BOOK

Time and Chance

The Elements of Scale in the Green Transition

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Contents

1 Preface . . . 2
2 A Note on Terms . . . 4
3 Part I — The Price of Money . . . 6
3.1 1. Why Capital Costs Too Much . . . 6
3.2 2. Financial Constraints as a Barrier to Renewable Uptake . . . 11
3.3 3. Why Risk Matters: A Primer . . . 13
4 Part II — Contracts: Making Revenue Bankable . . . 16
4.1 4. Why Contracts Beat Prices . . . 16
4.2 5. Commitment Devices: Contracts for Difference and Price Floors . . . 17
4.3 6. The Power Sector and Carbon Pricing . . . 19
5 Part III — The Instruments . . . 21
5.1 7. Forms of Guarantees . . . 21
5.2 8. Synthetic Sovereign Bonds for Green Energy Investment . . . 23
5.3 9. What the Record Shows . . . 29
5.4 10. Goals, Criteria, and a Worked Derisking Scheme . . . 31
5.5 11. Procurement Auctions and a Clean Energy Equity Fund . . . 35
5.6 12. Green Policy as Growth Policy . . . 37
5.7 13. The Sollar: A Solar-Panel-Backed Currency . . . 38
6 Part IV — Institutions and the Architecture of Concessionality . . . 42
6.1 14. Where the Risk Goes . . . 42
6.2 15. Overcoming the Balance Sheet Limit . . . 50
6.3 16. The Safe Intermediary Strategy: Toward a Theory of Concessionality . . . 56
6.4 17. Why the World Bank . . . 58
6.5 18. Scaling Up Policy Lending . . . 60
6.6 19. The Climate Investment and Insurance Fund . . . 64
6.7 20. The Climate Incentives Trust . . . 68
6.8 21. Rewarding National Carbon Stocks: The Notional Capitalized Carbon Value . . . 77
7 Part V — The Hard Cases: Utilities, Grids, Debt, and Coal . . . 80
7.1 22. The Offtaker's Own Economics . . . 80
7.2 23. The Other Half . . . 81
7.3 24. Avoiding the Non-Renewable Energy Debt Trap . . . 83
7.4 25. Debt Sustainability and Green Investment . . . 84
7.5 26. Phasing Out Coal: New Investment . . . 87
7.6 27. Retiring Existing Coal Assets . . . 88
7.7 28. Vietnam: The Whole Argument in One Country . . . 90
7.8 29. Two Worlds . . . 92
8 References . . . 95

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1 Preface

This book makes a single argument, and it can be stated in a sentence. The binding constraint on the energy transition in most of the world is not technology, and not the total quantity of capital available. It is the price at which that capital is offered — and the price is set by risk, which institutions can change.

The argument matters because of an arithmetic peculiarity of clean energy. A coal plant's lifetime cost is dominated by fuel. A solar park's is dominated by the cost of the money used to build it: the fuel is free, the maintenance is minimal, and almost everything is paid up-front. That makes the discount rate applied to a renewable project close to the only variable that determines the price of its output. The same solar panel, on the same roof, under the same sun, produces electricity at around 80 percent more in a country borrowing at 12 percent than in one borrowing at 4 percent, and at more than twice the price at 15 percent. Chapter 14 shows the calculation.

One estimate captures what turns on this better than any other figure in these pages. Under a major green public investment push, a developing country's debt-to-GDP ratio would rise by around 70 percentage points if it paid current bond market rates — and by around 10 percentage points at the rates the World Bank charges. The same physical programme, the same panels, the same megawatt-hours: either a debt crisis or a manageable expansion, decided entirely by the interest rate.

The figure comes from an illustrative simulation by the Independent High-Level Expert Group on Climate Finance, and like any such figure it depends on the size of the investment push assumed and on the starting point of the country in question. It is cited here not as a forecast but as a demonstration of scale: the interest rate is not one factor among several in the affordability of a transition. It is the factor.

If that is right, then a great deal of climate policy has been aimed at the wrong target. The instinct of economists has been to raise the cost of emitting. The argument here is that in the countries where most future emissions will be decided, more can be achieved faster by lowering the cost of not emitting — and that doing so requires financial and institutional design rather than carbon prices.

Time and Chance

So far this is an argument about cost, and cost is the easier half of it. The harder half is about timing.

The price of money does not only determine whether the transition is affordable. It determines how fast it can go — and speed matters here in a way it does not in most areas of public policy, because several of the mechanisms this book relies on only work above a certain rate. Technology learning curves reward volume, so the cost of a solar panel in Lagos in 2035 depends on how many were built in 2025. Financial learning works the same way: lenders who have watched five power purchase agreements perform will price the sixth differently, which means the cost of capital falls as a *consequence* of deployment rather than as a precondition for it. Political economy compounds both. Every year a country delays, the incumbent it must eventually displace has another year of sunk capital, another year of employment, and another year of political claim. What is cheap to prevent is expensive to reverse.

These are self-reinforcing dynamics, and self-reinforcing dynamics have thresholds. Below some rate of investment they do not catch, and the transition proceeds as an expensive

series of one-off projects, each negotiated from scratch. Above it they compound, and the intervention becomes temporary because the market takes over. The empirical literature on green growth points the same way: the measured growth benefit of renewable deployment appears to depend on crossing a threshold of investment, which would mean that half-measures are the worst of the available options, incurring the costs of transition without reaching the scale at which the benefits arrive.

The consequence is that a transition financed at twelve percent is not simply a more expensive version of one financed at four. It is slow, and small, and therefore never triggers the dynamics that were supposed to make it self-sustaining. It stays a subsidy programme rather than becoming an industry. The interest rate does not merely set the price of the transition; it decides which of two quite different futures a country ends up in.

Hence the argument for designing incentives that reward acting *now* rather than eventually — the dynamic incentives of Chapters 20 and 22, which give first movers a better deal than late movers, and the auction structures whose falling clearing prices reward whoever moves first. Hence, too, the emphasis throughout on structures that recycle their capital rather than consuming it, since a fund that doubles every three years is a mechanism for compounding and a grant is not.

There is a final sense in which chance belongs in the title. Almost everything in this book is about risk: who bears it, what it costs, and how much of it is real as against merely unfamiliar. A large part of the premium that developing countries pay is not compensation for hazards that will materialize. It is the price of an absent track record — of lenders having no basis on which to judge, and therefore charging for their ignorance. That component of the cost of capital can be removed by institutional design without anyone bearing a loss, and much of what follows is an attempt to do exactly that.

The Shape of the Argument

Part I sets out the diagnosis: how large the financing gap is, what creates it, why the barriers are as much informational as real, and what risk actually is.

Part II is about contracts, and it is where pricing policy enters this book. A cheap cost of capital requires a predictable revenue stream, and predictable revenue streams do not occur naturally — they are created by policy. Power purchase agreements, reverse auctions and contracts for difference are the instruments that manufacture them. The claim here is that these are not merely procurement conveniences but the foundation on which everything in the rest of the book is built: where no contracted revenue stream exists, none of the financial structures work.

Part III sets out the instruments themselves — guarantees, synthetic sovereign bonds, securitization vehicles, equity buffer funds, and one speculative currency.

Part IV turns to institutions, and to a theory of concessionality: the claim that much of what we call concessional finance can be manufactured out of credit ratings, long-term relationships and diversification, rather than paid for out of aid budgets.

Part V applies the argument to the two hardest cases — sovereign debt and coal.

A companion volume carries the material set aside from this one: the arguments about feebates and carbon market design, the work on green growth, the literature notes, and the institutional briefs from which several of these chapters grew.

A note on scope. This book is about mitigation — about financing the assets that reduce emissions. It says nothing about adaptation: about seawalls, drought-resistant agriculture, or the financing of resilience. That is a large omission and a deliberate one. The financing logic of adaptation is different, because adaptation assets rarely generate a contracted rev-

enue stream, and the argument here depends on that stream existing. A book on adaptation finance would need a different foundation.

Borrowing from the Future

One idea from the earlier drafts of this project deserves to stay in the preface, because it frames everything that follows even though no chapter depends on it.

Climate change is an obligation on the present to take care of the future. Economists have the notion of a Pareto improvement — an outcome in which everyone is better off — and there is a version of climate finance that qualifies. If the present borrows from the future to prevent damage to the future, and the damage prevented exceeds the debt service, then no generation loses. This is not redistribution between generations. It is an investment that happens to cross a generational boundary, and the only reason it does not happen automatically is that the beneficiaries cannot yet sign the contract.

One concrete mechanism was sketched: countries borrowing in proportion to their historical responsibility, beginning at USD 1 per historical ton emitted, with the United States as the largest historical emitter at 400 billion tonnes. The maximum liability would be USD 100 per ton for a country joining now, with only USD 1 payable at present. Rather than issuing bonds, participating countries would issue special drawing rights against the quantity of their historical emissions.

Whether or not that particular design survives contact with a treasury, the underlying observation holds, and it is the moral argument beneath the technical one. Borrowing to build assets that prevent future losses is not the same act as borrowing to consume. Chapter 24 makes the same point in the narrower language of debt sustainability.

2 A Note on Terms

This book uses a small number of financial terms repeatedly. They are explained where they first matter, but a reader may find it useful to have them in one place.

Cost of capital. The return that the people who finance a project require in order to finance it. For a solar park, it is the single largest component of the cost of the electricity, because almost all the cost is incurred up front and paid back over decades.

Power purchase agreement (PPA). A long-term contract, typically twenty to twenty-five years, under which a buyer — usually a utility — agrees to purchase a plant's output at a set price. It is what turns a solar park from a gamble on future electricity prices into a predictable revenue stream.

Offtaker. The buyer in a PPA. In most developing countries, a state-owned utility. Whether the offtaker pays on time is the largest single risk in an operating solar project.

Reverse auction. A procurement in which the government fixes the quantity it wants built and bidders compete on the price they will accept. The lowest bid wins a PPA.

Contract for difference (CfD). A contract under which the government tops up the producer's revenue if the market price falls below an agreed "strike price," and is paid back if the price rises above it.

Guarantee. A promise by a third party — a government, a development bank, an insurer — to pay if the primary obligor does not. Guarantees do not eliminate risk; they move it to a party better able to bear it.

Multilateral development bank (MDB). An institution such as the World Bank, owned by governments, which borrows cheaply on its shareholders' credit and lends to developing

countries. Its subsidiaries matter here: the IBRD lends to governments; the IFC invests in private projects; MIGA insures political risk.

Preferred creditor status. The observed fact that countries repay development banks even when they default on other creditors, because the relationship is worth more than any single payment.

Special purpose vehicle (SPV). A ringfenced legal entity created to hold one set of assets and issue securities against them, so that investors are exposed only to those assets.

Tranche. One slice of a financing, ranked in order of who is paid first. A senior tranche is paid before a junior one and is therefore safer and cheaper.

First loss, second loss. The order in which parties absorb losses. The first-loss party pays first; only when its capacity is exhausted does the second-loss party pay.

Concessional finance. Lending on better terms than the market would offer — a lower rate, a longer term, or both. Conventionally funded from aid budgets. This book argues that much of it can be manufactured instead.

Development policy financing (DPF). World Bank lending to a government's budget, disbursed on the condition that agreed policy reforms are carried out. The Bank's main instrument for rewarding reform.

Program-for-Results (PforR). A World Bank instrument that disburses against verified results rather than against inputs.

Financial Intermediary Fund (FIF). A pooled fund, hosted by the World Bank but with its own governance, through which donors channel money to a defined purpose.

Levelized cost of electricity (LCOE). The average cost per kilowatt-hour over a plant's life, with all costs discounted to the present. It is the number that the cost of capital most affects.

3 Part I — The Price of Money

3.1 1. Why Capital Costs Too Much

This book is about money — specifically, about why the capital needed for the transition is either unavailable or unaffordable in the places that need it most, and what determines the price.

The organizing question is simple to state and hard to answer. How should we reduce the gap between available finance and needed investment in green technology? This chapter approaches it from three angles: the size of the gap and the barriers that create it; a system-dynamic view encompassing policy complementarity, tipping points and economies of scale; and finally the specific realities of developing countries.

The Green Finance Gap and Investment Barriers

The IEA estimates global green financing needs of about $3 trillion per year, split roughly equally between power generation, end-use technologies and infrastructure (IEA, 2021a, 2021b). For developing countries excluding China, the figure required is around $600 billion in annual capital spending by 2030.

Set against that, the historical record is sobering. Between 2000 and 2017 total investment came to $138.9 billion (IRENA, 2020) — not per year, but cumulatively. The gap is not marginal. It is close to an order of magnitude, and closing it is not a matter of adjusting the terms on which capital flows but of building channels that do not currently exist.

It matters, too, that "finance" is not one thing. The investor base is heterogeneous — commercial banks, institutional investors with long liabilities, project developers, development finance institutions, domestic savers — and each responds to a different mix of risk, tenor and instrument. A policy that mobilizes one pool may be irrelevant to another. This is a theme that recurs throughout Parts III and IV: the instrument has to be matched to the investor.

So what are the barriers? Three stand out. Transaction costs, which fall disproportionately on small projects and make the very deals that developing countries can execute uneconomic to arrange. The complexity of available climate funds, each with its own application process, eligibility rules and reporting requirements, which imposes a capability tax on precisely the governments least able to pay it. And the risks associated with the innovative nature of the solutions on offer, which is a genuine problem rather than an imagined one: a technology with no local operating history has no local track record to lend against.

Overcoming these requires being clear about which actor does what, since much of the waste in climate finance comes from institutions attempting roles they are not suited to.

- **Governments** set policy direction. This is the domain of the policy taxonomy, and it is where Part II of this book and the companion volume apply.
- **Governments together with MDBs and other development institutions** derisk private investment. Neither can do it alone: the government holds the policy levers, the MDB holds the credit rating.
- **MDBs, DFIs and financial institutions generally** structure the innovative instruments for derisking and blended finance. This is a design capability, and it is scarcer than money.

Adaptation offers a useful demonstration that this division of labor can work. In the water sector, national and local governments have integrated private sector agents to support new infrastructure investment through public-private partnership structures, with considerable effect (Altamirano, 2021).

System Dynamics: Economies of Scale, Tipping Points and Policy Complementarity

The second approach starts from an uncomfortable premise: global resources for this are limited, and will remain limited. If that is accepted, then the objective is not to fund the transition directly but to find the points in the economic, technological, social and political systems where a limited intervention produces local change that then sustains itself. The aim is to buy virtuous circles rather than megawatts.

Several such dynamics are already visible.

Technology learning. The global collapse in renewable energy costs is the outstanding example. Each doubling of deployed capacity lowered costs, which raised deployment, which lowered costs again. Money spent on German feed-in tariffs in 2005 is why solar is cheap in India today.

