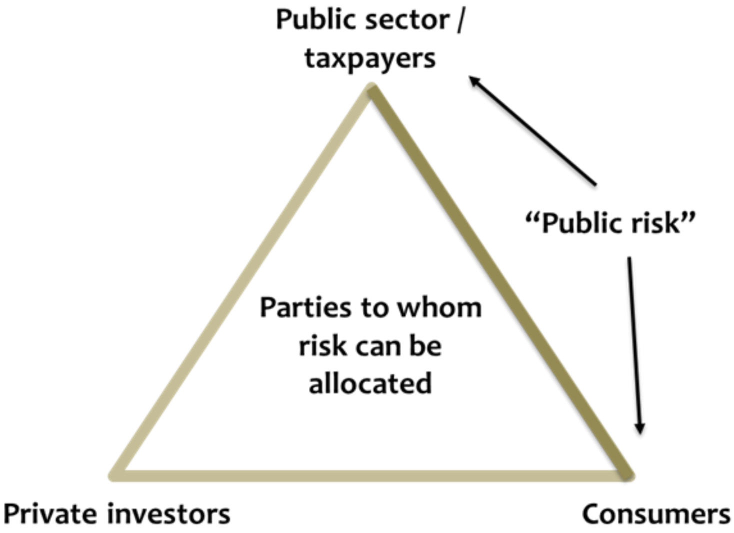
In this report, we focus on public versus private allocation of risk as a key distinction (see Figure 2 below). In other words, should the risk be borne by the public (taxpayers or consumers) versus private investors. There are many sub categories of risk ownership below this "public" versus "private" distinction:

Under "**public risk**", there are many different levels to which risk can be "socialized":

- *Consumer versus taxpayer*. Risks can be transferred to consumer through economic regulation or costumer ownership (where some or all of the cost risks are passed through to consumers via their tariffs). Or through public finance or ownership (eg, municipal or state-ownership) risks are borne by taxpayers. Socialising risks to taxpayers rather than consumers gives greater flexibility over how costs are distributed across the population. But also means costs are less targeted on users which can reduce incentives to control them.
- *Local, national or international*. The socialization of risks can be very localized (eg, if the investment is owned by local municipality or local consumers), national (eg, national SOEs) or even international (eg, MDB finance). The less localised the risk, the more remote those bearing the risk are from the decision-makers and management. Which can mean there is less direct pressure on decision-makers and they are instead more guided by the mandates given to them (eg, to promote growth or development).

Under "**private risk**", there are also many different private players and the allocation of risk between these is important in managing them effectively (eg, between private plant owners and private maintenance contractors).

Figure 2. The three key parties who can manage risk and our definition of "public" risk



Nevertheless, in the remainder of this report, we focus on the high-level "public" versus "private" distinction. The choice of "public" versus "private" risk has a major bearing on the cost of managing the risk, and this is a crucial decision that needs to be made in choosing ownership models and finance/policy instruments.. Other decisions on where risks should sit, such as whether taxpayers or consumers should bear the risk, are often driven by political economy considerations (eg, distributional effects) which sit outside the scope of this report.

At a high-level, the debate over whether a risk should sit with private investors, or be (partly or fully) socialized to a public entity or consumers often hinges on a trade-off between financing costs and efficiency. For example, the explicit cost of financing the construction phase of a privately owned project can be reduced through provision of government construction loan guarantees (or by allowing cost overruns to be passed-through to consumers). But the guarantee also means that the private owner has less incentive to limit construction cost overruns. If private investors are otherwise well-placed to manage construction costs, then reducing this incentive can result in increased costs.

Table 2 below summarizes all of the generic arguments for private versus public financing of risk. We discuss these arguments in relation to specific risks later in this section.

Table 2. Generic arguments for public versus private finance of risk

	Public risk	**Private risk**
Cost of capital	**Lower explicit cost of capital** (because public entities have tax-raising powers and risks can be spread across wide taxpayer or consumer base). **Public bodies less likely to misprice some risks** (eg, policy) given better knowledge and/or because private markets are illiquid.	**Public balance sheets strained in some countries** and large untapped private funds available (eg, from institutional investors). **Opportunity cost of public funds can be high** and implicit cost to taxpayers from public risk. Some private investors/firms will have "natural hedges" for some risks (eg, fuel costs offset by self-production) making the risk less costly to finance.
Cost & operational efficiency	**Public sector may have greater ability to manage risks around planning, regulation and policy**. **It can be more efficient for a central public body to pay for "common costs"** (eg, site surveys) rather than having multiple private competitors duplicating these. **Lower transaction and contract monitoring costs through direct public ownership**.	**Private shareholders and debt providers can exert a stronger pressure on cost efficiency**. Therefore exposing them to risks improves efficiency. **Competitive pressures mean only the most efficient private firms survive**. Therefore, the surviving private entities can be more efficient than public entities in managing some risks.
Capital allocation	**Public bodies typically have greater understanding of policy risk/change**, so they are more likely to allocate capital to projects which are consistent with this. **Public bodies can directly shift investment towards meeting social/environmental goals**.	**Private investors may provide stronger scrutiny & diligence on investments**. **Potentially better sector expertise**. **Less risk of political interference or corruption in investment decisions**.
Competition & distributional issues	**Where competition is limited or regulation weak, state-control helps protect consumers**. **Easier to address concerns around vulnerable customers and widening access**.	**Greater scope for competition to drive innovation**.

2.2 Identifying the risks which are most important

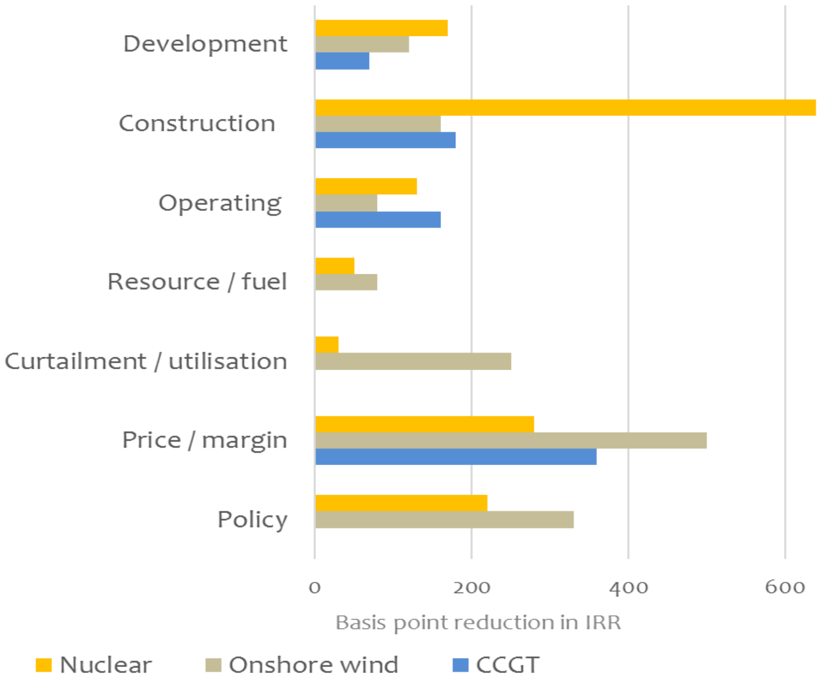
Before deciding on the right ownership models & instruments we need to understand the most material risks. These are the risks where it is most important to get the risk allocation right. Table 3 below describes some of the typical key risks for a power generation investment.

To assess which risks are most material we can estimate the impact that they have on investment returns. Figure 3, below shows the impact of a "1 in 10" (P90) event on on project returns (IRR) for typical power generation projects compared to the expected (P50) returns. We can see that for nuclear construction risks dominate so getting the allocation of these risks right is the crucial issue. In contrast for wind (and solar) price, curtailment and policy risk are most important. So these risks are where most of the analysis and debate should focus.

Table 3. Description of some common risks for power generation investments

Risk	**Description**
Development	*Investment in environmental surveys, engineering cost studies and planning / land acquisition.*
Construction	*Capex costs incurred in construction and delays (including technology procurement and construction contracts)*
Operating	*Operating and maintenance costs (excluding fuel).*
Fuel & carbon	*Price of fuel (e.g. gas, coal, biomass) and carbon allowances needed to generate electricity.*
Resource	*For technologies such as wind, solar and hydro, weather patterns (e.g. wind speeds, rainfall) affect output.*
Environmental & decommissioning	*Costs associated with environmental damage (e.g. hydro flooding, nuclear meltdowns)*
Curtailment	*When there is insufficient network capacity or demand, generators can have their output curtailed and, depending on the market design, may lose revenue.*
Price & offtake risk	*Risk around prices (e.g. wholesale prices) and, where power is contracted, the risk around whether the off-taker will default.*
Policy	*Changes to policy which impact on revenues or costs (e.g. reduction in subsidies)*
Political	*Risks related to major political changes (eg, forced closures, expropriation of assets and conflict)*
Currency	*Where investors are non-domestic but revenues are in local currency they face risk around FX rate.*

Figure 3. Impact of a "1 in 10" event on project returns (basis point reduction)



2.3 Principles for assessing how risks should be allocated

The overall cost of a project is minimized by allocating a given risk to the party which can best:

- **Manage and control the risk**. Being exposed to a risk gives an organization incentives to manage that risk. Therefore, greater reductions in a risk can be achieved by allocating it to the party best placed to manage it. For example, if private investors can better manage costs/operations than the public sector, exposing them to these risks increases efficiency. This situation is often the case for construction and operating cost management and there is a large amount of empirical evidence to support this[6].
  However, the argument for private finance of a risk varies hugely depending on the type of risk, the market context and the technology. If the private owners cannot manage a risk well (eg, regulatory or policy risk) exposing them to it simply raises the cost of capital, or deters investment altogether, without providing any offsetting efficiency or risk management benefit.
- **Understand the risk**. If private investors have limited understanding of the risk (eg, policy risk), they may misprice the risk through high premiums on their hurdle rates and/or underinvest (or underprice and overinvest). In this situation it can be optimal for the public sector to bear the risk as the public sector does not require high risk premia for such risks, and it may have a better understanding of them.
  For example, as policy-makers, governments can be expected to have greater visibility of and comfort with policy and regulatory risk. Given the high amount of policy risk in clean energy investment, some state finance of risk may therefore be important in reducing financing costs. For example, in developing countries, policy risk can add more than 200-300 bps to the private cost of capital of a renewables project, and public entities should be able to finance some of this risk at a lower cost (eg, through guarantees or policy risk insurance).
- **Bear and share the risk**. Some risks entail very high cost but low probability events which can be (i) difficult to absorb by a private firm and (ii) cannot be easily diversified in private financial markets, or it is expensive to do so (eg, if private financial markets are immature or illiquid). For example, the clean-up costs for Fukushima nuclear accident were $150bn. This cost is well beyond the market capitalisation of most private generators and there is lack of private markets to insure such risks. Not least because such risks are low probability/high impact events which are very difficult for insurance firms to quantify and diversify (eg, they are not negatively correlated with other events). As a result, some risks may need to be explicitly or implicitly borne by the public sector or consumers, because private investors simply cannot bear all of the risk.

2.4 How the right risk allocation depends on technology, country context and investment objectives

These are the basic principles of risk allocation. The right allocation of risk for a given investment will then depend on a number of factors, in particular the following.

2.4.1 THE NATURE OF THE TECHNOLOGY

The nature of generation technologies means their owners have differing abilities to manage and bear certain risks.

In particular, renewables are more capital intensive and their owners have less ability to manage price risks. Whereas capital costs can represent less than 25% of the levelized cost of a new gas CCGT, they are typically over 75% of onshore wind costs. As capital costs become more important, so the pay-off from reducing the cost of capital increases – a reduction in the weighted average cost of capital

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[6] For example, a study of PPPs in Australia found a median capital cost overrun of 0.7% compared to 10.1% for public sector managed projects. A recent econometrics study by the European Commission (2016) found that, controlling for factors such as size, state-owned entities are significantly less efficient than private companies in electricity generation and transmission.

(WACC) of 3% points reduces the levelized costs of technologies such as wind and nuclear by around 20%-25%. This situation shifts the balance towards finance models and policies which reduce the cost of capital (e.g. through socializing market risks) - even if they come at the expense of some reduced efficiency in operations.

In turn, owners of flexible technologies (eg, CCGTs, OCGTs and batteries) are better able to manage price and curtailment risk. Exposing them to these risks is important to encourage efficient dispatch. In contrast, once built, owners of many types renewables (eg, wind, solar) have limited ability to manage price and curtailment risks - since their generation is dictated by wind speeds and solar radiation. The factors effecting these risks (eg, global gas prices, transmission build out) are out of their hands. So exposing private renewable generators to these risks raises their cost of capital with very little offsetting benefit in terms of risk management.

2.4.2 THE COUNTRY AND MARKET CONTEXT

There are a wide range of contextual factors which will affect the ideal allocation of risk, including:

- **The level of actual and potential private sector competition.** If competition is limited the case for transferring risks the private sector is reduced, for two reasons. First, if there is a lack of competition, consumers may be exploited (eg, through high tariffs) in the absence of regulation to control this. Public ownership can be an effective way to protect consumers in these situations. Second, a lack of competitive pressures reduces the likelihood that private firms will be efficient and better at risk management (not least because inefficient firms are less likely to be competed out of the market).
- **The efficiency of state-owned entities (SOEs).** The case for privatizing risk also depends on how efficient SOEs are. In some countries these are very inefficiently run but in others they have management structures that means they can be relatively efficient (eg, they can be run at "arms-length" from government and may have some minority private shareholders to increase pressure on management).
- **The liquidity and maturity of private financial markets**. In some countries, private markets needed to diversify and pool risks may be underdeveloped, making it difficult for private investors to finance and bear certain risks.
- **The extent to which public policy influences risks**. In some countries public entities have a high amount of control over factors affecting development risk (eg, planning, grid expansion, auctions), giving a stronger case for these entities bearing these risks.
  For example, the growth of renewables auctions as a method of allocating and setting subsidy contracts is amplifying development risks and making them more difficult for private investors to manage. Development risk is amplified because development spend needed to cost and deliver a credible bid will be sunk if a contract is not awarded (sometimes called "allocation risk"). A recent study by NERA surveyed investors who argued that "allocation risk" around getting a subsidy contract in the UK renewable auction is currently adding over 200 bps to private wind hurdle rates[7]. In these situations, there may be a greater role for the public sector in managing development risks. For example, in India state-financed "solar parks", such as those in Gujarat, have emerged. Sites in these parks, with planning permission and grid connection already secured, are then sold to different private developers who do not need to bear the development risks. Similarly, the national Danish Energy Agency finances pre-development of offshore wind farms ahead of auctions.
- **The importance of currency risk**. The next 30 years will see a shift in energy investment towards developing countries, with over 60% of energy supply investment taking place in non-OECD countries. Much of the untapped finance that could be used to finance this investment is held by institutional investors who manage around $100 trillion of investments and have liabilities denominated in dollar and euros. Therefore, the allocation of currency risk is a very important consideration in some contexts. There may be a case for transferring these risks to taxpayers or

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[7] *Electricity generation costs and hurdle rates*, NERA (2015).

consumers in some cases (eg, through public provision of currency swaps or by denominating PPA in euros or dollars), because national governments have more influence over exchange rates and private markets for hedging can be highly illiquid.