Information and demonstration. The first project of a given type in a given country is worth more than its megawatts, because it establishes that the thing can be done — the permits obtained, the grid connection achieved, the tariff actually paid. The second project is easier to finance for reasons that have nothing to do with technology.

Financial deepening. The cost of capital in a developing country falls as experience with a new asset class accumulates. Lenders who have seen five solar PPAs perform will price the sixth differently. This is a learning curve in finance rather than in engineering, and it is arguably the more valuable of the two, for reasons Part III develops.

The Political Economy Has the Same Shape

The political economy of the transition exhibits the same dynamic structure, which is what makes it tractable.

Ask whether it is easy to implement a substantial carbon tax in a country where coal is the dominant power source. It is not, and for two compounding reasons. Incumbent industries resist changes that reduce their profitability, and they are organized to do so — the logic of collective action set out in Chapter 4. And the high costs imposed on a coal-dependent system are passed through to consumers, who then resist as well. The policy creates its own opposition on both sides of the meter.

The way out is to separate the incentives needed to transform an industry from the *cost* of that transformation. This is the single most important structural idea in this book, and it appears in three different guises: as the feebate of the companion volume, which delivers a marginal signal without a net burden; as derisking in Part III, which lowers the cost of the alternative rather than raising the cost of the incumbent; and as the concessionality architecture of Part IV. In short, the transformation should be encouraged by giving neutral incentives and access to cheap, available finance.

Note also the interaction that runs the other way. As long as fossil fuel subsidies persist, there is no incentive to invest in renewables, and the transition is delayed regardless of what else is done. Introducing a carbon tax is an excellent way of pricing that market failure. The instruments are complements, not alternatives, and a country that removes subsidies while derisking renewables gets more from each than the sum of the two.

Sometimes a virtuous circle reaches a *tipping point*, beyond which the market takes over without further intervention. This is what makes the strategy affordable: the intervention

has a finite duration. Tipping can happen locally, regionally or globally, and the literature identifies several distinct varieties (Van der Ploeg, 2021):

- **Policy tipping.** The more countries that follow a particular route, the more likely others are to follow, and the smaller the international leakage from any one country's action.
- **Technology cost tipping.** As demand for greener technology increases, production costs decline, which lowers prices and raises demand again. The consequence for this book's purposes is that the needed technology becomes cheaper precisely in the capital-constrained countries that could not have afforded to develop it.
- **Social tipping.** Leading figures in society — not necessarily politicians — advocating green policies changes the perceived urgency of adopting them, and thereby the political cost of resisting.
- **Political economy tipping**, where the constituency benefiting from the transition outgrows the constituency defending the incumbent.
- **Technological business model tipping**, where a new way of organizing production becomes the default.
- **Financial business model tipping**, where a financing structure becomes standardized enough to be replicated without bespoke arrangement — the explicit objective of the schemes in Part III.
- **International tipping**, where the interaction of the above across borders becomes self-reinforcing.

The literature converges on a coordinated and practical approach in which different parts of the economy are systemically linked through strategic goals, rather than each being addressed with its own isolated instrument.

Reality Check for Developing Countries

What is the reality check for developing countries in particular? When we look at investment in developing countries, we find that poorer ones rely more heavily on government and on multilateral development banks. Many are now constrained in their public finance capability — several are already at their debt-sustainability limits.

This produces a paradox that has to be resolved rather than deplored. Government guarantees or government financing are needed to reduce the cost of capital, and there is no realistic substitute for them. But risks and long-term contingent liabilities have to be minimized, because the government's balance sheet is the binding constraint. The resolution may be to develop dedicated risk-absorbing funds that enhance the derisking capability of governments and MDBs — extending what those institutions can guarantee without extending what they must ultimately pay. Part III is largely an attempt to build this.

Many developing countries are rich in natural resources, which in principle should make it easier for them to transform their economies and move from fossil dependence to renewables. In practice the transition is harder than that suggests. The relevant technology may not yet be developed locally, the volumes of capital required are large, and sources of finance are scarce.

Africa as the Case

Africa illustrates the whole problem compactly. The continent produces the smallest share of global emissions (Collier and Venables, 2012) — not because of green policy but because of poverty. It depends heavily on rain-fed agriculture, which means climate shocks hit living standards harder there than in regions less exposed to the weather. The continent is thus maximally vulnerable and minimally responsible, which is the core of the equity argument.

The physical resource is abundant. Africa has more intense sunlight than most northern countries, and it is distributed more evenly through the year — which matters, because it reduces the seasonal storage requirement. On hydro the gap between potential and actual is stark: the continent could generate 8 percent of its electricity from hydroelectric sources and currently generates 2.7 percent.

What is missing is capital, and the reasons compound. Households have low savings. Governments have not built efficient tax systems and hold few savings of their own, so they cannot make the investments themselves. And a history of debt default makes private investors reluctant to lend, so risk premia and therefore interest payments are higher than in developed countries. Since renewable energy is capital-intensive, a high interest rate translates almost directly into a high cost per kilowatt-hour — which is why the same solar panel produces expensive electricity in Lagos and cheap electricity in Lisbon.

The consequence is dependence: lacking capital, the continent relies on others to develop the technology and then imports it. Given how much climate change threatens African living standards, and hence how urgent the technology is there, this is close to the worst possible allocation of urgency and capability.

The Division of Labor

It is worth setting out explicitly the natural division of labor between the entities involved, because the schemes in Part III depend on each party doing only what it is good at.

Governments provide guiding policy and program direction. Private contractors provide technical capability. MDBs provide a high credit rating and project experience — and, importantly, act as a signal to other participants about which projects are investable. Finally, risk-absorbing equity funds allow the capability of all the other actors to be fully leveraged, by taking the first loss that none of the others can afford to take.

What Deters Private Investors

The literature is consistent that public and private sectors must work together, and reasonably consistent about what currently prevents the private side from showing up.

The principal deterrent is lack of confidence: unknown technology risks, lack of information, and lack of experience (Hafner et al., 2020). Note that only the first of these is really about technology; the other two are about the *absence of a track record*, which is a problem that solves itself once enough projects exist, and which is therefore an argument for subsidizing the first few.

Governments should continue to provide capital, but should also introduce policies that derisk and build private confidence. Issuing green bonds is one such measure — though it should be understood as a short-term risk-minimizing step rather than the ultimate answer to the financing gap.

Two further barriers deserve mention. Long bureaucratic processes for implementing projects are a deterrent that governments could remove quickly and at almost no fiscal cost, which makes it one of the higher returns available in this whole field. And the absence of a long-term climate framework leaves investors worrying about the intentions of future administrations — the credibility problem of Chapter 5. The answer is long-term national commitments of the kind that commitment devices and contracts for difference are designed to make binding.

There is also a straightforward incentive problem. The private sector currently lacks reason to commit the capital needed to develop green technologies, and it will keep lacking it as long as investment in brown infrastructure remains available (Hafner et al., 2020). Since

most of the sector's hesitation concerns risk, the instruments that help are those that reallocate it: grants, guarantees and insurance (Global Green Growth Institute, 2016).

One encouraging counter-example is worth recording. In Latin America and the Caribbean, microfinance institutions have increased their clean energy lending since 2012, when 4 percent of their budgets went to such projects (Forcella et al., 2017). What is notable is the motivation. It was not primarily projected returns. Boards of directors had concluded that their own clients would be harmed by climate impacts, and that developing the technology was necessary to limit that harm. These institutions identify current regulation as the main barrier to doing more — which is a solvable problem, and a reminder that some of the capital is already willing.

Conclusion

The literature identifies the barriers to adopting the green technology that fighting climate change requires. Some of that technology is still undeveloped and therefore requires high levels of capital investment, which poorer nations lack. Developed nations pledged to help finance this; since covid-19 the flows have in practice gone the other way.

Other barriers are political. Most politicians are concerned with the next election rather than the next generation, and are therefore unwilling to take measures that jeopardize their position — which is a large part of why carbon taxes remain rare. Some governments continue to subsidize fossil fuels, deterring renewable investment directly.

The private sector needs to be involved, and is held back by risk, whether objective or perceived. The composition of that reluctance is instructive: commercial investors will accept higher risk but want short project timeframes; institutional investors will accept long timeframes but want low risk. Green infrastructure is long and risky, and therefore falls between the two. Much of Part III consists of structures designed to split a single project into a long-dated low-risk tranche and a shorter high-risk one, so that each investor gets the profile it actually wants.

Viable ways forward include green bonds and crowdfunding to provide finance for green projects, and carbon taxation to discourage coal and correct the externality. Revenue from such taxation could be invested in green financing — and specifically in green derisking funds, which can be leveraged many times over. That multiplication is the argument for preferring a derisking fund to a direct subsidy of the same size.

Tipping points in policy, technology and social norms may accelerate the transition, and they are interrelated: one raises the probability of another. In the short term there may be a green paradox effect in which emissions rise, as owners of fossil reserves accelerate extraction in anticipation of future restriction.

But reducing emissions ultimately requires a global collective effort in which developed nations provide funds and capital to developing ones. Failing that, any policy introduced carries an increased risk of leakage. Without collective implementation of policies favoring renewables, the switch from fossil fuels can be delayed by as much as forty years (Van der Ploeg and Rezai, 2016). That figure is the reason the burden-sharing arguments of Part II and the institutional architecture of Part IV are not optional extras.

Further literature bearing on this chapter — on the role of domestic politics in green investment (Besley and Persson, 2019), on poorly-designed policy and the limits of oil-consumption measures absent carbon taxation (Van der Ploeg, 2016), and on coal specifically (Collier and Venables, 2014) — is summarized in Appendix 1.

3.2 2. Financial Constraints as a Barrier to Renewable Uptake

The previous chapter surveyed the gap. This one narrows the focus to a single technology in a single set of countries — solar PV in emerging markets — because that is where the argument of the rest of the book can be made concrete and, in principle, tested.

The Question

The underlying research programme is to measure the impact of Green Financial Sector Interventions on climate change mitigation outcomes. Derisking is one family of such interventions, and this chapter goes into it in detail, guarantees included, as a way of reducing both the risk and the perceived risk of green projects.

The mechanism is worth stating precisely, because two distinct effects are usually conflated. Projects with lower risk attract finance at a lower *cost* of capital, which reduces total project cost and can turn an uneconomic project economic. Separately, reducing risk increases the *quantity* of finance available, from domestic and international investors alike. The first effect changes the price of a project; the second changes whether it can be financed at all.

The core question is how the design of derisking instruments can induce positive spillovers — risk transfers to capital markets, for instance — that reduce the overall cost and scale of the public intervention required. Well-designed policy and financial instruments could raise financial inflows to emerging markets and developing economies, enabling climate mitigation at scale even under tight financial constraints. The objective is leverage, not expenditure.

Why Solar

This analysis focuses on the expansion of renewables, and on solar PV in particular, as the concrete context for guarantees and derisking. A high share of renewable supply is the backbone of net-zero scenarios consistent with the Paris goals (IEA, 2021).

The economics have already turned. Solar PV and onshore wind are cost-competitive with coal or gas-fired generation in many markets and are already the cheapest option in many countries (BloombergNEF, 2020). Renewables are not dispatchable in the way a thermal plant is, but storage costs are declining and are expected to become increasingly competitive within the decade. Solar has the additional property of working in a decentralized configuration, without costly investment in grid infrastructure — which is particularly valuable for short- and medium-term energy access goals in low-income countries.

For the purposes of this book, though, the decisive argument for solar is financial rather than technical. From a risk perspective solar has unusual advantages. Once a solar park is operational and grid-connected, operation and maintenance costs are minimal — there is no fuel to purchase, no fuel price to hedge, and comparatively little to break. Because insolation in most emerging markets is reliable, output is predictable. And the plant can sell power at a predetermined price, ideally set through an auctioned power purchase agreement.

Put those three properties together and a solar park looks less like an industrial asset and more like a bond: a predictable physical output sold at a contracted price with negligible running costs. That is the observation the whole of Part III builds on. If an asset has bond-like cash flows, it should be financeable at bond-like rates — and the gap between what it actually costs to finance and what its cash flow profile deserves is the value that derisking structures exist to capture.

The Constraint

Despite being economically viable, financing costs for renewables are high, particularly in emerging markets. This is a substantial constraint on any large-scale capacity increase.

There is a further twist that turns the problem into something more urgent than a cost issue. As international investors[1] align their portfolios with the Paris goals, emerging economies whose emissions trajectories are *not* aligned with those goals may see financial *outflows*. The countries that most need capital for the transition risk losing capital because they have not yet made it.

This is why the benefits of instruments that make renewable projects in emerging markets financially attractive are twofold. First, the energy sector in those countries can be decarbonized, which is a prerequisite for the Paris targets being met at all. Second, international financial flows can be drawn toward those countries rather than away, avoiding a drying-up with serious developmental consequences. Low-carbon and development objectives are no longer a tradeoff: recent cost developments allow countries to leapfrog the fossil-based development path entirely, provided they can finance the leap.

Investor Sentiment as a Barrier

Investor sentiment can itself obstruct the low-carbon transition (Battiston et al., 2021). Projects perceived as risky must compensate that perception with a higher return.[2] Overall project costs rise, less funding is available, and investment is restrained. Note the word *perceived*: some of this risk is real and some is informational, and the two call for different remedies. Real risk has to be reduced or transferred. Perceived risk can be addressed by track record, standardization and the presence of a credible institution alongside the project.

The open question, then, is how financial risk can be reduced so as to increase the availability of financing and lower its cost.

The chapters that follow give an overview of the policy instruments currently used to stimulate renewable capacity — power purchase agreements, and financial instruments including guarantees and equity funds — and then examine how they can be combined to derisk renewable investment effectively. The aim is to exploit the properties of PPAs and guarantees so as to reduce financial risk by *more* than the public financial input, which is the only way an intervention of this kind can reach the necessary scale.

Power Market Structure

None of this can be designed without attention to the market it sits in. The typical electricity market structure in emerging markets consists of a state-owned enterprise operating the grid, with power produced by independent power producers selling to the grid operator or to distribution companies.[3,4] This is the single-buyer model, and it has an important consequence: the creditworthiness of the entire renewable programme depends on the creditworthiness of one state-controlled counterparty. Chapter 7 returns to what can be done about that.

[1]Examples include the Net Zero Asset Managers Initiative ($57 trillion AUM), the Net Zero Insurance Alliance, and the Net Zero Banking Alliance (representing over 40% of global banking assets).

[2]While some investors, such as institutional investors, might need to abstain from those riskier investments entirely as they do not satisfy their required risk structure.

[3]We assume here that there is a state-owned enterprise operating the grid, purchasing power from independent power projects. Other market structures are possible, from a pure state-owned monopoly, to fully unbundled and competitive generation and distribution. But in other cases, it is usually possible to contrive a market structure like that of the SOE/IPP relationship, and in any case some sort of auctioned tariff is usually necessary.

[4]Foster and Rana, *Rethink. Power Sect. Reform Dev. World*.