2.4.3 THE OBJECTIVES AND STAGE OF THE INVESTMENT

The social and environment objectives of the investment also have a bearing on whether risks should be publicly or privately financed. Where the state is investing, it can more directly shift investment to meet social and environmental goals. This option is particularly important where these social benefits/costs are not priced in market, or encouraged through regulation. For example, if widening access to electricity is a social policy priority, it may be more directly achieved through the state investing than by providing policy incentives for private investors.

Similarly, if the investment is in an infant technology or pilot project, socialization of risk might be important to overcome barriers to private finance of new technologies and to exploit knowledge spillovers. For example, if a "first of a kind" investment is publicly financed (e.g. a CCS project), the state has the power and means to ensure learnings from this (e.g. on efficient construction, operation and maintenance techniques) are disseminated widely. Private financers, in contrast, may want to keep these learnings commercially confidential to help secure a competitive advantage. In addition, because a private financer will not capture all the learning benefits from a new technology investment, it is likely to underinvest where there are high learning externalities.

2.5 Methods for analysing the ideal allocation of risks

So how do we robustly and systematically assess the ideal allocation of each risk? This assessment involves understanding how different risk allocations affect two key cost and productivity drivers:

- **Finance costs**. Here we want to understand how the cost of capital for an investment is affected by how the risk is allocated. For example, if we are considering long-term price risk we can assess the cost of capital for the private investor when they do face this risk (ie, merchant investment) versus when they don't and this risk is socialized (eg, under Feed-in Tariffs). This analysis can be done through a combination of financial modelling and market intelligence. For example, an investor survey by Diacore found that removing long-term wholesale price risk through a fixed FiT or CfD reduced the cost of capital by 90-160 bps[8].
- **Operational and cost efficiency**. We then need to consider how the allocation of a given risk effects operational and cost efficiency. For example, exposing private owners to cost risk can often deliver higher efficiency, since (i) private shareholders and debt providers can exert a stronger pressure on cost efficiency than public owners and (ii) competitive pressures mean only the most efficient private firms survive. This assessment can be done by analyzing, firstly, the extent to which a private owner is able to control a given risk. And secondly by reviewing available evidence on the relative performance of private and public entities in managing costs.

We also need to consider the transaction costs associated with different risk allocations. For example, there are various policy and finance instruments (see Section 4), which can be used to shift risks away from private investors (eg, public guarantees, Feed-in Tariffs). There are costs associated with these (eg, arrangement, administration and monitoring costs) which need to be assessed and factored into the analysis of how the risk should be allocated. These costs can be high for bespoke instruments for small projects (relative to the overall cost of the project) but often immaterial for generalized instruments for large projects or the industry as a whole.

There are trade-offs between these impacts. In particular, we can lower the private cost of capital by socializing a risk, but this will also reduce private owners' incentives to manage that risk. For example, we can reduce private cost of capital by providing public guarantees in the construction phase of a

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[8] *The impact of risks in renewable energy investments and the role of smart policies*, Diacore (2016)

project. But this cost of capital benefit may come at the cost of dramatically reduced construction cost efficiency, since the private investors incentives to manage these are lower.

As a result of these trade-offs, as far as is possible, quantifying the above factors is desirable so the overall impact can be assessed. Table 4 below summarizes some of the research methods that can be used to assess the ideal allocation of each risk.

Table 4. Methods to assess the ideal allocation of risks

		Impacts from different risk allocations and ways of assessing these		
		Finance costs	**Cost & operational efficiency**	**Transaction costs**
Factors affecting the ideal risk allocation	**Managing & understanding the risk**	-Conduct investor surveys/interviews to assess attitudes to and pricing of risk. -Gather market observations of finance costs for different parties with/without risk. -Carry out financial modelling on the impacts of risk on private cost of capital.	-Assess controllability of the risk for different parties. -Gather evidence on the efficiency of public vs private owners. -Assess level of actual & potential private sector competition.	-Assess transaction costs of risk transfer instruments.
	Bearing the risk	-Assess the maturity & liquidity of private finance & insurance markets. -Assess state of public finances & capacity to bear risk.		-Assess the costs of regulation and monitoring needed if private owners cannot bear risk.

Based on this process we can start to see how the ideal allocation of risk varies depending on the technology type. Table 5 gives an indicative assessment of what the ideal risk allocation could look like for onshore wind versus a gas CCGT using this framework. It shows how we can look at the case for public risk on the basis of both “financing costs” and “efficiency”, before coming to an overall assessment.

Taking some specific risks:

- **Operating risks**. For both onshore wind and CCGTs, private investors are likely to be best placed to manage operational risks, as typically they can understand and manage these risks well[9]. Therefore for both “financing cost” and “efficiency” reasons there is good case to leave the risk with the private investor.
- **Construction risk.** Here the story is similar to operating risks. Private investors are likely to be best placed to deliver construction cost “efficiency” given their experience in managing these risks. Moreover, there is strong empirical evidence that private investors tend to deliver greater construction cost efficiency than public investors. In general, they are also relatively well-placed to understand and bear the risk, meaning there isn’t a strong case for transferring the risk away from private investors for “financing cost” costs reasons.
  For other technologies such as nuclear, where policy and regulation can have a major influence on construction costs and the private cost of capital, the argument is different (eg, a change in safety regulations can increase costs substantially). Here there is a stronger case to transfer some, but not all, of the risk to the public sector or consumers, because private investors

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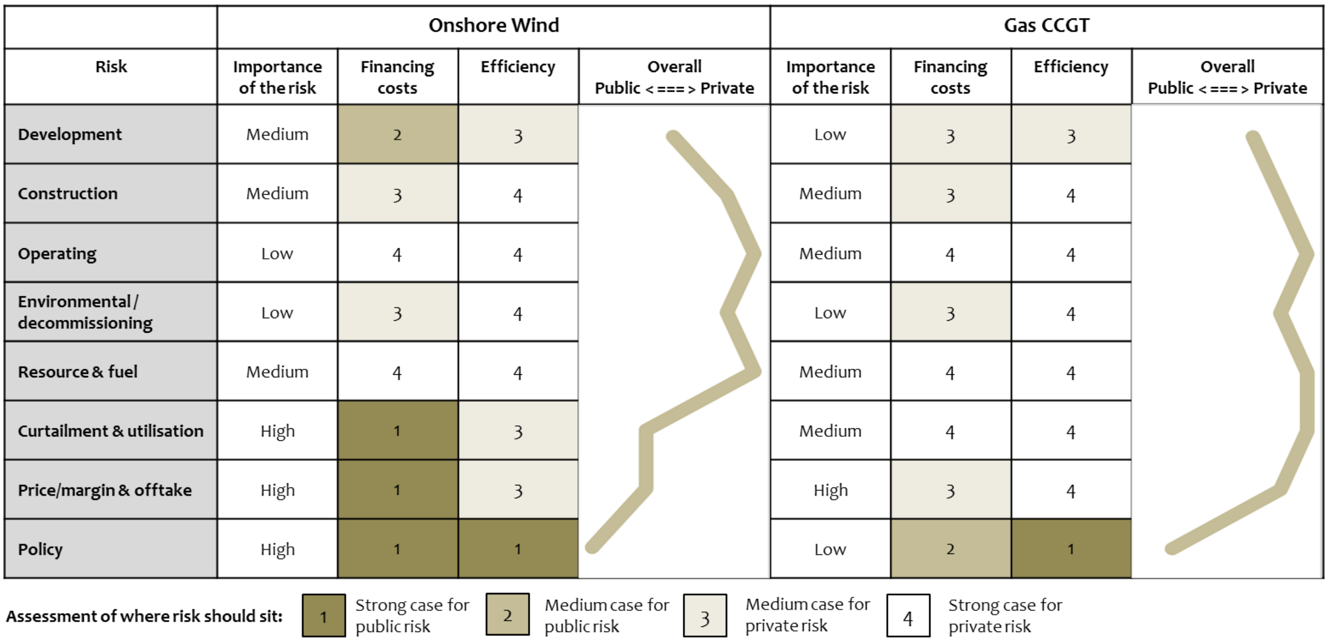
[9] A recent econometrics study by the European Commission (2016) found that, controlling for factors such as size, state-owned entities are significantly less efficient than private companies in electricity generation and transmission.

are not fully able to control, understand and bear the risk, and may therefore price in very high risk premia.