Auctioned PPAs typically support the roll-out of renewables, because they set the price to be paid to the project and thereby create a fixed and foreseeable revenue stream. The mechanics are straightforward: the government or state-owned grid operator sets a quantity of renewable capacity to be built, private operators bid for the tariff, and the lowest bid wins. The winning developer knows in advance what will be paid for the power.

That predictability is the whole point. A predictable cash flow is what allows financial planning and access to finance at lower interest rates. Such agreements are already a common approach to scaling up renewables. The argument advanced here is stronger: they are not merely a procurement convenience but the vital policy component that makes financial risk reduction possible at all. Everything in Part III is built on top of a contracted revenue stream, and where no such stream exists, the structures do not work.

3.3 3. Why Risk Matters: A Primer

Everything in this part of the book is an argument about risk, so it is worth spending a short chapter on what risk is, what can be done about it, and why a development institution is unusually well placed to do it. Readers comfortable with the financial vocabulary can skip ahead; the one section they should not skip is the last, on superseniority.

Two Reasons Risk Matters

Risk matters for two distinct reasons, and conflating them causes confusion later.

The first is direct. Uncovered risk causes harm when it materializes — a project fails, a currency collapses, a government defaults, and someone bears the loss.

The second is the one this book cares about most. Risk raises the cost of borrowing. The lower the risk an investor bears, the lower the return that investor requires. For a capital-intensive asset with a twenty-five-year life, that required return is the dominant term in the cost of the output. Which means that reducing risk is not a defensive activity. It is the cheapest available method of reducing the price of clean electricity.

Reduction Versus Transfer

Risk can be dealt with in two fundamentally different ways, and the distinction runs through every structure in this part.

It can be *reduced* outright — genuinely made smaller, for instance through good hedging or through arrangements that change the underlying behavior. Or it can be *transferred*, moved from one party's balance sheet to another's. Transfer is enormously useful, because parties differ in their capacity to absorb a given risk, and moving a risk to someone better able to hold it lowers its price without changing its size.

But transfer has a characteristic failure mode that deserves emphasis. Many transfer strategies work normally almost all of the time and then fail together. They have tail risks: the counterparty that was diversified turns out to have been correlated, and the insurance is worthless exactly when it is needed. A structure that relies entirely on transfer with no reduction is a structure that has hidden its risk rather than dealt with it.

Types of Risk

Whose risk one is talking about matters, because the same event looks different from each balance sheet.

- **From an investor's point of view:** market risk, including foreign exchange risk; construction risk; and political risk.
- **From a government's point of view:** energy price risk, and fiscal risk arising from climate itself — both from physical damage and from the transition.

- **From an MDB's point of view:** borrower credit risk, above all.

A well-designed structure allocates each risk to the party for whom it is smallest or cheapest. Construction risk belongs with the developer, who controls it. Policy risk belongs with the government, which creates it. Currency risk belongs, ideally, nowhere — which is why so much of this part is about avoiding it rather than pricing it.

Four Strategies

There are four basic tools: diversification, hedging, security, and seniority.

Diversification. Don't put your eggs in one basket. The essential distinction is between diversifiable risk — idiosyncratic and uncorrelated across projects, so that pooling makes it shrink — and undiversifiable or systemic risk, which pooling does nothing about. A single solar park in a single country carries a great deal of diversifiable risk: this grid connection, this offtaker, this government. A portfolio spread across a dozen countries carries much less. This is the single most powerful and most underused property in climate finance, and it is why the equity fund in Chapter 10 can act as a cross-guarantor for projects it does not own.

Hedging. The point of a hedge is that the downside is covered. Two families of instrument do this.

Options, of which insurance is the everyday example: you pay a premium, and if the downside occurs you receive a larger payment. You keep the upside and buy away the downside, and the premium is the price of that asymmetry.

Forwards: going short, or taking the inverse bet. You enter a contract or hold an asset that moves opposite to your risk. This can be settled by *physical delivery*, or through a financial contract that simply pays the difference in price — a contract for difference. That is the same instrument as Chapter 5′s policy commitment device, which is worth noticing: a CfD is a hedge against the government's own policy, sold by the government.

Security and relationship. Stronger security means a better claim on something if things go wrong. But there is a softer and, for our purposes, more important version: caring about the relationship. This is the key feature of MDBs, and it has two components. They are considered secure, which is why they can borrow cheaply. And other countries value the relationship with them, which is why they get repaid. A borrower who expects to need the lender again behaves differently from one who does not, and that expectation is an asset — arguably the most valuable asset a development bank has.

Seniority. Not all promises are equal. A structure can create different claims on the same cash flow, ranked in order of who gets paid first. This is the workhorse technique of Part III: the point of tranching is that a single risky project can be split into a very safe claim and a very risky one, and sold to two different investors who each get the profile they want. The sum of the parts is worth more than the whole, because the pension fund that could not have touched the project can buy the senior tranche.

Green Superseniority

There is a specific and, in this book's view, underexplored idea worth flagging here, since Part IV returns to it: privileging green lending as *supersenior* — a claim that ranks above other claims on a sovereign or a utility.

The logic is straightforward once stated. If green lending is structurally the most senior claim, it is the cheapest claim, and the cost of capital for the transition falls furthest exactly where fiscal space is tightest. The cost is borne by other creditors, whose claims become correspondingly more junior — which means the policy is not free and would need to be established before the other debt is issued, or negotiated as part of a restructuring. But as

a way of directing the world's cheapest capital toward its most urgent investment, it is one of the more powerful levers available, and it requires no new money at all.

4 Part II — Contracts: Making Revenue Bankable

4.1 4. Why Contracts Beat Prices

The two preceding chapters established that risk sets the price of capital, and that the price of capital sets the price of clean electricity. This part asks where a low-risk revenue stream comes from. The answer is that it is manufactured, by policy — and that the policy which manufactures it best is not the one economists usually recommend.

The Standard Recommendation, and Its Limit

The orthodox instrument for decarbonization is a price on carbon. Its virtue is well understood: a single price equalizes marginal abatement cost across the whole economy, and no planner has to decide which technology wins.

The difficulty is that a carbon price tells an investor what emitting costs *today*. It does not tell them what emitting will cost in 2045, which is the number that matters when the asset in question has a twenty-five-year life and its entire cost is incurred in the first eighteen months. An emissions trading scheme is worse in this respect than a tax, because the quantity is fixed and so all the adjustment happens in the price, which then moves with the business cycle, the weather, and the politics of allowance allocation. A carbon tax is steadier but sits inside the budget, where a rate set in one fiscal year can be changed in the next.

The result is that the number an investor must put into a twenty-five-year model is a number no government has promised to maintain. And because the investor cannot verify it, the lender will not lend against it. A price signal that nobody will finance is not a price signal; it is an announcement.

Quantity Instruments Coordinate Across Time

There is an alternative, and its advantage is specifically intertemporal.

A reverse auction fixes the *quantity* and lets the market discover the price. The state contracts for a defined volume of renewable capacity; developers bid the tariff at which they will supply it; the lowest bid wins. Where the policy objective is to have a certain amount of something built by a certain date — which is precisely the objective in a transition with a deadline — a quantity instrument coordinates the investment path more reliably than a price instrument does.

This is the third of four claims about environmental taxation that ran through the earlier drafts of this project, and it is the one that matters most here: *procurement auctions coordinate intertemporally better than given prices*.

The fourth claim follows from it, and it is the hinge of this whole book: *the financing cost of renewables is lower under procurement auctions*. An auctioned power purchase agreement converts a merchant project, exposed to volatile wholesale prices, into a contracted project with a predictable revenue stream. Lenders price that difference — and since renewable energy is capital-intensive, a few percentage points off the discount rate is worth more than almost anything else a policymaker can do.

Put the two claims together and the conclusion is stronger than it first appears. The auction is not a second-best substitute for a carbon price, tolerated because carbon pricing is politically difficult. It is doing something a carbon price structurally cannot do: creating a contract. And a contract is a financeable asset.

What This Means for the Rest of the Book

Chapter 2 observed that a completed solar park has an unusual economic shape — a predictable physical output, sold at a contracted price, with negligible running costs. That is the shape of a bond, not of an industrial asset. An asset with bond-like cash flows ought to be financeable at bond-like rates, and the gap between what such projects actually pay and what their cash flow profile deserves is the value that every structure in Parts III and IV exists to capture.

But notice the precondition. The bond-like quality comes from the *contract*, not from the sunshine. A solar park selling into a spot market is not a bond; it is a commodity producer with a fixed cost base, which is a considerably worse thing to be. Every guarantee structure, securitization vehicle and equity buffer fund in this book is built on top of a contracted revenue stream. Where no such stream exists, the structures do not work — which is why a book about finance has to begin with a chapter about policy.

A Note on Political Economy

One further principle belongs here, because several later chapters lean on it. Following Mancur Olson, call it the logic of collective action.

A necessary condition for a policy to be politically feasible is that its benefits be concentrated and its costs diffuse, rather than the reverse. Where costs fall on a group that can organize its own members — a trade association, a state-owned utility, a regional industry — that group will lobby to block the policy. Costs spread thinly across millions of households are individually too small to be worth acting on, and organizing those millions is prohibitively expensive.

This is uncomfortable for carbon pricing, whose costs are concentrated on identifiable emitters and whose benefits are diffuse. It is comfortable for the approach taken in this book, and that is not a coincidence. Lowering the cost of capital for clean investment concentrates its benefits on developers, lenders, ministries of finance and electricity consumers, all of whom can identify what they gained, while its costs are borne by a guarantor's balance sheet in states of the world that mostly do not occur. It is, in Olson's terms, a policy shaped to pass.

The companion volume develops the same principle in the direction of feebates — instruments that deliver a carbon price's marginal signal without its net burden — and readers interested in the pricing side of the argument will find it there. In this volume the principle appears in a narrower role: as an explanation of why financial instruments have travelled further, and faster, than the prices economists have spent thirty years recommending.

4.2 5. Commitment Devices: Contracts for Difference and Price Floors

A price signal that investors do not believe is not a price signal. It is an announcement. This chapter is about the instruments that turn one into the other.

The Credibility Problem

Carbon pricing as actually practiced rarely delivers the certainty that long-lived investment requires. Emissions trading schemes produce a volatile price by construction: the quantity is fixed, so all the adjustment happens in the price, and the price then swings with the business cycle, the weather and the politics of allowance allocation. Carbon taxes are steadier in principle but sit inside the budget, where a rate set in one fiscal year can be changed in the next. Either way, the number an investor must plug into a twenty-five-year model is a number no government has promised to maintain.

Commitment devices, price floors and price caps address this directly. They keep the price within a band that investors and international agencies can rely on, and they do so through mechanisms that are costly for a future government to reverse.

Two distinct reasons make this worth doing.

The first is international. A policy commitment that is credible and hard to unwind is worth more, in negotiation and in the design of conditional finance, than one that can be reversed after the next election. This has a direct implication for how development institutions should design their conditionality: a prior action consisting of a long-term commitment should count for more than one that does not. A carbon tax legislated for this year is a gesture. A carbon tax with a statutory floor trajectory and contractual counterparties is a commitment.

The second is investment. Private agents need certainty to fund long-term projects whose costs exceed the incumbent alternative's. This is most acute exactly where it matters most — in high-risk environments, in developing countries, and for green technologies competing against an established fossil incumbent that has already amortized its capital.

Contracts for Difference

Contracts for difference are the sharpest tool in this category. A CfD is a contract issued by a government guaranteeing that a particular policy will keep providing a price signal over the life of an investment. It works by defining a strike price. If the market price — of carbon, or of power, or of hydrogen — falls below the strike, the government pays the difference. Most CfDs are two-sided: if the price rises above the strike, the counterparty pays the government back, so the arrangement generates revenue in exactly the states of the world where the policy is succeeding on its own.

What this buys the investor is a return above breakeven for the duration of the project. That is the thing investors actually need and the thing that pricing instruments, emissions trading schemes above all, are structurally incapable of providing. The design is already proven: CfDs are established in electricity markets and are being used in emerging hydrogen markets, and in both cases they have been decisive in getting low-emissions alternatives financed.

The fiscal logic deserves emphasis, because it is often misread. A two-sided CfD is not a subsidy. It is a swap of price risk for quantity certainty, in which the government takes on a risk it is better placed to bear — it is, after all, the party that controls the policy — in exchange for a much lower cost of capital on the project. As Part I argues at length, that lower cost of capital is where most of the value is created.

Carbon Price Floors

The blunter version of the same idea is a floor: a commitment that the carbon price will not fall below a stated level. Floors do less than CfDs for any individual project, since they guarantee a minimum rather than a return, but they are administratively simpler and they do one job extremely well. A credible floor is what forces high-emission incumbents — coal generation above all — out of the merit order and keeps them out. Without a floor, a coal plant can simply wait for the allowance price to soften. With one, it cannot.

Floors and CfDs are complements rather than substitutes. The floor sets the level below which the system will not fall; the CfD converts that system-level assurance into a project-level revenue stream that a lender will accept as collateral.

4.3 6. The Power Sector and Carbon Pricing

Every argument in this book about pricing eventually has to be tested against one sector, because one sector carries most of the load. This chapter sets out why the power sector is the place where carbon pricing does its best work, and what specifically complicates it there.

Why Power Comes First

Electricity matters twice over. It is a large emitting sector in its own right. But it is also the principal energy carrier for a decarbonized economy: in almost every net-zero pathway, transport, heating and a large slice of industry are electrified, which means their emissions become the power sector's emissions. Decarbonizing power is therefore not one task among several. It is the precondition for the others. The power sector cannot serve as the clean energy source for the whole economy until it is itself clean.

Carbon pricing acts on power through three distinct channels, each operating on a different timescale: the *generation* decision, which responds within hours as the merit order reshuffles; the *retirement* decision, which responds over months and years as plants become uneconomic; and the *investment* decision, which responds over decades.

Two Features That Cut in Opposite Directions

The first is that power is an unusually economic sector — in the sense that its decisions are made on relatively clean cost comparisons, and its assets are dispatched by merit order. Shifts in relative prices caused by carbon pricing therefore produce large shifts in emissions at reasonable cost. This is carbon pricing at its most effective, and it is the strongest single argument for putting a price on carbon at all.

The second cuts the other way: the power sector in much of the world, and in most developing countries, is state-owned. Economic sensitivity to a carbon price is only as strong as the decision rules of the entity making the decisions. A vertically integrated state utility operating under a politically set tariff, a mandate to keep the lights on and a balance sheet that the finance ministry ultimately underwrites will not respond to a carbon price the way a merchant generator does. It may not respond at all. Any serious program of work here has to assess in detail how different market structures — merchant, single-buyer, vertically integrated state monopoly — actually transmit a carbon price into generation, retirement and investment decisions. Chapter 2 returns to this.