- **Price and curtailment risks**. There is a strong case for private CCGT owners bearing price/margin risk for "efficiency" reasons, because they are flexible and being exposed to changing prices encourages them to dispatch efficiently. However, there is much less of a case for private onshore wind investors facing price and curtailment risks given the technology is much less flexible and therefore owners have limited ability to manage the risks. Moreover, fully exposing wind investors to these risks can have a major impact on their "financing costs". Not least because it can be difficult for private investors to understand the risk: future prices and curtailment rates are very difficult to predict and depend on factors outside the control of a private investor (eg, grid developments). Depending on the context, exposing private investor to price risk can increase the cost of capital by 100-300 bps or more, with little offsetting benefit in operational efficiency.

When applying this framework in a specific context, ideally, a quantified assessment for each risk would be undertaken using the methods set out in Table 4. However, if time and data/information is limited a more qualitative assessment may be necessary, which considers who is best placed to manage, understand and bear each risk. Annex 1, sets out, for each different risk type, some of the key issues and questions that need to be considered when making this assessment. We now assess how to choose a blend of ownership models and policy/finance instruments to achieve the ideal allocation of risks.

Table 5. An indicative assessment of the case for public versus private finance of different risks



	Onshore Wind				Gas CCGT			
Risk	Importance of the risk	Financing costs	Efficiency	Overall Public <===> Private	Importance of the risk	Financing costs	Efficiency	Overall Public <===> Private
Development	Medium	2	3		Low	3	3	
Construction	Medium	3	4		Medium	3	4	
Operating	Low	4	4		Medium	4	4	
Environmental / decommissioning	Low	3	4		Low	3	4	
Resource & fuel	Medium	4	4		Medium	4	4	
Curtailment & utilisation	High	1	3		Medium	4	4	
Price/margin & offtake	High	1	3		High	3	4	
Policy	High	1	1		Low	2	1	

Assessment of where risk should sit: 1 Strong case for public risk; 2 Medium case for public risk; 3 Medium case for private risk; 4 Strong case for private risk

3. Choosing the appropriate ownership model

The ownership model for an investment (eg, public ownership, private finance under regulation, pure private ownership) has a major bearing on how the risks of an investment are allocated. In this section we set out the range of possible ownership models and how they allocate risks differently. We then discuss how, to the extent investors and policy makers have a choice, the most appropriate ownership models for a given investment can be selected.

3.1 The range of ownership models for power investments

There is a spectrum of different ownership models that can be used for infrastructure investments which vary in the extent to which risks are transferred to taxpayers or consumers. Table 6 sets out six generic ownership models which capture the range of possibilities.

Table 6. Ownership models for power generation and network investments

Ownership model	Description	Examples
1. Direct public ownership	The investment is made directly by government, or by a majority state-owned firm backed by government guarantee. As a result the taxpayer bears the risk of the investment (or sometimes consumers through use charges).	Coal plant in South Africa and other developing countries.
2. Mutual/customer ownership	Mutual ownership is where the firm is owned/controlled by its members or customers. Mutuals are typically 100% debt funded but customers bear the majority of risks (i.e. if costs rise this risk is transferred directly to customer through their charges).	Some US electricity utilities and generation firms.
3. Public finance for development/construction then sold to private sector	The build of a project is publicly funded, but on completion the asset is sold to private investors for operation.	Denmark offshore wind pre-development; India solar parks
4. Private finance under formal regulation	Network assets (which are natural monopolies with little scope for competition) are often operated with private ownership but under formal, independent regulation. These regimes (e.g. price, revenue and cost-plus regulation) share cost, performance and demand risks in different proportions between the private investors and customers (e.g. through different levels of cost pass-through).	Electricity networks in Europe and the United States; generation in the United States.
5. Private finance under fixed-price regime	There are a wide variety of models which involve private sector finance but where some of the risks are socialized through a long-term contract. These models includes public-private partnerships (PPPs) where the utility (often state-owned) pays the private investors via a Power Purchase Agreement (PPA). Feed-in tariffs, which provide a long-term fixed price for generation output, are also included in this category.	Feed-in tariffs for renewables, PPPs for fossil power stations in India.
6. Pure private ownership	Here investment is made by private investors without any government contract. Therefore private investors bear the full risks of the investment.	Merchant power stations in Europe.

In practice, there are a large number of hybrids and variants of these options. For example:

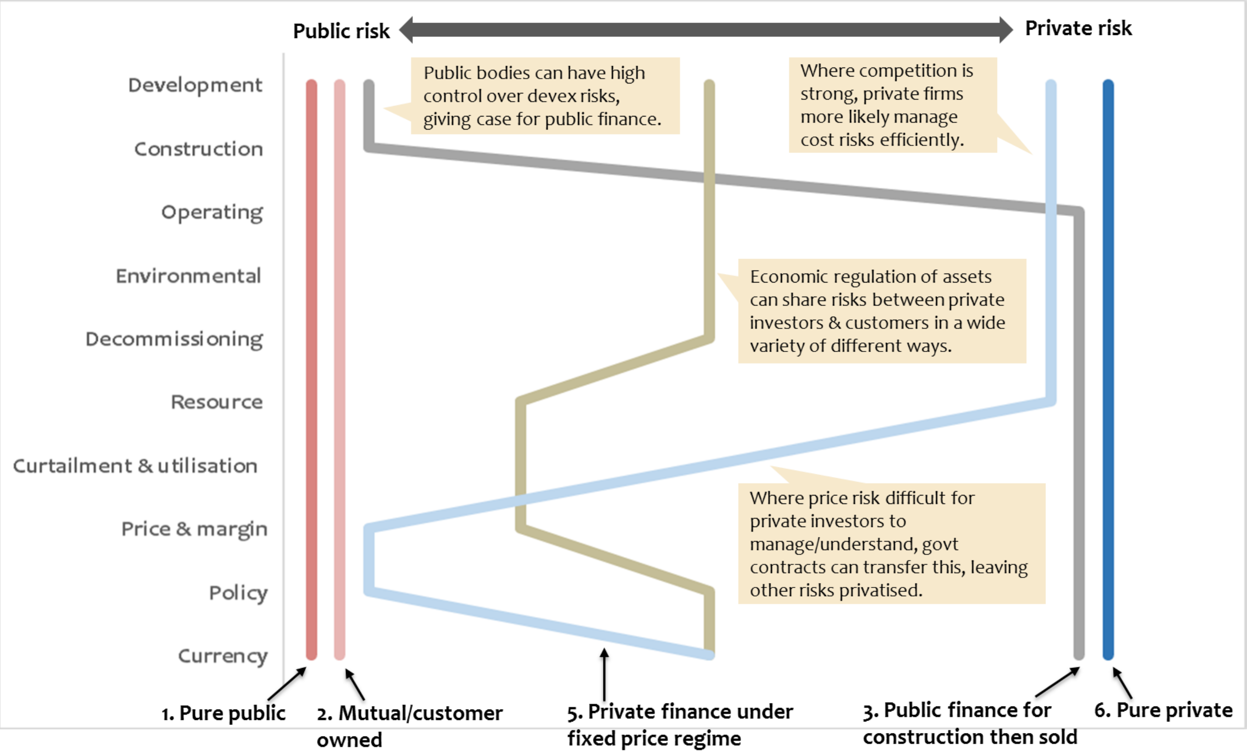
- Many majority state-owned entities (SOEs) are publicly listed and partially privately owned.
- Many private sector firms and projects are partially public financed. In particular they may receive grant, equity co-investment or debt finance from national governments or DFIs.

3.2 How different ownership models imply different risk allocations

These ownership models result in different patterns of risks allocation. Figure 4 below, shows how at a generic level, these ownership models can allocate risks. For example:

- **Pure public ownership** leaves risks with taxpayers. For example, if a state-owned entity makes losses as a result of rising costs and/or falling revenues, governments will cover these with taxpayer-funded equity or debt injections.
- Under **mutual or customer ownership**, risks ultimately sit with the customers who own the business. For example, if there are cost overruns these will be passed onto customers via their tariffs.
- **Private finance under fixed price regime** leaves construction and operational risks with the private owner while transferring some price risks away. For example, a private renewable generator may sign a fixed price PPA with a state-owned utility. In this case, construction and operational risks remain with the private owner, but price risks are transferred away.
- **Private finance under formal regulation** offers a wide spectrum of options for sharing risks between private investors and customers (eg, through different cost-sharing incentive rates). For example, a regulated fossil power generator may be allowed to pass some or all of the changes in its fuel costs through to consumers in their tariffs.
- **Pure private ownership** leaves risk with private investors. The private equity and debt investors into these firms ultimately bear the gains/losses associated with all of the risks.

Figure 4. How different ownership models can allocate risks differently



So, to the extent policy makers and investors have a choice on the ownership model for an investment they need to pick the one which most closely matches out ideal risk allocation. For the most important risks, we need to assess which ownership model gets closest to the ideal allocation. As discussed in detail in the previous section, this assessment should factor in:

- **The country and market context.** Key factors include: the performance of SOEs; the level of actual and potential private sector competition; the strength and capacity of regulators; and liquidity/maturity of private finance markets.
- **The objectives and stage of the investment**. In particular, whether social goals (eg, expanding access) and innovation spillovers are more easily met through a public ownership model.

In addition, it is important to note that policymakers and investors will often be constrained in the choice of ownership model they can make for a specific investment. In particular, the ownership model may not fit with the prevailing market framework. For example, if the generation sector has been fully privatized, public ownership of a specific investment may distort competition and/or may violate State Aid rules.

As a result of these constraints, and because ownership models do not provide a precise allocation of each specific risk, there will typically be "gaps" between the risk allocation provided by the ownership model and the ideal allocation. We set out how to plug these gaps in the next section.

4. Evaluating and selecting finance and policy instruments

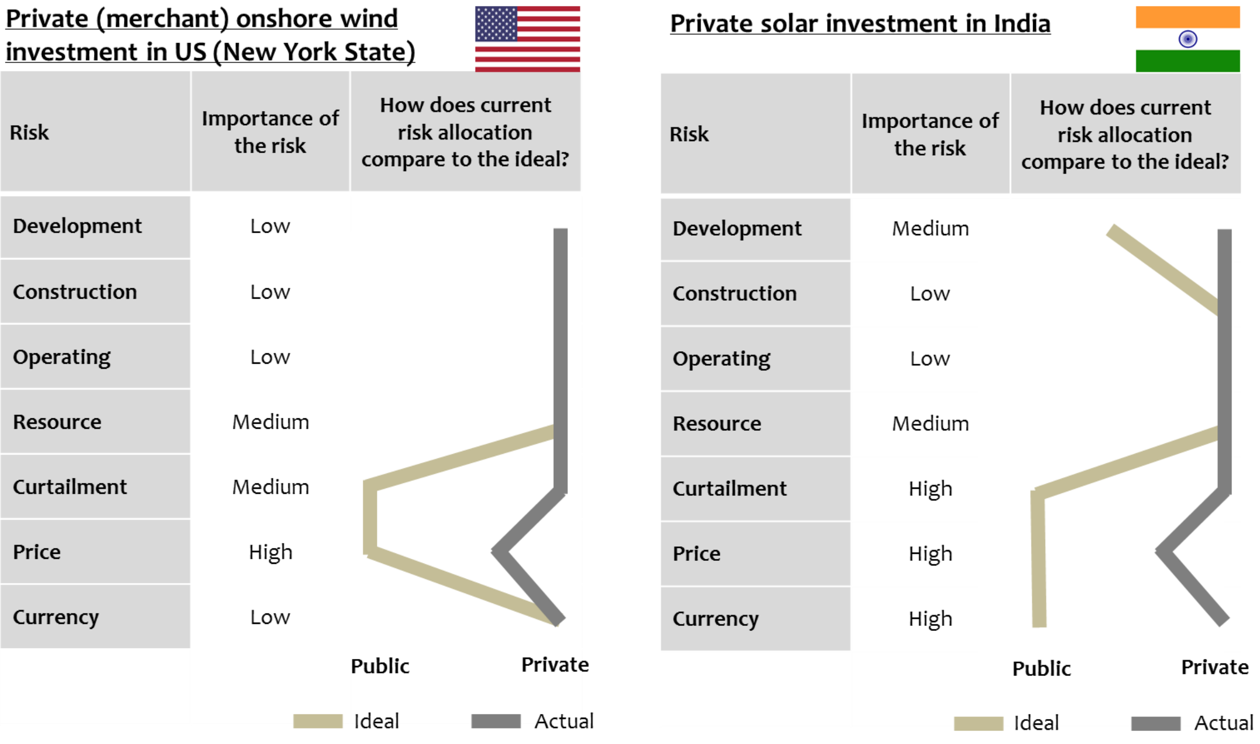
The ownership model for an investment will typically not allocate all of the risks in the ideal way. Some specific risks will not be allocated to the ideal party. In this section, we show how specific policy and finance instruments can be used to "fine tune" to the ideal risk allocation. We set out the range of instruments that can be used, and show how these have been selected and evaluated.

4.1 Identifying the gaps between the "actual" and "ideal" allocation of risks

A simple exercise to understand where and when additional risk transfer instruments may be needed is to map the "actual" allocation of risks for an investment type against the "ideal". Figure 5 below shows an illustration of this mapping for two typical renewable investments in the US and India (although we stress there will be many real-world investments in these regions which don't fit this pattern). In these examples we assess the main risk "gaps" as follows:

- Under a **private merchant wind investment in USA** (New York State) private investors receive a fixed price contract for renewable energy certificates (RECs) but they are exposed to wholesale market price risk (eg, there is no long-term fixed price PPA in place) which represents the majority of their revenues (around 2/3rds). Ideally, wind should not be fully exposed to this wholesale price risk as wind farms have very little ability to manage the risk (ie, they can only generate when the wind is blowing so they cannot adjust output in response to prices).
- In the example of **private solar investment in India** the private investor is fully exposed to development, curtailment and currency risks, and mostly exposed to price risk in the "actual" situation. Ideally the private investor would not be fully exposed to these risks. For example, curtailment risk is something that a private solar investor has very limited ability to manage or understand. Curtailment rates are very difficult to predict due to uncertainties around future renewables deployment, network upgrades and demand. In addition, private developers have limited access to network data needed to understand these factors. State-owned network owners are therefore much better placed to manage and understand this risk.