The Pass-Through Problem

Carbon pricing also acts on the demand for power. Because power is at present often highly emissions-intensive, a carbon price raises its cost, and that increase passes through to end consumers. This is where the politics bites, and there are three distinct challenges with the pass-through.

The first is distributional. Electricity is close to a necessity, and spending on it takes a larger share of poor households' budgets than of rich ones', so an unmitigated pass-through is regressive. This is a solvable problem — the case for targeted transfers and per-capita rebate components applies directly — but it must actually be solved rather than assumed away.

The second is that the pass-through works against electrification. Raising the price of electricity to reflect its current carbon content discourages exactly the switching — from gas boilers to heat pumps, from internal combustion to electric vehicles — that the strategy depends on. The instrument bites hardest on the substitute it is trying to promote. This is a strong argument for output-based rebating: charge on the fuel, refund per kilowatt-hour delivered, and the generation mix moves without the retail price rising.

The third is credibility, and it loops back to Chapter 5. Where tariffs are regulated or politically set, a carbon price that would raise consumer bills is the carbon price most likely to be suspended, exempted or reversed. A pass-through that cannot survive a bad winter is not a signal investors will finance against.

5 Part III — The Instruments

5.1 7. Forms of Guarantees

If risk is the problem, guarantees are the most direct answer, and the oldest. This chapter surveys what is actually available, what each form costs the guarantor, and why the best structures combine several rather than choosing one.

What a Guarantee Is For

Guarantees provide higher certainty to lenders in renewable energy projects. The objective, importantly, is *not* to guarantee all risks. It is to mitigate the specific risks created by a lack of confidence in state institutions: policy and payment risks caused by the government or a state entity, and political risks.[5]

That targeting is what makes the instrument affordable. A guarantee against everything is an equity investment with extra steps. A guarantee against the two or three risks that the market is mispricing — because they are unfamiliar, or because the counterparty is a state-owned distribution company with a poor payment record — buys a large reduction in perceived risk for a small assumption of real risk.

Several distinct forms exist, along with related devices including indirect contracting and securitization, all of which can reduce policy and payment risk and thereby improve a project's financial profile. This chapter does not attempt to cover them all. It concentrates on standard sovereign and development bank guarantees, risk insurance, and indirect contracting approaches, in which a creditworthy intermediary increases the certainty of power purchase agreements and thereby allows independent power producers to reach sovereign bond markets.

Each form has its own advantages and disadvantages. The argument developed over the following chapters is that a *combination* leverages the benefits of each, and that the combination is worth considerably more than the sum of its parts.

Sovereign and Development Bank Guarantees

A sovereign guarantee may cover either the contract issued by the state-owned enterprise or the borrowing undertaken by the independent power project.[6] Such guarantees are genuinely useful: they provide credit certainty over and above the creditworthiness of the SOE or the IPP itself.

But a guarantee is a contingent liability on the guarantor's balance sheet, and that is the binding constraint on the whole approach. It limits the overall scale of investment that can be guaranteed — which means that in the countries where guarantees are most needed, the capacity to issue them runs out fastest. Risk transfer, such as MIGA's reinsurance practice, and risk reduction, such as the IBRD's use of its country relationships, are the two available routes to reducing the contingent liabilities that guarantees generate.[7]

Multilateral development banks provide guarantees of their own. The Multilateral Investment Guarantee Agency offers two forms addressing risks that commonly arise in emerging markets. Political Risk Insurance protects against adverse political events such as the nationalization of investments. Credit Enhancement products guarantee against credit risk.

[5]Market risk and liquidity risk in the financial markets are also significant but are not emphasized in this brief.
[6]International Renewable Energy Agency, "Sovereign Guarantees - Renewable Energy Finance Brief 01."
[7]MIGA, "MIGA: Advancing Sustainable Investments."

The mechanics of MIGA's guarantees repay attention, because they show how scale can be achieved. They are typically *reinsured*: the risk is not retained on MIGA's balance sheet but shifted to reinsurers'. That reinsurance costs money, but the risk transfer is a vital component, because it recruits the capacity of the global insurance market rather than being limited by the capital of a single agency.

The International Bank for Reconstruction and Development — the World Bank's primary legal entity — also provides guarantees, and it does so on a different principle. The IBRD might guarantee a state-owned enterprise, but the state concerned provides indemnification to the IBRD in return. If there is a default and the IBRD pays, the state is liable to reimburse it.

This looks circular until one sees what it accomplishes. The *long-term relationship* between the state and the IBRD reduces the riskiness borne by the guarantor, because states do not typically wish to default to the IBRD — the relationship is worth more than any single payment. In effect, the IBRD acts as a commitment device, using its strong credit rating to allow a government to guarantee its own state-owned enterprise at a *higher* rating than it could achieve directly. The government's promise becomes more credible by being routed through an institution that the government cannot afford to disappoint.

This is the single most important structural insight in this chapter, and it recurs throughout Part IV. The concessionality is generated not by spending money but by borrowing credibility.

Reducing the Risk of the PPA Itself

Energy markets in emerging economies commonly suffer from three compounding problems: the poor financial condition of energy providers, the high cost of further investment in grid and generation, and a limited investor base. The specific characteristics of power purchase agreements offer a way for investors and developers of independent power projects to get past all three.

Intermediate contracting is the key device. In India, independent power producers contract with the Solar Energy Corporation of India[8] rather than with the distribution companies, which are typically in poor financial shape. A separate agreement between the distribution companies and SECI provides for the same fee to be paid. Because the federal Solar Energy Corporation carries a far better rating than the Discoms, it is perceived by investors as more financially stable and viable. The federal government then indemnifies SECI, and the state governments in turn guarantee their distribution companies.

Read that chain carefully and one can see it is the IBRD principle applied domestically: the risk has not disappeared, but it has been moved to a point in the chain where a long-term relationship makes it much cheaper to bear. Chapter 8 develops this into a general model.

Secure Vehicles to Issue Green Bonds

There are further options for reducing the risk borne by the IPP, of which the most powerful is the securitization of PPA proceeds.

A special purpose vehicle can be created to receive the PPA payments directly. In return, the SPV lends the IPP the money to make the initial renewable energy investment. The combination of guaranteed energy payments and a guarantee from a highly rated entity — a state or a development finance institution — allows the SPV to issue green bonds at low interest. Such instruments could attract a specific pool of investors committed to the Paris goals, which is a real and growing pool with a structural shortage of eligible assets to buy.

[8]Gadre et al., "India's Clean Power Revolution."

Special purpose vehicles can be housed within a global investment bank or a secure development bank institution. The essential mechanic is the order of payments: guaranteed payments are routed to the SPV, which pays bondholders first, before any money is directed to the project's equity investors. The bondholder is therefore exposed to the guarantor rather than to the developer — which is precisely the risk that can be priced cheaply.

5.2 8. Synthetic Sovereign Bonds for Green Energy Investment

This chapter sets out the central instrument of the book: a bond that carries a developed-country credit rating, funds clean power in a developing country, and consumes almost none of that country's fiscal space.

Summary of the Proposal

The proposal is for synthetic sovereign bonds for green energy investment — bonds partially co-guaranteed by a consortium of developed-country governments.[9] Such bonds could be arranged by MDBs without using developing countries' scarce fiscal balance sheet space.

The second half of the proposal is what makes the first half work. The clean power generation assets underlying such bonds would be derisked at the level of their *power purchase agreements*, through national or regional institutions modelled on the Solar Energy Corporation of India: a specialized government agency acting as intermediary between renewable energy project developers and wholesale electricity purchasers — in India's case the distribution companies, or Discoms. SECI ensures that participating generators are paid in full and on time for the power they produce.

The reason for attacking the problem at the PPA rather than at the bond is developed below, and it is the analytical core of this chapter.

Context: The Scale of What Is Required

The IEA suggests that global clean energy investment needs to reach $3 trillion per year by 2030 (IEA, 2021a, 2021b) for the world to meet the Paris goals. Roughly a third of that — $1 trillion per year by 2030 — is needed directly for energy supply, principally renewables, with similar quantities for end-use technologies and public infrastructure. The total splits roughly equally between China, the developed world and the developing world.

This investment has to happen against a backdrop of fiscal constraint in many developing countries, following the pandemic and the spike in energy prices. Infrastructure investment in those countries typically involves a large role for the state and for MDBs, particularly in the least developed. And the state's role in electricity is larger still: generation and distribution are frequently in the hands of state-owned enterprises, and markets, where they exist at all, are designed and regulated by governments and government agencies.

The energy-related emissions problem divides into supply and demand. This chapter restricts itself to needed investment in energy *supply* in developing countries. Renewable generators and other low-carbon power sources are the key to the transition, because they are the principal primary energy sources for any future low-carbon energy system. The existing generation sector must be decarbonized — and generation must simultaneously be scaled far beyond its current size, as per capita energy use rises, populations grow, and transport and heating electrify.[10]

[9] This relates to the idea of a 'climate club'.

[10] Deployment of electrified end-user technologies (for example, air conditioning/heat pump units and lightweight, cheap electric vehicles) and infrastructure (charging point networks, transmission grids, utility-scale energy storage) must be scaled up quickly. This is not the topic of this paper, but rather the more general T2B report.

The costs of wind and solar fell dramatically between 2010 and 2020, and both are cost-competitive with fossil fuels for new investment in a growing number of regions, India notably among them. Recent cost increases driven by supply chain pressures and anticipated short-term mineral constraints notwithstanding, solar is expected to continue falling in price.

The Scaling Problem

None of which resolves the difficulty. Low-carbon electricity has a *scaling* problem: how can renewables, at present a relatively small sector, expand at the pace needed to cover the bulk of total energy demand, within the timescales the Paris targets imply?

Some of the constraints are endogenous, which means the system has to be *pushed* to expand rapidly in order to overcome them — the constraint relaxes as a consequence of the expansion, so waiting for it to clear on its own is a mistake. Physical constraints also need unlocking: grid connections, supply chains, mineral resources and the speed at which mines can open,[11] land, and labor markets.

But perhaps the most important scale constraint is the one this book is about: achieving the necessary scale and speed of *low-cost renewable energy project development financing*.

How PPAs Currently Work

Developing countries have a range of power market structures, from state monopolies to fully liberalized generation and distribution markets. In all of them, policies exist intended both to encourage renewables and to reduce their financing cost, and in all of them a *contract* for the power produced is struck between the independent power project and the power distributor — often a state-owned enterprise.

The terms of these contracts can be set by state fiat, as with feed-in tariffs, or auctioned through reverse auctions in which prospective suppliers compete by offering lower prices per MWh, typically in the context of twenty-year power purchase agreements. Reverse auctions that guarantee power prices for project financing are relevant right across the spectrum, from state monopolies — which can reduce financing costs by creating stand-alone contracted entities — to fully liberalized markets. The United Kingdom, a liberalized market, runs a reverse auction for offshore wind that awards contracts for difference, paying generators the difference between the market price and an auction-determined strike price.

Auctioned PPAs for renewables serve two purposes. Historically they were used to *subsidize* renewables. But they also provide a high degree of *certainty*, and can therefore be used to reduce financing costs. Since the costs of renewables are largely fixed rather than variable, such contracts make both economic and financial sense: a fixed-cost asset paired with a fixed-price contract is a coherent object, in a way that a fixed-cost asset exposed to volatile merchant prices is not.

PPAs and Fiscal Risk

Three things need saying about these contracts in the context of fiscal risk, and the first is uncomfortable for enthusiasts of the instrument.

PPAs are themselves a macroeconomic risk. Suppose a contract is signed for solar power at 5c/kWh in 2023, at a constant real price through 2030. Now suppose the cost of new renewable energy falls to 2.5c/kWh. Relative to new investment, the old contract is generating a loss of 2.5c/kWh on every kilowatt-hour produced — a loss borne by the offtaker, which is to say by consumers or by the state. This is not hypothetical; it is the standard history of every

[11] See: https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

successful renewable support scheme, and it is why early feed-in tariffs became politically toxic in Europe.

The remedy is to design the auction for the world as it will be rather than as it is. Auctions can be structured so that the contracted price *declines* over time, in step with the expected decline in renewable costs. Rather than contracting for 5c/kWh flat in real terms, one might contract for 6c/kWh now, falling to 3c/kWh by 2030 — a higher price when capital is being repaid and cost comparisons are favorable, a lower price later when the alternative has become cheap. If the real-terms value of these contracts does not decline, they store up financial risk for the long term.

The declining tariff is not free either, and it should be said who pays for it. A price that falls on a schedule fixed in advance is a bet that solar costs will fall at least as fast as the schedule. If they do not — supply chain disruption and mineral constraints have both interrupted the decline in recent years — the developer is squeezed, and a developer who anticipates being squeezed bids a higher starting price. The declining PPA therefore moves cost-curve risk from the offtaker to the developer, and the developer charges for carrying it. The design is still right, because the offtaker is the party least able to bear an open-ended real-terms commitment; but the saving is smaller than the headline decline suggests, and the schedule should be set against a conservative cost path rather than an optimistic one.

There is a second revenue risk inside the contract that the bond-like description of Chapter 2 tends to hide: curtailment. A plant that is contracted but whose grid cannot take its output earns nothing for the hours it is curtailed. Whether that loss falls on the offtaker or the developer depends on a single clause — a *take-or-pay* contract obliges the buyer to pay for contracted output whether or not it is delivered; a *take-and-pay* contract pays only for what is taken. Under the first, curtailment is the offtaker's problem and the cash flow really is bond-like. Under the second it is the developer's, and the developer prices it. In a weak grid the difference can be several percentage points on the cost of capital, and it is the reason transmission appears alongside offtaker reliability in every survey of what investors fear.

But PPAs also reduce macroeconomic risk elsewhere. Higher certainty reduces the financing cost, and a lower financing cost reduces the tariff that has to be contracted in the first place. The two effects work against each other, which is why the design of the decline profile matters so much: get it right and the contract is cheap and durable; get it wrong and it is either unfinanceable or a long-term liability.

And PPAs can be made more certain. The credit rating of the payment guarantor makes a very large difference to the certainty of payments and therefore to the risk of the power projects themselves. Guarantees can be used — but in the context of power markets, the efficient thing to guarantee is the *payor* in the reverse auction. That is the cornerstone of risk reduction, and it is the insight the rest of the chapter builds on.

What Green Synthetic-Sovereign-Rated Bonds Are

Synthetic sovereign bonds for green energy investment are structured to be rated similarly to the highest-rated developed-country sovereigns. They can fund green energy projects at large scale, and are especially useful in developing countries. They are backed by real assets *and* by payment guarantees issued by an AAA-rated entity.

Achieving a very high credit rating does two things. It allows capital to be raised at scale, from international markets and from domestic savings alike — the pools of money that require investment-grade instruments are vastly larger than those that will take emerging market project risk. And it reduces the interest cost, which is a major component of the total cost of green infrastructure. A low risk of bond default reduces the levelized cost of green

electricity, and that reduction can be shared between higher developer margins and lower consumer energy costs.

The goals of the proposal are therefore to:

- reduce the cost of capital on renewable investment;
- access low-cost capital at scale, reaching international institutional investors and attracting domestic savings;
- allow investment into poorer countries, where investment is presently dominated by the state and the MDBs; and
- enable green infrastructure investment to be scaled up under constrained fiscal space.

Guarantee the Offtaker, Not the Loan

Here is the key difference between this proposal and its predecessors. The guarantees sit principally at the level of the *offtaker* for the power, rather than at the level of the debt financing. The payment risk is reduced at source.

Why does that matter? Three reasons, and they compound.

It is simply more efficient. If the PPA is guaranteed, that specific risk is isolated from all the other risks in the structure, and each can then be priced and allocated separately. Guarantee the loan instead and you have bundled policy risk, payment risk, construction risk and currency risk into a single undifferentiated obligation.

It preserves recourse. If the *borrower* is guaranteed, there is unlikely to be any recourse to the source of the risk — the guarantor pays, and the state-owned enterprise that failed to pay faces no consequence. Whereas if the *payment* is guaranteed, then even where the offtaker cannot pay today, it can still repay the guarantor over the long term. The obligation converts into a credit relationship rather than vanishing, which is exactly the mechanism that made the IBRD structure in Chapter 7 work.

And it creates the right incentive. A distribution company that knows its arrears become a debt to a guarantor it must deal with again behaves better than one whose arrears are simply absorbed.

The SECI Model

India provides a working demonstration that institutional innovation can reduce financing costs.

Some Indian solar contracts are routed through a highly rated central auctioning company, the Solar Energy Corporation of India. SECI acts as intermediary between wholesale purchasers of electricity — the distribution companies — and generators, whether independent power producers or partially state-owned generation companies. SECI contracts with the generator to make timely payments for delivered power, and separately sells that power under contracts with the Discoms. If the Discoms are late paying SECI, SECI pays the generators anyway.

SECI can do this because it holds credit lines with the Reserve Bank of India, and because it is indemnified by state governments over the long term. The arrangement substantially reduces the counterparty payment risk faced by generators — risk which in India is very real, since most Discoms are owned by state governments and many are in poor financial condition for structural political-economic reasons that will not be resolved quickly.

The elegance of this is worth stating plainly. Nobody has fixed the Discoms. What has been fixed is the *sequencing* of who waits for whom. The generator, which needs certainty to raise cheap capital, is paid on time. The state, which can wait, waits. And the cost of that rearrangement is a credit line rather than a subsidy.

Scaling the Model Elsewhere

In larger countries — Nigeria or Brazil, say — a SECI-like intermediary could be established nationally. For smaller countries, regional clubs sharing a single SECI-like institution would be the way forward, and would have the additional benefit of diversifying across several sovereigns.

Such an arrangement provides high certainty for bondholders, especially for the financing of *operational* infrastructure: bonds funding portfolios of operating renewable assets whose construction is already complete. This is an important restriction and a useful one, since it separates the two risks that institutional investors are least willing to hold together. The World Bank could help create SECI-like structures without taking the risk onto its own balance sheet.

One further element would be needed to bring developed countries in as guarantors: the carbon value of the investments, in the form of a certified measure of avoided emissions. That is the principal reason a developed country would provide an international guarantee — it is buying mitigation, and it needs to be able to say how much. There is a legal foothold for this. The Paris decision refers, at paragraph 108, to the social value of mitigation activities, which could serve as the basis for valuing carbon reduction within SECI-like regional institutions. This connects the instrument directly to the pricing argument of Part II: the guarantee is the vehicle, and the global social cost of carbon is what determines how much of it a developed country should be willing to write.

Currency: The Risk That Cannot Be Guaranteed Away

The currency of the original PPA introduces a revaluation risk if it moves relative to revenues, and this is the hardest problem in the structure.

The mechanism is the familiar one from sovereign debt. Just as denominating government bonds in foreign currency amplifies the burden of payments when the local currency devalues, the same is true of PPAs. If PPAs are defined in dollars or another hard currency, there is a risk that they become, over the long term, a fiscal cost to the developing country — crystallizing precisely when the currency depreciates, exactly like external debt.

One mitigation is the declining PPA already discussed: define a price that falls year by year, matching the expected future cost of new solar, so that the hard-currency obligation shrinks as the exposure accumulates.

The alternative is to denominate in local currency, but this trades one problem for another. Assets denominated in weak local currencies may be useful for mobilizing domestic savings but will not attract international investment. Where that is the case, the bonds should be designed explicitly for the domestic savings market rather than pretending to international placement — a smaller pool, but a real one, and one whose liabilities are in the same currency as the asset.

There is no clean solution here within this instrument, which is why Chapter 12 raised the possibility of a green numéraire and why Chapter 13 develops it.

The Trade Balance

Related to currency risk is the effect of renewable equipment imports on the local economy. A large solar programme financed in hard currency and built with imported panels is a substantial import bill.

This argues for accompanying supply chain and industrial policies, to ensure that domestic or at least regional capability is built alongside deployed capacity. The industrial policy is not a distraction from the financing problem; it is part of the answer to it, since domestic manufacturing converts part of the hard-currency cost into local currency spending.

The Mechanics of Issuance

The derisked power purchase agreement ensures that, once a project is complete, there is a secure set of cash flows to back issued bonds or money market funds. Four technical points complete the structure.

Bond priority to cash flows. A highly rated intermediary provides a secure source of cash flow to back financial assets. Once a plant is finished and grid-connected, a solar park in a sunny location has very little business risk apart from the price paid for its power — and that is guaranteed. This permits a further innovation: a securitization arrangement in which the guaranteed PPA cash flows go *directly* to bondholders, so that bondholders are exposed only to the risk of the intermediate guaranteeing agency and not to the project developer at all. The bond becomes, in substance, a claim on a highly rated institution.

Construction risk. Plenty can go wrong before a plant is operational, so further guarantees are needed to achieve a AAA rating. The cleanest resolution is to separate the phases: a bank makes the initial construction investment, and the long-term bond financing is made available as a *refinancing* once the project is complete. This is the single most important structural feature of the whole scheme, since it means the cheap long-term money never bears construction risk, and the expensive short-term money is only outstanding for eighteen months.

Secondary guarantees. Alongside the primary guarantee from the central counterparty, secondary guarantees may be needed to secure the AAA rating. One approach is a dual-use equity fund, which co-invests in projects and also acts, for a fee, as a cross-guarantor for the bonds of *other* projects — earning a diversification benefit in the process, for the reasons set out in Chapter 3. Above this first-loss fund, bonds would be guaranteed by a final guarantor: a developed-market sovereign, or a reinsurer such as Swiss Re or Munich Re.

The resulting stack. Read from the bottom up, the structure is: a contracted revenue stream, guaranteed at the offtaker by a SECI-like intermediary, indemnified by the state; securitized into an SPV that pays bondholders first; with a first-loss equity buffer beneath the bonds and a sovereign or reinsurance guarantee above them. Each layer addresses one risk, and each is held by the party best able to hold it.

Conclusions

The cost of capital and investment risk are the large barriers to investing in developing countries. A derisked project financing model can reduce that cost and mitigate those risks.

The key innovation, already successfully deployed in India, is a central counterparty or guarantor for power purchase agreements. Strong contracts brokered by an expert agency of that kind can become the basis for issuing AAA-rated bonds, or bank deposit money market funds, which in turn provide institutional investors and domestic savers with safe, highly rated savings and investment products.

That last point deserves emphasis, because it is easy to read this chapter as being only about cheaper electricity. It is also about the creation of a safe asset where none existed. A country that can manufacture investment-grade instruments out of its own sunshine has gained something more durable than a power station.

5.3 9. What the Record Shows

The previous chapters have argued from mechanism. This one asks what has actually happened in the places that have run auctions, attached guarantees, and built a track record — and whether the record supports the claim, made in the preface, that much of the developing-country risk premium is the price of ignorance rather than of hazard.

Five lessons stand out, and each now has evidence behind it.

The Cost of Capital Drives Everything Else

Interest payments are a large part of the overall cost of solar, so reducing the cost of capital is the crucial lever on the cost of the electricity.[12] Chapter 14 sets out the calculation. Here is the independent confirmation.

The IEA's Cost of Capital Observatory, launched in 2022 with the World Economic Forum, ETH Zurich and Imperial College, surveyed lenders and investors on the returns they actually require. For utility-scale solar in emerging and developing economies in 2021, financing costs accounted for around half of the levelized cost of electricity, against 25 to 30 percent in advanced economies and China. Median required weighted average costs of capital ranged from just under 10 percent in India and Mexico to about 13 percent in Brazil — two to three times the OECD level. The 2023 update, which extended coverage to Kenya, Peru, Senegal and Vietnam, found the emerging-market cost of capital for solar still more than twice that in advanced economies, and estimated that narrowing the gap by one percentage point would cut clean energy financing costs by around $150 billion a year.

The Observatory also found what the book has argued from first principles: projects financed on a merchant basis carried higher costs of capital than those backed by a PPA, feed-in tariff or contract for difference, and about 90 percent of surveyed projects had such backing. The contract is not a detail. It is the largest single determinant of the number.

Solar Plus Auctioned PPAs Is the Right Foundation

The core issue is intertemporal: high upfront cost against low, stable revenue thereafter. Solar's operating costs are minimal and its annual output is predictable, which makes it the natural asset on which to build derisking. The record of auctioned programmes is the evidence that this works.

South Africa launched its Renewable Energy Independent Power Producer Procurement Programme in 2011, having chosen competitive auctions over a feed-in tariff. Bidders offered a tariff and, if they won, received a twenty-year PPA with Eskom, the state utility, with the PPA obligations backed by a National Treasury guarantee. Tariffs fell by around 70 percent between the first and third bid windows. By the sixth window, solar was clearing at roughly 0.62 to 0.75 rand per kilowatt-hour against a retail tariff of 1.85. The programme has attracted over 256 billion rand of private investment and more than 7,300 megawatts across some 95 projects, and is now regarded as one of the best-designed renewable procurement programmes in the world.

The IFC's Scaling Solar programme applied the same idea to countries with almost no institutional capacity: templated documents, a pre-negotiated financing package, and a World Bank Group guarantee attached to the offtaker. In Zambia in 2016 the first auction cleared at 6.02 US cents per kilowatt-hour, fixed for twenty-five years — where unsolicited proposals

[12]Komendantova et al., "De-Risking Policies as a Substantial Determinant of Climate Change Mitigation Costs in Developing Countries: Case Study of the Middle East and North African Region"; Steckel and Jakob, "The Role of Financing Cost and De-Risking Strategies for Clean Energy Investment."

to the same government a year earlier had been priced at around 12 cents. Senegal followed in 2018 at 3.80 and 3.98 euro cents. Uzbekistan's first round cleared at 2.7 US cents.

Two cautions belong here, because the record is not only a success story. Scaling Solar itself did not scale: only three countries completed projects under it. And a later analysis argued that the World Bank Group's messaging understated the concessional finance — partial risk guarantees, concessional loans, an interest rate swap — that made the Zambian tariff possible, with the result that a neighbouring finance minister cited Zambia's headline price as grounds for cancelling fourteen solar projects priced at 11.5 cents. The tariff was real. So was the derisking that produced it, and a programme that hides its own derisking undermines the case for doing it again. This book's argument is that the derisking should be visible, priced, and replicated — not that low tariffs happen on their own.

Policy and Payment Risk Can Be Almost Eliminated — Not Quite

Through guarantee structures the risk that a state-owned enterprise or government defaults on a PPA can be substantially reduced. The most interesting forms are commitment devices: a secondary institution reduces the risk not by holding capital against it but by making default unattractive. India's Solar Energy Corporation is the working example and it deserves an honest account.

SECI was set up in 2011 to aggregate demand and reduce the offtaker risk of India's distribution companies. It sits between developers and Discoms: it signs a twenty-five-year PPA with the generator and a back-to-back power sale agreement with the Discom, and pays the generator whether or not the Discom has paid it. Behind it stands a Payment Security Fund, established in 2016 with central government money and replenished from Discom payments and developer penalties; a 2017 tripartite agreement among the Reserve Bank of India, the central government and the states, under which the centre can withhold transfers to a state whose Discom defaults; and since 2019 a requirement that Discoms open letters of credit before power is supplied.

It has worked, in the sense that matters. Solar tariffs in SECI auctions fell to around 2.44 rupees per kilowatt-hour by 2017, among the lowest in the world, and developers were prepared to bid those prices because they were confident of being paid. The relationship structure did what this book says it does.

But the Discoms have not been fixed. Their outstanding dues to generators stood at 1.32 trillion rupees in mid-2022 and 779 billion in March 2024, of which some 273 billion was overdue. The central government has twice had to inject liquidity — 90,000 crore in 2020, later raised to 135,000 crore — to keep the chain of payments moving. And when "change in law" claims arose, the regulator ordered SECI to reimburse developers first and recover from Discoms afterwards, which left lenders asking whether SECI's own balance sheet could bear the timing gap. The risk was moved, exactly as Chapter 8 argues it should be. It was not eliminated, and the party it was moved to has needed periodic support from the party behind it. That is what the structure is for, and it is also its cost.

Splitting Debt and Equity Is a Winning Strategy

Bond markets are distorted in a way that can be used. Insurance companies and pension funds must hold low-risk paper; central banks intervene in bond markets; investment-grade bonds are therefore cheap financing, particularly in advanced-country currency. Structuring a project so that most of its capital is investment-grade debt and the residual risk sits in a small equity tranche moves the bulk of the financing into a demand pool that would not otherwise touch it.

The South African record shows what happens to equity returns as this takes hold. Real equity returns in the first bid window averaged 17 percent. By the fourth window they averaged around 9.5 percent. That is not a sign of a deteriorating programme. It is what track record looks like in the data: the risk premium that early investors demanded for an untested programme compressed by roughly half in four rounds, and the saving went into the tariff.

Long-Term Relationships and Credit Ledgers Are Key
Risk falls further where a long-term relationship exists between a highly rated guarantor and the guaranteed party, because a failure to pay need not be a default. It can be a ledger entry, repaid over time. SECI's back-to-back agreements and the Reserve Bank's tripartite withholding mechanism are exactly this. South Africa's Treasury guarantee is another form of it: when Eskom cannot pay, the sovereign does, and Eskom owes the sovereign.

The caveat from the earlier chapters stands. Alongside relationships with established suppliers there should be nursery-slope arrangements that give domestic firms the financial room to scale, or every contract goes to the incumbent foreign supplier and the local capability never forms.

Decomposing the Premium
The preface made a claim that this chapter can now test: that a large part of the developing-country premium is the price of an absent track record rather than of hazards that will occur.