Figure 5. Illustrative examples of risk gap analysis



Private (merchant) onshore wind investment in US (New York State)

Risk	Importance of the risk	How does current risk allocation compare to the ideal?
Development	Low	
Construction	Low	
Operating	Low	
Resource	Medium	
Curtailment	Medium	
Price	High	
Currency	Low	

Private solar investment in India

Risk	Importance of the risk	How does current risk allocation compare to the ideal?
Development	Medium	
Construction	Low	
Operating	Low	
Resource	Medium	
Curtailment	High	
Price	High	
Currency	High	

4.2 The range of instruments to close the risk “gaps”

So having identified these risk “gaps” how do we fill them? There are a wide range of finance, policy and regulatory instruments that can be used to transfer one or more risks to taxpayers or consumers.

One way to categorize these is according to: (i) the risk that they transfer; (ii) who they transfer the risk to; and (iii) the type of instrument. A sample of instruments categorized like this is shown in Table 7 below. For example:

- **Public finance instruments** can be used to transfer various risks to taxpayers. For example, governments can provide loan guarantees for the construction phase of a project, which partially transfers construction risks to the taxpayer. Policy risks can also be transferred through development bank insurance which compensates private investors in the event of specified policy changes (eg, government expropriation of assets, or default/cancellation of a government contract). A common example of this kind of instrument is Partial Risk Insurance provided by DFIs such as MIGA.
- **Government contracts** can also transfer risks away from private owners to taxpayers. For example, a private renewables investor can sign a fixed price Power Purchase Agreement (PPA) with a state owned utility, as is becoming common in many parts of the world. This contract transfers wholesale price risk away from the private investor. These PPAs can also be defined on a “take-or-pay” basis which means that the private investor doesn’t face curtailment risk.
- **Policy instruments** can transfer risk away from private investors to consumers. For example, fixed price Feed-in Tariffs transfer price risks away from private investors, and the cost of these are recovered from consumer bills.
- Finally **regulatory instruments** can also transfer risks to consumers. In particular, where generation or networks are subject to economic regulation, the incentives and revenue allowances can be set up so that some or all of the cost changes they experience can be passed through to consumers in their tariffs.

Table 7. Sample of finance and policy Instruments that can be used to transfer specific risks

Risk	Public finance	Government contracts	Policy mechanisms	Regulatory instruments
Development	-Public equity finance -Grant finance -Concessional loans -Loan guarantees	-Cost sharing arrangements in government contracts	-Special planning arrangements	-Cost pass-through arrangements in regulated tariffs
Construction				
Operating				
Resource		-Availability-based PPAs	-Availability-based FiTs	-Availability-based regulated tariffs
Curtailment & utilisation		-State-backed “take or pay” PPAs	-Capacity mechanisms -Priority dispatch	
Price & margin		-State-backed fixed price PPAs	-Feed-in Tariffs & Contracts for Differences	-Fuel cost pass-through in regulated tariffs
Environmental	-Limited liability -Insurance			-Regulated cost-pass through
Policy	-Policy risk insurance	-Change in law provisions		
Currency	-Currency hedging products	-PPAs indexed in international currencies	-PPAs indexed in international currencies.	-Tariffs indexed in international currencies

Risks transferred to taxpayers

Risks transferred to customers

☐ Common

▨ Very common

4.3 Evaluating the instruments

Having identified the instruments that can be used to plug the remaining risk gaps, the next step is to evaluate these instruments. This evaluation can follow a process aligned with that described in Section 3, specifically:

- **The impact on finance costs**. In particular, what is the impact of the instrument in reducing private finance costs (ie, the impact in reducing their cost of capital)? And, where the instrument is public finance, how does this compare to the finance costs for the public entity?
- **The impact of operational and cost efficiency**. We then need to consider how the risk transfer affects operational and cost efficiency. For example, if construction risks are partially transferred away from private investors through a guarantee, will that have an impact on their incentives to reduce costs? Or if price risks are transferred through a fixed price PPA or Feed-in Tariff will that have any negative effects on dispatch efficiency (eg, it could give plants incentives to run less flexibly making it more difficult to balance supply and demand).
- **Transaction costs**. Finally, we need to consider the transactions cost associated with the instrument. For example, there will typically be arrangement, administration and monitoring costs associated with an instrument, as well as potential legal costs if there are disputes around the instrument (eg, arbitration costs in the event of a government contract default). These costs can be high for bespoke instruments for small projects (relative to the overall project costs) but often immaterial for generalized instruments for large projects or industry-wide instruments.

Table 8 below shows, at high level, the evaluation of three different instruments. Clearly there are different levels of depth that this assessment can go into. Given there are trade-offs between these impacts (ie, we can lower the private cost of capital by socialising a risk, but this will also reduce their incentive to manage that risk), quantifying the impacts is desirable, as far as possible.

Table 8. Examples of assessing policy and finance instruments to transfer risks

Risk	Instrument	Impact on finance costs	Impact on efficiency	Transaction costs	Overall assessment
Curtailment	**"Take or pay" contracts** which pay generators for potential rather than actual output.	**Large +ve.** Large reduction in financing costs where high risks of uncompensated curtailment (eg, India). Curtailment of 500 hrs/year reduces IRR by 250 bps.	**Small –ve.** Depending on the mkt design, can remove incentives for generators to site where they are less likely to cause grid congestion.	**Small -ve.** Requires mechanisms to allow system operators to curtail generation and monitor potential generation.	**Desirable in contexts where curtailment risk is high and system operators are able to directly monitor/control generator output.**
Price	**Feed-in tariff / Contract for Differences providing** a fixed price for output over the long-term.	**Large +ve.** An investor survey found that removing long-term wholesale price risk through a fixed FiT or CfD reduced the cost of capital by 90-160 bps.	**Medium –ve.** Can reduce incentives to turn-down plant to manage supply surpluses, increasing system costs.	**Small –ve.** Cost of systems to pay generators and recover costs from consumers. Relatively small for large schemes.	**In countries with (i) high price volatility and (ii) lower renewables penetrations, the benefit in financing costs is likely to outweigh dispatch inefficiencies.**
Policy	**Multilateral Development Bank (MDB) policy risk guarantee** (eg, subsidy removal, expropriation of assets)	**Large +ve.** MDBs can finance policy risks at a lower cost than private investors because they can control and understand the risks better.	**Medium +ve.** Pressure MDBs can apply on governments helps reduce policy risk.	**Medium –ve.** Arrangement costs can be higher for small, bespoke projects.	**Desirable where policy risk is high and where MDBs have a high influence.**

5. Estimating the savings from getting the risk allocation right

In this project we have shown a process for using ownership models and specific instruments to achieve the ideal risk allocations for power generation investments. In many real world contexts risks are not allocated well, and there are major savings in the cost of energy that can be achieved from correcting misallocations of risk.

In this section we set out one example of the savings that can be achieved, and present some working hypotheses about where risks tend to be misallocated around the world.

5.1 Estimating the savings from optimizing the risk allocation

To illustrate the savings we can achieve from getting the allocation of risks right, we can use the two stylized examples which we introduced in the previous section.