The Observatory's analysis for Kenya and Senegal decomposes the cost of capital into a base rate — the country's sovereign borrowing cost — and sector-specific premiums. It finds the base rate accounts for 60 to 90 percent of the solar cost of capital in Africa, against 35 percent in China and about 10 percent in advanced economies. The sector premiums on top were driven by the regulatory environment, the reliability of the offtaker, and the health of the transmission network. Investors also named political, currency and transmission risk as the principal concerns everywhere surveyed.

Read that with the auction records. The sector premium — the part attributable to offtaker, regulation and grid — is precisely what the guarantee structures address, and it is what compressed in South Africa as returns fell from 17 to 9.5 percent and in Zambia as bids fell from 12 cents to 6. The base rate is what those structures do not touch, and it is the largest component in the poorest countries. So the honest decomposition is this. Between a third and a half of the premium in a typical emerging market, and a smaller share in the poorest, is the kind of risk that a track record and a guarantee dissolve — the price of ignorance, in the preface's terms. The rest is sovereign risk, and it yields only to the safe-intermediary structures of Part IV, which route the borrowing through an institution whose base rate is not the country's. The book's structures are aimed at both. It is important to be clear which chapter is aimed at which.

5.4 10. Goals, Criteria, and a Worked Derisking Scheme

This chapter does three things. It states what a derisking structure is for, sets out the criteria by which any such structure should be judged, and then works through one concrete scheme in enough detail to be criticized.

Goals
The objective is to create innovative financing structures that scale up renewable energy deployment while containing the pressure on public finances, by overcoming the barriers that keep private financial institutions out. Three goals follow.

Reduce risk for investors by leveraging MDB due diligence capacity. MDBs have extensive expertise and experience with projects of this kind, and their involvement has two effects. The direct effect is the assessment itself. The indirect, and arguably larger, effect is *signalling*: the indication that a project forms part of a particular programme tells risk-averse investors that it has been assessed to a standard that makes participation reasonable. This is the informational component of risk from Chapter 2, and an institution's reputation is a remarkably capital-efficient way of addressing it.

Enable IPP projects to tap international capital markets. The barriers to those markets are currently substantial for developing countries. Getting past them conserves scarce public finance space, especially at the guaranteeing agencies — and that is the constraint that determines how large any of this can become. If guarantees can be moved *off* the balance sheet of, say, an MDB, the scalability of the structure improves accordingly. And if the derisking generates some profit, scalability improves again, since a for-profit equity fund can presumably attract considerably more capital than a facility whose purpose is to absorb losses.

Create opportunities for local financial products, using international intermediation. Financial innovation matters here as much as financial engineering. The micro-solar pay-as-you-go model leveraged existing mobile payment infrastructure to finance rooftop systems with great success — a reminder that the binding constraint is sometimes the payment rail rather than the interest rate.

Assessment Criteria

Three criteria serve to assess any guarantee or derisking structure.

Cost-risk effectiveness. How adequately do the guarantees reduce risk to investors? How risky are they to the guarantor itself? Is there an inherent synergy available — as in the example of insuring policy risk, where the guarantee also functions as a commitment device and therefore reduces the risk it insures? Risk appetite is the binding constraint for most institutional investors, so a structure that moves a project across a ratings threshold is worth far more than one that merely improves its economics.

Capital efficiency. How much space does the guarantee occupy on the guarantor's balance sheet? Different guarantors apply different standards. Ideally a contract would be highly capital-efficient, using up as little lending capacity as possible.

But it remains crucial to know who *ultimately* bears the risk. Capital efficiency achieved by obscuring where the risk has gone is not capital efficiency; it is the 2008 financial crisis. Legitimate efficiency comes from splitting a risk into smaller parts borne by multiple investors, each of whom knows what they hold and finds it attractive.

System dynamic potential. Can the derisking be self-financing while still meaningfully reducing capital costs? Can a virtuous circle with a plausible theory of change be created — of the kind Chapter 1 described? And can the scheme contribute to the collective action problem of climate change, by generating something resembling a global commons fund? A structure that merely subsidizes projects one at a time fails this test however well it performs on the first two.

A Worked Derisking Scheme

With those elements in mind, here is an example scheme. It is offered as an illustration of what the criteria imply rather than as a finished blueprint.

5.4.3.1 Foundations

The scheme rests on two familiar foundations.

A network of approved developers and operators of independent power projects, with locations available for solar. Developing country governments would set aside land and grid connections for new solar parks. Grid connections from retired coal power stations are the most valuable asset here, since the connection is the scarce component and it already exists — new solar parks could connect directly by replacing existing or planned coal stations. Community solar parks are the other model, with connections to the wider grid, direct microgrid connections to homes, and electric charging points.

Auctioning for good-quality PPAs and offtake agreements with a guarantee structure. PPAs are agreements to purchase power from a power station — here, a solar farm — and they guarantee the price paid by the grid operator, usually a state-owned enterprise, to the independent power project. They are a standard feature of electricity systems in which the grid operator is state-owned and the developer private.

Such auctions should follow best practice, which above all means being open to all participants. Part of the bargain is that developing countries scale up the *number* of auctions, since a pipeline is what justifies building the machinery.

Two design features deserve attention. A proportion of the tariff could be denominated in international currency — but in exchange, the tariff should decline over time, or carry a sunset clause with subsequent payments indexed to some international measure of the ongoing cost of new solar construction. This is Chapter 8's declining PPA, and its purpose is to avoid locking in long-term liabilities at prices that will look absurd in a decade.

And the PPAs should be guaranteed — ideally not directly but through a long-term international lending facility that lends temporarily to IPPs to cover any default by the state-owned enterprise. The facility pays the IPP, then recovers the money from the SOE or the government later. This is the credit-ledger principle again: the generator is made whole immediately, the state repays over time, and no one has written off anything. The Global Climate Equity Derisking Buffer Fund described below would be the final guarantor, at risk only if neither the SOE nor the government ever paid.

5.4.3.2 Main Components

The heart of the proposal is two innovations: a special purpose vehicle, housed within existing financial institutions, for issuing derisked green bonds; and an equity capital fund providing initial finance for derisked projects.

The special purpose vehicle. Its primary purpose is to lend money at low rates to independent power projects. The key innovation is that the portion of PPA revenues needed to cover interest and principal on the debt would go *directly to the SPV*. The PPA repays the lender directly rather than passing through the IPP.

In other words, the PPA payments are securitized. The SPV packages the repayments into securities issued to the market — green derisked bonds. The SPV, and there could be several globally, would be managed by a financial institution such as a global investment bank, and ringfenced from the rest of that institution. Any losses from the derisking would ultimately be covered by the buffer fund, and AAA-rated institutions — a sovereign or an MDB — would also guarantee the SPV. The objective is to borrow as close as possible to the rates of the safest sovereigns: Germany, the United States, Switzerland. The currency mix of the bonds issued would match that of the underlying PPAs, which is how the structure avoids taking a currency position of its own.

The Global Climate Risk Equity Fund. This fund participates in independent power projects as *initial financing*, as part of the derisking bargain. Its investors could be governments

and private investors up to some maximum individual holding — say $100,000 — which keeps it available to ordinary savers rather than only to institutions.

The fund could carry profit-sharing provisions: some portion, say 25 percent, of its profits allocated to the populations of participating countries as a reward for participation. The remaining funds would continue to be reinvested, with developing country populations as the ultimate beneficiaries — a sort of supplementary pension fund for the population. This is not decoration. It is what converts the scheme from something done *to* a country into something the country's own constituents have a stake in defending, which matters for exactly the political-economy reasons set out in Chapter 4.

How the two fit together. The project developer receives low-cost borrowing from the SPV. In exchange, the equity fund either takes a project equity stake or receives an *option* to purchase a share of the project equity at planned investment cost. The option version is the better design, because it means the equity buffer fund carries no construction risk.

A worked example makes this concrete. Imagine a $1 million PV project financed 80 percent with derisked borrowing from the SPV and 20 percent — $200,000 — with equity. During construction that $200,000 is provided by the private developer. In exchange for the low-cost debt, the developer issues the equity fund an option to purchase $150,000 of shares at that value on completion. If those shares are then worth more than $150,000, as is likely given the low funding costs, the equity fund profits.

It is fair to ask where the gain actually goes. Suppose the derisked structure lowers the project's cost of capital from 12 percent to 8, which on the arithmetic of Chapter 14 cuts the cost of the electricity by roughly a fifth. In the example, the developer keeps the equity it put in and sells a minority stake to the public fund at cost; the fund captures the appreciation on its $150,000; and the remaining $50,000 of equity — and its appreciation — stays private. Of the saving, then, roughly three-quarters of the equity uplift goes to the developer and a quarter to the public fund, in the first project. The consumer's share comes not from this project but from the next auction: developers who know the derisked structure exists bid lower, and the South African record — tariffs down 70 percent in three rounds, equity returns from 17 to 9.5 percent in four — is what that transfer to consumers looks like over time. The distribution in any single deal favours the developer. The distribution across a programme favours the buyer, and the public fund's stake is what ensures some of the early excess is recycled rather than simply kept.

The expectation is that this model would, in its early stages, produce higher profitability for investors — both the private component and the Global Climate Equity Fund. That is a feature rather than an embarrassment. High profitability attracts further interest in both solar projects and the fund itself, and given the scale of the required build-out, initial profitability is desirable precisely because it accelerates entry. Because the public fund participates, much of that profit also flows back into scaling up dedicated global climate finance. Over time, investor competition would compress profit rates and lower the auctioned cost of solar PPAs — which is the intended end state, with the excess returns having done their work of recruiting capital in the meantime.

5.4.3.3 Suggested Advantages

Three claims are made for this structure.

First, the financial architecture — and specifically the SPV securitizing guaranteed PPA revenues — can reduce debt financing costs beyond what existing derisking practice achieves, toward developed-country sovereign bond levels.

Second, a hybrid global climate equity fund, funded by donor governments and small investors, that makes profits and reinvests them is a genuine innovation. Dedicated international public climate finance is scarce. Allowing a public climate fund to earn and recycle profits means more can be raised and the same money can be used repeatedly. Profit sharing with participating countries, after any risks have materialized, provides the participation incentive.

Third — and this is the claim that matters most for scale — the model does not weigh down anyone's balance sheet. Project finance sits off the balance sheet of energy companies; the financing sits off the balance sheets of financial institutions; it does not significantly consume MDB lending space; and the developing country government's exposure is a contingent liability that crystallizes only if it reverses its own policy or lets its own offtaker default — a liability it controls rather than one it is merely exposed to, as Chapter 14 argues. Every previous approach ran into a balance sheet constraint somewhere. This one is designed so that no single institution is the bottleneck.

Conclusions and Further Work

Guarantee structures on their own reduce the cost of capital, but simple guarantees are limited by available space on the guarantor's balance sheet. More advanced structures can self-fund, through a combination of secure green bond issuing vehicles that cut interest costs and equity co-financing that earns a return.

Solar PV plants provide a convenient context for scaling self-funding derisking: they leverage MDB capabilities and free scarce public funds for the costlier options that genuinely need grants. Any analysis of guarantees should assess both the risk and the possibilities of combining multiple instruments — including, notably, derisking debt sufficiently that it can participate in central bank repo frameworks or asset purchase programmes, which would connect this machinery to the deepest pool of cheap money in existence.

A further benefit of the derisking approach, easy to overlook, is the packaging itself: assembling projects into vehicles that are attractive to large-scale funds and to domestic investors. Standardization is what turns a series of bespoke deals into an asset class, and an asset class is what attracts capital without anyone having to negotiate.

5.5 11. Procurement Auctions and a Clean Energy Equity Fund

Drafted as a blog pitch with Anders: a public procurement take on the energy transition.

The previous chapter's scheme can be told as a story about financial engineering. It can also be told, more simply, as a story about public procurement — and told that way it becomes considerably easier to sell to a finance ministry.

The pitch in three lines: the green transition can reduce fiscal costs and risks while creating jobs; but it requires forward planning of investment; and it requires risk management for investors. Where fiscal space is limited, procurement auctions and guaranteed revenues are effective measures — and they enable cheap financing off the government's balance sheet.

The Scale and the Price of Money

The finance needs of the clean energy transition are large. The IEA suggests approximately $4 trillion per year globally, with $1–2 trillion per year needed in emerging markets and developing economies.

For that finance to be sustainable it has to be *low cost* — meaning at interest rates comparable to those of the World Bank itself. That benchmark is worth pausing on. It is not an aspiration to cheapness for its own sake; it is the recognition, from Chapter 9, that for capital-intensive assets the interest rate largely *is* the cost.

The World Bank has a crucial role in scaling up clean energy finance in developing countries, because it can do two things at once: enable low-cost finance, and provide incentives for more rapid policy action than would otherwise occur. The two reinforce each other, which is the argument of Part IV.

The Additionality Requirement

There is a condition on all of this that is frequently stated and rarely enforced. When money is lent for clean energy — for climate mitigation — it should be *additional* to what would have been provided as non-climate development finance. Two reasons, and the second is the more important.

Climate mitigation finance needs are very large and genuinely additional to business-as-usual development needs. A country does not need less health spending because it needs more transmission lines.

And the incentives that climate finance provides for policy action only work if the financing is additional to the existing development envelope. If a government undertakes a difficult reform and receives climate finance that is offset by a reduction in other concessional finance, it has been paid nothing, and it will not do it again. Non-additional climate finance does not merely fail to help; it destroys the credibility of the incentive for everyone watching.

Why Risk Absorption Is the Constraint

For low-cost debt financing to be financially sustainable, structures that absorb risk are necessary. Somebody has to stand behind the safe tranche.

At present there are three sources of such absorption, and each is constrained. In the World Bank's case, equity capital injections come from its shareholders — governments — which are a limited resource and subject to political constraint. In project finance, project equity investors absorb risk, but in limited quantity and at a high required return. And for specific risks such as political risk, guarantees are used effectively, but they consume balance sheet as Chapter 7 described.

The shortage of risk-absorbing capital, not the shortage of capital as such, is what limits the transition. There is a great deal of money in the world that would fund clean energy at 4 percent. There is very little that will take first loss.

The Proposal

The response is a clean energy equity fund combined with in-depth guarantee structures — the same pool of loss-absorbing equity that Chapter 10 worked through project by project, and that Part IV develops institutionally. Told as procurement, its features are simple. The fund co-invests during construction, when risk is highest and cheap money is unavailable, and cross-guarantees other projects for the diversification benefit of Chapter 3. Regional funds could be established with the regional development banks. The guarantee structures enable low-cost debt in local currency, and in dollars where needed. Investors include governments and small savers, and can be geographically spread — a rich country investing on behalf of a poorer one makes a burden-sharing transfer without a grant, because the money is invested, not given, and it returns. Once the buffer exists it enables leverage, so that in many cases developing countries can finance their own development. It supplies the additional equity the transition most lacks, and because outside investors can participate there is no real limit on its capitalization — unlike the World Bank's own capital model, which depends on periodic shareholder replenishment and the politics that accompanies it.