5.1.1 PRIVATE (MERCHANT) ONSHORE WIND INVESTMENT IN USA

In the USA (eg, New York State), many onshore wind investments have been made on a private merchant basis. This ownership model leaves most of the risks with the private owners which we generally assess is the correct allocation (eg, the private owners are best place to manage construction and operational risks).

However we assess that there is some misallocation of price risk. Although the windfarm owners receive a long-term fixed price contract for renewable energy certificates (RECs) they produce, they do not receive a fixed price contract for the power they generate. Therefore, they are exposed to wholesale market price risk which represents the majority of their revenues (see Figure 6 below). In our assessment, wind should not be fully exposed to this risk as wind farms have very little ability to manage it (ie, they can only generate when the wind is blowing so they cannot adjust output in response to prices).

The price risk could be transferred away from private windfarm owners by mandating the utility who offtakes the power to provide a fixed price PPA or Feed-in Tariff. In effect this arrangement means the price risks are socialized with consumers ultimately paying the fixed price PPA.

We estimate that moving to a fixed price PPA or Feed-in Tariff would reduce the private cost of capital by 120-200 bps (as the lower risk allows the project to be financed with more low cost debt)[10]. We assess that there would not be a material reduction in operational efficiency from providing the fixed price PPA since, as an inflexible generator, there is little a wind farm can do to change output in response to wholesale price changes. Therefore, based on a reduction in the cost of capital of 100 bps, we estimate that the overall levelized costs of wind in New York State could be reduced by at least 10%.

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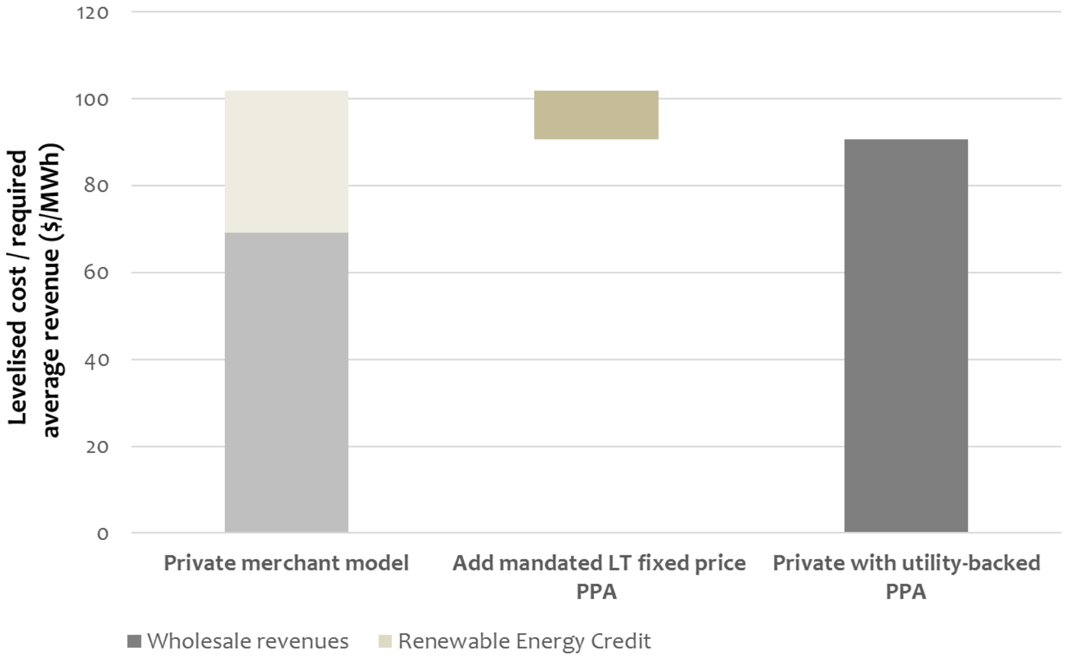
[10] *Large-scale renewable energy development in New York: options and assessment*, NYSERDA (2015).

Figure 6. Illustration of a stylised onshore wind investment in USA (New York State) and how achieving the ideal risk allocation reduces costs



5.1.2 PRIVATE SOLAR INVESTMENT IN INDIA

Starting from a position where the solar investment is on a private merchant basis, we can see the savings from reallocating risks first through the choice of ownership model and then through different instruments.

First, a long-term fixed price PPA contract should be offered to private investor since they are not well-placed to manage **price risk**. We estimate that socializing this risk reduces the cost of capital by around 300 bps (by allowing the private developers to get more debt in the project and by reducing the cost of equity). And because solar is inflexible, removing their price exposure does not negatively affect dispatch efficiency in a material way. We note that having a creditworthy state offtaker is crucial to achieving the cost of capital reductions as a result of the PPA. In India, many local state-owned DISCOMs are in financial distress so additional measure may is be required (such as having PPAs payments guaranteed by national SOEs who are more creditworthy).

Second, **development risk** can be transferred to public entities. At the development stage, there is a good argument that state entities are better placed to navigate the process of land acquisition and to arrange grid connections than a private investor. This argument is particularly strong in India where planning rules are highly bureaucratic and politicized with restrictive legal provisions - especially in rural areas where land is owned by undivided families with multiple stake-owners. In addition, there is large uncertainty around future network upgrades. This makes project development very risky for private investors.

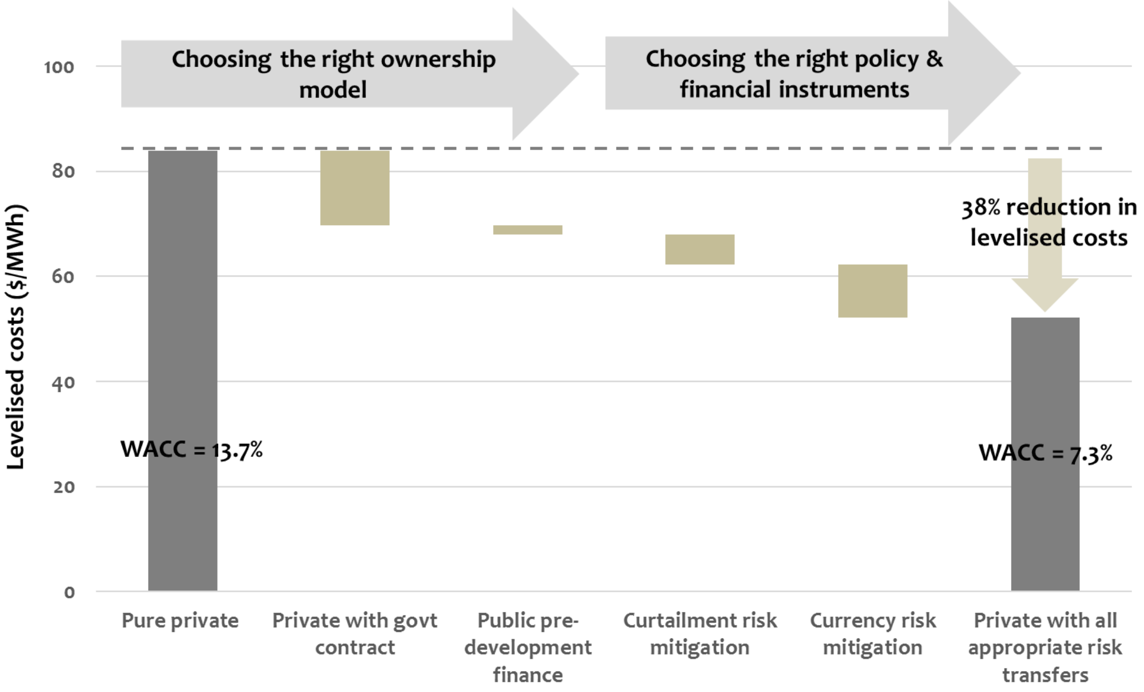
Therefore public finance at this stage can reduce development costs and the risk around obtaining grid connection (as is the case with government-funded solar parks that have been developed in some parts of India).