That final point is the reason this chapter sits where it does. Every structure in Part III eventually runs into the question of who provides the equity. An equity fund open to outside

investors is the only version of the answer that is not ultimately rationed by the willingness of a small number of treasuries.

5.6 12. Green Policy as Growth Policy

Before the most speculative instrument in this book, a chapter on the largest claim in it: that building a low-risk financial system around green assets is not merely a way to finance decarbonization but a way to make the macroeconomy work better. Everything in Parts III and IV can be read as machinery for constructing such a system. This chapter says why the construction matters beyond climate.

How Financial Systems Split

Financial systems tend to evolve into two parts. There is a no-risk part — the banking system, ultimately guaranteed by the central bank and the state — and a risky part, where returns are uncertain and nobody stands behind them.

Macroeconomic policy operates almost entirely on the first. When a central bank moves interest rates, it moves the price of safe money, and the assets that respond most strongly are the safe ones: assets with some form of factor monopoly, such as land, or some form of market power, such as equity in large incumbent firms and particularly resource extractors. These are the assets whose value rises when money is cheap, because their returns are secure enough to be capitalized at the new, lower rate.

This has two unattractive consequences. It makes the economy unstable, because monetary easing transmits through asset prices rather than through productive investment — a rate cut inflates house prices long before it builds factories. And it makes the economy more unequal, because the assets that respond are the assets the already-wealthy hold. A decade of very low rates after 2008 produced exactly this pattern across the rich world: asset prices rose, investment did not, and the distribution of wealth widened.

The Case for a Green Safe Asset

The proposal is to construct, deliberately, a low-risk financial system around green assets — and the derisked bonds, guaranteed PPAs and equity buffer funds of this book are the means.

The first benefit is macroeconomic. If green assets are safe assets, then low interest rates transmit into building things rather than into bidding up land. A solar park is a productive asset that cannot be capitalized without being constructed. Growth becomes more responsive to monetary easing, because the channel through which easing flows leads to investment rather than to revaluation. There is even the possibility of interest rate separation — a green sector funded at rates distinct from the rest of the economy, through central bank eligibility or regulatory preference, which would give policymakers an instrument they currently lack: the ability to ease for investment without easing for speculation.

The second benefit is specific to developing countries, and it is the more striking. Many countries with weak currencies face a choice between dollarization and a high domestic cost of capital. Dollarize, and the country surrenders monetary policy and imports the dollar's cycle; refuse, and every long-term contract carries a currency premium. Green financial assets denominated in something other than the dollar could serve as an alternative numéraire — a unit in which long-term contracts could be written. And unlike dollarization, the assets underlying it would be physically located and economically productive inside the country rather than parked abroad. Capital that would otherwise flee stays, and generates power.

Such an instrument could plausibly function as an international reserve asset. More immediately, it could serve as the denomination for long-term liabilities such as PPAs. What

one wants from a numéraire for a twenty-five-year contract is that it be strong, stable, and accessible to a developing country that has, at minimum, a solar industry. A green asset of this kind is a candidate on all three counts.

The Dilemma It Resolves

This would resolve a dilemma that recurs throughout the book. Dollar-denominated debt is cheap but carries the currency risk that has bankrupted governments; local-currency debt carries less currency risk but costs far more. A green numéraire, backed by real assets generating real revenue inside the borrowing country, is an attempt to have both — the cheapness of a hard currency and the safety of a local one, because the asset that backs it earns in the local economy but has a value the world can recognize.

The next chapter's proposal for a solar-panel-backed currency is the most developed version of the idea, and the reader should approach it knowing that it is speculative in its design and serious in its purpose. The purpose is the one set out here: to change the unit of account so that the rest of the machinery becomes less necessary.

5.7 13. The Sollar: A Solar-Panel-Backed Currency

The last chapter of this part is the most speculative, and the closest to the theme raised in Chapter 12. Every structure so far has taken the world's currencies as given and tried to manage the risks they create. This one asks a different question: what if the unit of account were the thing being built?

Summary

The proposal is for an international financial instrument based on installed solar photovoltaic panels in dedicated utility-scale solar parks around the world. At any moment, one *Sollar* — pronounced like dollar, with an S — represents a certain quantity of solar panels, shared like an index fund across the solar parks participating in the scheme.

Over time, the quantity of solar panels represented by one Sollar *increases*, because profits from selling the electricity are reinvested in further panels. The unit appreciates in real terms, in physical units, without anyone managing a monetary policy.

Investors wishing to cash out can, after an introductory period of five years, convert each Sollar into a bond representing the *fixed* quantity of panels held at the moment of redemption. From that point the revenues from those panels are paid out as dividends.

Sollars are therefore intended to be *both* currency and investment. They are currency in that they are intended to have a standardized value and pay no dividends. They are an investment in that their value is expected to rise over time, and the structure is designed to suit pension investment: a growth phase while held as currency, and the ability to convert into a standardized dividend-paying instrument appropriate for funding a retirement. That convertibility is what gives the currency tangible value — it is redeemable in something real.

The Sollar is intended as a straightforward way to channel pension fund money into renewable investment worldwide. It is also intended to be a strong currency and a sound investment for people in developing countries.

And since the interest rate associated with issuing Sollars is expected to be lower than that of issuing debt, using them offers an additional means of leveraging a given equity investment.

The Problem It Addresses

Financing renewable energy in developing countries is expensive. Those countries tend not to have well-developed capital markets. Raising capital in domestic currency is expensive;

borrowing on international markets is both expensive and risky. Currencies are often weak, and corruption is a recurring problem. Higher credit risk ratings raise both the interest rate charged by banks and the return required by equity investors.

All of which makes new renewable infrastructure costly to finance. And because renewable energy is capital-intensive, the interest rate charged has a powerful effect on the levelized cost per kilowatt-hour — the same point as Chapter 9, arriving from a different direction.

The General Idea

The idea is a solar-panel-backed currency. It is called a currency, though it shares characteristics with a financial investment.

Issuing this solar currency would be a means of financing international solar plants, competing with the existing means: equity, project debt, corporate debt, government spending and international grants.

Each Sollar represents a certain quantity of solar panels at each point in time, growing over time. Suppose that at the end of 2020 one Sollar represented enough panels to produce, on average, one watt of electrical output across the year — 8.8 kWh annually. Depending on the insolation where the panels are installed, that corresponds to between five and ten watts-peak of capacity.

The electricity produced is sold. Some fraction of the proceeds — around 10 percent, say — accrues to the operator of the solar park. That fraction is *variable* according to whether the panels performed as expected: if a park produced less than the expected quantity of electricity over the year, the operator's fee is reduced. This is a performance incentive built into the payment structure rather than enforced by contract, and it is what makes the instrument reliable without extensive monitoring. In a state-run electricity system, contracts for the value of the electricity produced would need to be agreed with the government.

The panels sit in dedicated solar parks in different places around the world. Governments and private developers who build such parks would have the option to issue Sollars once a project was complete. During the growth phase they could *borrow* Sollars from international institutions, paying their suppliers in the borrowed currency. Once the panels were built, they would issue Sollars to repay the institutions.

Follow that through and something striking emerges. It is possible that the solar park costs nothing to produce, because it is financed entirely by borrowed Sollars, and the panels then support the issuance of at least as many Sollars as were originally borrowed. A given quantity of original investment finance goes very much further than before. A developer pays their suppliers in the thing they are about to manufacture.

Design Choices

Reinvested profits, then dividends. Like a growth stock, money from selling the electricity is reinvested in more panels — potentially in different parts of the world from the original ones, which builds diversification into the instrument automatically.

After an initial phase of about five years, conversion into a bond-like instrument would be permitted, on the 1st of January each year. The currency converts into an instrument representing a *fixed* quantity of panels — those accumulated up to that point. The dividend paid represents the output of those panels globally, is paid in dollars, and would typically decline slightly over time as the panels age. Convertibility is what anchors the whole scheme: it gives a reference point that makes the currency's value tangible rather than notional.

Borrowing Sollars. A proportion of the Sollars would be purchased by international organizations, which could then lend them to project developers who cannot yet issue their own. Because the Sollar itself appreciates, the interest rate *in Sollar terms* is likely to be low,

zero or slightly negative — the appreciation does the work that interest would otherwise do. Developers therefore need to borrow Sollars only for the construction phase. Once the project is complete they can sell Sollars, since the park now contains the underlying asset.

Administration. The scheme would be administered by an international organization — plausibly part of the World Bank Group, the IBRD or the IFC, much as the IFC organized a local green bond issue in India. That involvement would pump-prime the market for the instrument, which is the hard part of launching any new asset.

Guarantees Needed

Several parties need to guarantee different things for the scheme to function.

The park *operator* must guarantee that over a yearly period the panels will produce a certain quantity of electricity, making up any shortfall out of the percentage fee. This makes the operator's incentive align with the instrument's integrity.

The *purchaser* of the electricity must guarantee, contractually, the price paid. That price may well fall over time as solar becomes cheaper, but there must be contractual arrangements covering the price paid across the working life of the panels. Such guarantees are easiest to provide when combined with electricity feebates — combinations of carbon taxes with feed-in tariffs — which connects this instrument directly back to Part II and to the companion volume. The price paid needs some form of guarantee over the whole life of the asset.

Because the panels in the scheme are located all over the world, the risk associated with any single government is diversified away. This is the structural advantage the Sollar has over any national instrument, and it is considerable: a portfolio spread across thirty jurisdictions is not exposed to any one of them.

In the early stages the scheme would nonetheless need guaranteeing. International organizations would have to provide various guarantees to get it started.

Policy Coordination

Solar energy is already cost-competitive. But the potential profits are greater where a carbon tax or a system of feed-in tariffs for renewables exists, and such policies accelerate the shift to a clean energy system. The instrument and the pricing agenda are complements.

The development benefit of solar parks is also enhanced when local production facilities are involved. Developing local solar industries would keep more of the Sollar's benefit in-house — the industrial policy point from Chapter 8, in its positive form.

There is a real tension to manage, and it should be stated rather than finessed. It matters that a substantial share of Sollars is retained *within* developing countries, to avoid international financial investors coming to own too much of vital infrastructure. Incentives could be introduced to favor Sollars held domestically, and especially those held by ordinary people. But there is an unavoidable trade-off between engaging international financial markets — with their capacity to finance at scale — and the risks that engagement brings. One possible resolution is to introduce Sollars in developed countries too, and to include non-solar power sources, broadening the base and diluting any single group's ownership.

Conclusions

Designing a solar-backed currency is an opportunity to reduce financing costs for solar — and, in the limit, to make solar plants self-financing. It allows developer-operators to pay their suppliers in something they will themselves produce: solar panels. Diversifying the investment-currency internationally, and giving it international backing, may provide a stable and strong currency-investment that aids the solar build-out while offering a sound home for savings.

Whether or not the Sollar is ever issued, it clarifies something the rest of this part has been circling. The reason capital is expensive in developing countries is not that the underlying assets are bad. Sunshine in the tropics is a better physical resource than sunshine in northern Europe. The reason is that the *unit of account* in which the asset's revenues are denominated is unstable, and the institutions that would otherwise absorb that instability are thin. Fix the numéraire and much of the rest of this book's machinery becomes unnecessary. That is a large claim, and it is the reason the idea is worth taking seriously even in its present speculative form.

6 Part IV — Institutions and the Architecture of Concessionality

6.1 14. Where the Risk Goes

Part III described a set of structures and made a large claim for them: that they can lower the cost of capital for clean energy without consuming anyone's balance sheet. Chapter 3 contains the objection that claim has to survive. Risk transfer strategies, it said, work normally almost all of the time and then fail together; a structure that only transfers risk has hidden it rather than dealt with it. This chapter takes that objection seriously and answers it. It also does two other jobs: it puts numbers behind the arithmetic the book has so far asserted, and it consolidates the various funds and guarantees of Parts III and IV into a single picture, since a reader who has met the same equity buffer five times under five names is entitled to ask whether it is one idea or several.

The answer to the objection has three parts, and they are the three cases this chapter makes. First, that the risk in a solar project is smaller, shorter and more specific than the risk premium suggests — it is concentrated in a two-year construction phase and in the credit of a single offtaker, and both can be isolated. Second, that guarantees and intermediaries do not make risk disappear; they buy a lower cost of capital at the price of reduced flexibility, and the flexibility surrendered is the real cost, which should be named. Third, that currency risk — the hardest residual — can be hedged, at a price that is known, in most of the countries that matter.

The Arithmetic First

The book has said repeatedly that the cost of capital is the dominant term in the cost of solar electricity. Here is the calculation.

Take a representative utility-scale solar project: capital cost of $800 per kilowatt, a 20 percent capacity factor giving 1,752 kWh per kilowatt per year, operating costs of $12 per kilowatt per year, and a twenty-five-year life. The levelized cost of electricity is the annual capital recovery charge plus operating cost, divided by output. Only one thing changes across the rows of the table: the discount rate.

Cost of capital	LCOE (US c/kWh)	Relative to 4%	Financing share of LCOE
4%	3.6	1.00	30%
6%	4.3	1.18	41%
8%	5.0	1.38	49%
10%	5.7	1.58	56%
12%	6.5	1.80	61%
15%	7.8	2.15	68%

Two things in this table matter for everything that follows. The electricity costs 80 percent more at 12 percent than at 4 percent, and more than double at 15 percent. And the share of the cost that is *finance* rather than hardware rises from under a third to over two-thirds. In a developing country paying 10 to 12 percent, most of what a consumer pays for solar electricity is not the panel, the land, or the labor. It is the return demanded by whoever put up the money.

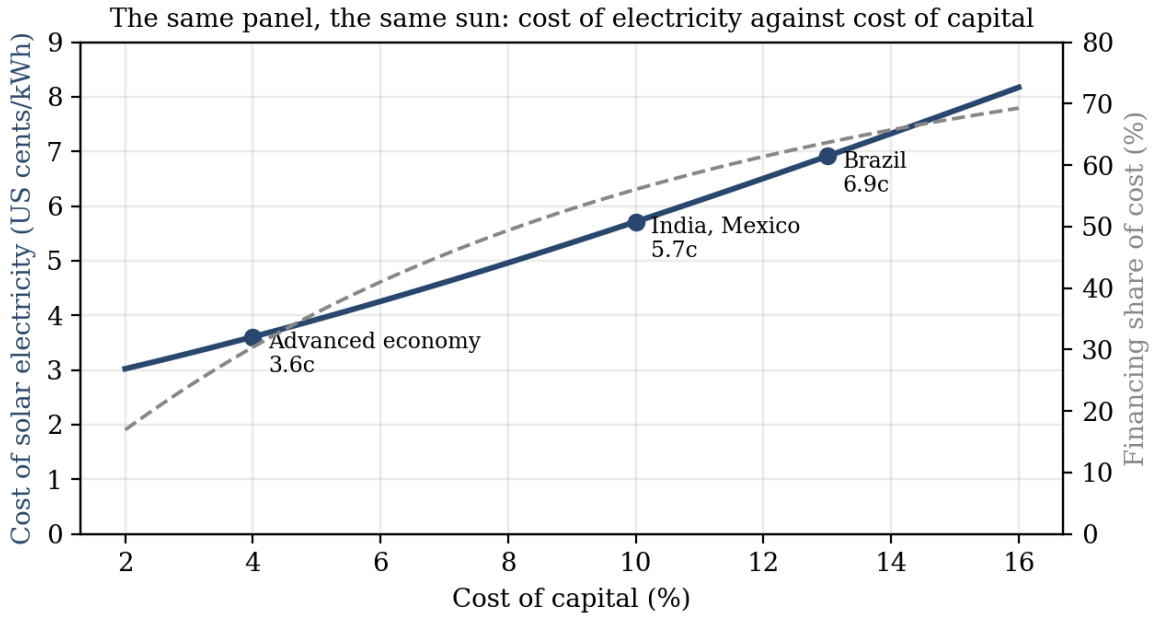


Figure 1. The same representative project across discount rates. Points mark the IEA Observatory's median required returns.