Third, we can transfer **curtailment risk** to the state off-taker through “take or pay” provisions in the PPA contract. Curtailment rates are very difficult for private developer to predict due high due to rapid solar capacity growth, delays in network upgrades, uncertain demand and low data transparency. As a result private developers are not well placed to manage or understand the risk. Instead, it is largely under the control of state-owned transmission and DISCOMS through their network developments. By transferring curtailment risk by making PPAs “take or pay” we can reduce the cost of capital, again with no material loss in dispatch efficiency since solar is not a dispatchable technology.

Finally, **currency risk** can be transferred away from private foreign investors through government provision of a currency hedging instrument. Previous work by CPI showed[11] this could reduce the currency hedging cost in India by nearly 50% compared to market-based instruments (since governments are better placed to manage, understand and bear the risk). In turn this would allow project to be financed with lower cost foreign debt.

In summary, in this stylized example the ideal model is private finance but with many risks shifted to public entities or consumers. This reallocation generates very large savings, reducing levelised costs by 30-40%, mainly as a result of a reduced cost of capital for private investors.

Figure 7. Illustration of a generic solar investment in India, and how achieving the ideal risk allocation reduces costs



The above examples show that large savings in the cost of electricity can be achieved from getting the allocation of risks right in some contexts. Given energy is expected to account for around US$25 trillion of investment between 2015 and 2030, the potential savings from getting risk allocation right are therefore very large.

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[11] *Reaching India's renewable energy targets cost-effectively: A foreign exchange hedging facility*, CPI (2015)

6. Conclusion and next steps

The main message of this working paper is that each risk should ideally be allocated to those best placed to understand and manage it. To help policy-makers and investors achieve this we have developed a simple four step framework for choosing ownership models and finance/policy instruments for energy investments:

Step 1: Identify the key risks and their impact, given technology type and country context.

Step 2: Assess how these risks should be allocated between private investors, taxpayers and consumers.

Step 3: Choose the most appropriate ownership model.

Step 4: Identify and select instruments to "fine tune" the desired pattern of risk allocation.

6.1 Recommendations and next steps

We are continuing to develop this framework so that it can be used as a practical tool for energy ministries, finance ministries and development banks (as well as for private investors in power generation). This framework is designed to complement decision-making processes used by these institutions, such as the "Cascade" approach currently being implemented by the World Bank[12].

This initial work has also suggested some key risks which are (i) having a major impact of the cost of renewable energy and (ii) where further quantitative analysis of the right risk allocations and ownership model/instruments to achieve this are warranted. These include:

- **Price and offtake risks**. These risks can have a large impact on the cost of capital for renewables and, as we have argued, there is a good case for transferring much of these risks away from private investors in many contexts. To a large extent this risk allocation is already happening in many countries through the use of fixed price PPAs for private investors. But in turn the growth of this model means offtake risk is becoming a more important issue. In many developing countries, the offtaker for PPAs is a state-owned utility which is financially weak. As a result the private investor can face large risks around contract default (or payment delay). Evaluating the effectiveness of instruments to help manage these risks better (eg, development bank insurance) is a key issue.
- **Curtailment risk**. As the penetrations of renewables in electricity markets grow, curtailment rates are also likely to grow. In turn, curtailment risks will grow and could have an increasingly large impact on financing costs, depending on how they are allocated. As we have argued, in many contexts most of these risks should be socialized, since private renewables generators have limited ability to manage this risk once a plant is built.
- **Development risks**. The correct allocation of development risks is also becoming a major issue for two reasons. First, renewables (eg, wind, solar) tend to be geographically dispersed and the ability to acquire land, navigate local planning rules and arrange grid connection Is critical to managing the risks. Second, the growth of auctions amplifies these risks. For a private developer the risks around (i) what the future auctions volumes will be and (ii) whether they will be successful in these auctions can be very high, implying a high cost of capital at the development stage. Given that national/local governments and regulators have a major impact on these risks (eg, they determine auction volumes and set planning rules), public entities may be better placed to manage these in some contexts (eg, by financing development work publicly as is the case with solar parks in India).

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[12] The World Bank's "Cascade" approach starts by asking whether the private sector can finance a project. If this isn't possible the next step assesses whether reforms to regulation or policy can get private investment flowing. Then if the project is still not privately financeable, the World Bank will look to deploy risk sharing tools, such as guarantees and insurance. Finally, if these measures are still insufficient to bring in private funding, direct public finance becomes the option of last resort. *Forward look: A vision for the World Bank group in 2030 – progress and challenges*, World Bank (2017).

Annex 1: Key considerations in assessing the ideal allocation of each risk

In Section 2 we set out a framework for assessing the ideal allocation of each risk between private investors and taxpayer/consumers. Table 9 below sets out some of the key questions that typically should be considered for each risk as part of this process.

Table 9. Key issues to consider when assessing the right allocation of risks

Risk	Key issues/questions when assessing the ideal allocation of risks
Development	To what extent do decisions and policies made by public entities impact on development risks (eg, planning and land acquisition rules, licensing, decisions on future auctions volumes)? Are public entities better placed to understand and manage these risks than private developers? To what extent are there "common costs" (eg, site surveys) that could be undertaken more efficiently by a single public entity rather than multiple, competing private developers?
Construction	What is the evidence on the construction cost efficiency of state-owned firms versus private developers? To what extent can future changes to policy and regulation impact on construction costs (eg, nuclear safety regulations)? How do these potential changes impact on risk perceptions and the private cost of capital in the construction phase?
Operating	What is the evidence on the operating cost efficiency of state-owned firms versus private developers? To what extent can future changes to policy and regulation impact on operating costs (eg, nuclear safety regulations)? What impact do these potential changes have on the cost of capital?
Resource	To what extent can private developers of the technology (eg, wind) influence resource risk (eg, the level and uncertainty in wind yields) through their siting decisions? What impact does resource risk have on the private cost of capital? Do private financial markets offer competitively-priced products for hedging resource risks (eg, weather insurance)?
Decommissioning & environmental	To what extent could future changes to decommissioning regulations influence decommissioning cost? What impact does the risk around these potential changes have on the cost of capital? Are public entities or private owners best placed to manage and understand these risks? To what extent can private owners control environmental risks? And to what extent can private investors bear the risks (eg, can these risks be effectively diversified in private markets)?
Curtailment	To what extent can private owners of the technology manage curtailment risk through their siting decisions? Once built, to what extent can private owners manage curtailment risk? In particular, given the technology, how easily can they flex their dispatch up and down? How large is the risk around curtailment and to what extent can private investors understand this risk (eg, is the outlook on grid development predictable and transparent)? How do perceptions of curtailment risk impact on the private cost of capital?
Price & offtake	To what extent does exposing private owners to price risks improve the efficiency of dispatch (eg, does the generation type have the flexibility to adjust output in response to price signals)? What is the impact of price risk on the private cost of capital? If there is a long-term PPA or FiT in place, who is the counterparty (eg, state-owned utility)? What is the risk around payment default or delay (offtake risk) and how it this affected by the counterparty? How is this risk impacting on the cost of capital?
Policy	How large is the risk around policy? How is this risk impacting of the cost of capital? Is it possible to separate policy risk from other risks to allow a 'clean' transfer of this risk (e.g. if nuclear costs overrun it may be difficult to untangle how much is due to changes in safety regulation and how much due to lax management)?

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