This is not a modelling artefact. The IEA's Cost of Capital Observatory found that financing costs accounted for around half of the levelized cost of solar projects reaching final investment decision in emerging and developing economies in 2021, against 25 to 30 percent in advanced economies and China — which is what the table produces at 8 to 10 percent against 4 percent. The Observatory's survey put median required WACCs for solar at just under 10 percent in India and Mexico and around 13 percent in Brazil, two to three times the OECD level. Its 2023 update found that closing the gap by a single percentage point across emerging and developing economies would reduce clean energy financing costs by around $150 billion a year.

The same source records something else that this book has been arguing from mechanism: projects financed on a merchant basis, without a price guarantee, showed higher WACCs than those supported by power purchase agreements, feed-in tariffs or contracts for difference, and roughly 90 percent of surveyed projects had such support. The contract is not incidental to the cost of capital. It is most of it.

Case One: What the Risk in Solar Actually Is

Roughly half of the investment required in new power generation capacity over the coming decade is solar, and solar is the largest single item in global clean energy investment. If the risk in solar can be characterized precisely, half the problem has been characterized.

It can. A solar project has two phases with entirely different risk profiles, and the whole art of financing it lies in not confusing them.

The construction phase lasts about two years. South Africa's procurement programme requires commercial operation within 24 months of commercial close; the IFC's Scaling Solar template reached financial close in around a year and broke ground within months after. During construction, real things can go wrong: cost overruns, delays, grid connection failures, contractor default. This is genuine, project- specific risk and it deserves an equity-like return.

But it is *short*, and it is *bounded*. Two years, not twenty-five. And it can be isolated by two-stage financing: a construction lender or a developer's own equity carries the project to commercial operation, at which point long-term money refinances it. Chapter 18's worked example shows why this matters — the refinancing is where the return is created, because the operating asset is a different risk from the asset under construction and conventional single-stage financing prices both the same. Two-stage financing does not eliminate construction risk. It confines it to the parties and the period in which it actually exists, so that the twenty-five-year money never bears it.

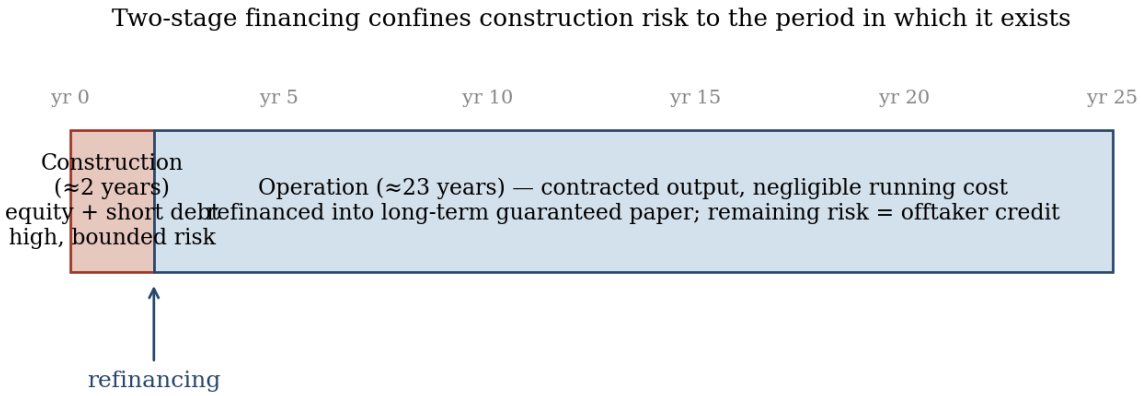


Figure 2. The risky phase is short and bounded; long-term money arrives only after it.

The operating phase is the other twenty-three years, and here the observation from Chapter 2 governs. Once built, connected and contracted, a solar park has a predictable physical output, negligible running costs and no fuel. Its remaining risk is almost entirely one thing: whether the offtaker pays. The physical asset is not the risk. The counterparty is.

That is why the guarantee belongs at the power purchase agreement, as Chapter 8 argued, and it is why the relationship structures matter. The Solar Energy Corporation of India pays generators on time even when the distribution companies are late, because it holds Reserve Bank credit lines and state government indemnities — nobody fixed the Discoms, but generators no longer bear their credit. South Africa's programme pays through Eskom, a utility in persistent financial trouble, with the PPA obligations backed by a National Treasury guarantee: the sovereign's credit substituted for the utility's. Zambia's Scaling Solar tender attached an IDA partial risk guarantee to the offtaker obligation, and the winning bid was 6.02 cents per kilowatt-hour where unsolicited proposals to the same government a year earlier had been priced at 12. Half the tariff disappeared, and what disappeared was not hardware. It was the premium for a counterparty nobody would otherwise trust.

So the risk in half of the required investment resolves into two components: a bounded construction risk that two-stage financing confines, and an offtaker credit risk that relationship structures transfer to a party for whom it is cheap. What remains after both is what the rest of this chapter addresses.

Case Two: Guarantees Buy Cost of Capital with Flexibility

Here is the honest statement of what a guarantee does. It does not make risk vanish. It moves risk to a party better placed to bear it, and in exchange every party to the arrangement gives up some room to move. The lower cost of capital is real; so is the flexibility surrendered; and a book that claims the first should account for the second.

The government gives up the ability to change its mind. A twenty-year PPA backed by a sovereign guarantee is a commitment the next government inherits, and the commitment is precisely what makes the tariff cheap. South Africa showed both sides of this in a single episode. Its programme cut solar tariffs by around 70 percent across the first three bid windows and took equity returns from 17 percent real in the first round to under 10 percent by the fourth — the track-record effect this book predicts, in the data. Then in 2017 the energy minister announced an intention to renegotiate every fourth-round solar contract above a threshold price, after Eskom had delayed signing the agreements for nearly three years. The programme's credibility took years to recover. The flexibility the government tried to reclaim was exactly the flexibility whose surrender had made the low bids possible.

The offtaker gives up dispatch flexibility. A take-or-pay contract means paying for power whether or not it is wanted; a take-and-pay contract leaves curtailment risk with the developer, and the developer prices it. Either way the flexibility has a price. Chapter 16 lists grid and curtailment as unfinished business, and they are, but the direction of the trade is clear: the more the offtaker can walk away, the more the developer charges for the possibility.

The developer gives up upside. A contracted tariff caps what the project can earn; the merchant project that might have captured a price spike has been traded for a bond. That is the deal, and most developers take it gladly, but it is a surrender nonetheless.

And the guarantor commits balance sheet — not in cash, and not in most states of the world, but in the tail. This is the point the next section takes up directly, because it is where the book's "used but not used up" formulation needs to be made precise rather than repeated.

What this case establishes is that the transaction is real. Nobody is getting a lower cost of capital for nothing. They are getting it in exchange for commitment, and commitment is valuable exactly because it is costly to reverse. That is a stronger foundation for the argument than the claim that risk has been engineered away.

Case Three: Currency Risk Can Be Hedged

Chapter 8 called currency mismatch the risk that cannot be guaranteed away, and that was too pessimistic. It cannot be *guaranteed* away. It can be *hedged*, at a known price, in most of the relevant markets, and the price is falling.

The problem is familiar. A solar park earns local currency from a domestic tariff while its debt and its imported panels are denominated in dollars or euros. When the currency falls, the debt does not, and either the developer, the offtaker, or the government eats the difference — usually the government, eventually, as Chapter 24 describes.

The instruments exist. The Currency Exchange Fund, TCX, established in 2007 by a consortium of development finance institutions and governments, provides long-dated cross-currency and interest rate swaps in more than 140 frontier and emerging market currencies, specifically in the currencies and tenors where commercial hedging is absent. By 2024 it had enabled more than $10 billion of local currency funding on a capital base of around $1.8 billion, and had laid off some $3.5 billion of hedging exposure to private counterparties — which means the risk is not merely being warehoused by donors but is progressively finding private buyers. It has continued to write hedges through the emerging-market currency episodes of the past decade.

The price is not trivial. Commercial hedging in frontier currencies frequently costs 600 to 1,200 basis points a year, which in the LCOE table above is the difference between the 6 percent row and the 12 percent row all by itself. But three things follow from the hedge existing at all.

The risk becomes *priced* rather than hidden. A government that signs a dollar PPA is taking a currency position it does not account for; a government that pays a hedge premium knows what its exposure cost. The book's structures should require the second.

The price can be *shared* and *reduced*. Donor capital in TCX lowers the premium below the commercial rate; partial indexation — a tariff with a dollar component and a local component, as Chapter 10 proposed — hedges only the imported share of the cost; and the declining tariff shrinks the hard-currency obligation year by year so that the exposure is largest when the plant is newest and smallest when it is oldest.

And in the countries that matter most, the market is *already there*. Half of the South African solar projects in the IEA's survey were financed in local currency, which removes the mismatch at source. India has a deep rupee bond market. The residual problem is concentrated in the smaller and poorer countries, and there the green savings accounts of Chapter 18 — domestic savers funding domestic assets in domestic currency through a guaranteed vehicle — are the answer that requires no hedge at all.

So the honest position is this. Currency risk is real, it is the largest single component of the emerging market premium after sovereign risk, and the book's structures do not abolish it. What they can do is ensure it is hedged where hedges exist, priced where they do not, and avoided by local currency finance where the savings pool is deep enough. None of that is free. All of it is better than the current practice, which is to denominate the liability in dollars and hope.

The Correlated Shock

Now the objection from Chapter 3, stated at full strength. The structures in this book rely on diversification: an equity fund that cross-guarantees projects across thirty countries, a bond vehicle whose currency mix matches its PPAs, a guarantor whose exposure is spread. Diversification reduces idiosyncratic risk — this grid, this offtaker, this government. It does nothing for a shock that hits everything at once. A global rate spike, a dollar surge, a wave of emerging market defaults: in that world every PPA is stressed together, the equity buffer exhausts, and the AAA guarantor pays. What then?

Walk through the stack. Losses fall in order on the developer's equity, then on the sovereign as first loss — which, being a ledger entry rather than a default under the structures of Chapter 7, means the government's arrears to the guarantor accumulate rather than crystallize — then on the equity buffer fund, and only then on the AAA guarantor. In a correlated shock the first two layers absorb what they can and the third is drawn down. The guarantor's exposure is what is left.

Size it. Suppose a $100 billion portfolio of guaranteed bonds, a 5 percent equity buffer, and a severe stress in which 15 percent of offtakers fall into arrears simultaneously and the currency component of the affected PPAs loses a quarter of its value. The loss before recovery is on the order of $15 billion; the buffer covers $5 billion; the guarantor is exposed to $10 billion, against which it holds recovery rights on the sovereign ledgers. That is a large number. It is also the number a guarantor should hold capital against, and it is roughly what MIGA or a reinsurer does when it writes political risk cover: the premium is small and the tail is real.

So the precise version of "used but not used up" is this. The guarantor's rating is *lent* to the structure in normal times, at the cost of a reserve against the tail. It is *spent* only in the correlated case, and then it is spent as a reinsurer's capital is spent — drawn down, with recovery over time. The claim that the structures consume no balance sheet is true in expectation and false in the tail, and the book should say both.

Three things make the tail smaller than a naïve reading suggests, and they should be stated without overstating them. The currency component, if hedged as Case Three describes, moves to the hedge counterparty rather than the guarantor. The first-loss sovereign layer is not a default but a debt, and sovereigns that owe development institutions repay them at very high rates — the preferred creditor record that Chapter 18 cites is the empirical basis for the whole structure. And the physical asset survives the shock: a solar park in arrears is still generating, and its output has value that a defaulted coal plant's does not, since there is no fuel bill to fund before the next kilowatt-hour.

What the tail does not permit is the claim, made in Chapter 10 and retired here, that the structure adds nothing to developing country government liabilities. It adds a contingent liability. The defensible argument, and the one this book makes, is that the liability is *conditional on the government's own conduct* — it crystallizes only if the government reverses the policies it committed to or lets its offtaker default — and that a liability one controls is a different thing from a liability one is exposed to. Debt sustainability frameworks are right to count contingent liabilities. They should also distinguish those that a government can avoid by keeping its word from those that fall on it regardless, and Chapter 25 argues for that distinction.

Interest Rates Have Moved, and the Argument Survives

Parts of this book were drafted when AAA paper could be placed at 4 percent and the refinancing arithmetic of Chapter 18 assumes it. In 2026 that is not a safe assumption. The question is whether the argument depends on it.

It does not, because the argument is about the *gap*, not the *level*. Rerun the Chapter 18 example. A $1 million project, 80 percent debt, and $100,000 a year of distributable revenue. At 8 percent construction debt refinanced at 4 percent, equity income rises from $36,000 to $68,000 and nearly doubles. Refinance at 6 percent instead and it rises to $52,000 — still a 44 percent gain. Refinance at 8 percent and there is no gain at all, because there was no gap.

Now put the example where it belongs, in a developing country. There the construction-phase debt is not 8 percent but 12. At 12 percent the $1 million project pays $96,000 in interest and leaves $4,000 for equity — it is barely viable. Refinance the operating asset at 8 percent and equity income is $36,000; at 6 percent, $52,000. The gain from derisking is the same four points of spread whether the world's safe rate is 2 percent or 5. What has changed since the low-rate years is the absolute level of every row in the LCOE table. What has not changed is the distance between the row a developing country sits on and the row a guaranteed structure could move it to, and that distance is what this book is about.

There is one genuine effect of higher rates that should be conceded. The higher the safe rate, the larger the absolute financing share of solar's cost, and so the more a given reduction in spread is worth — the table's financing share rises from 30 percent to 41 percent between the 4 and 6 percent rows. Higher rates make the book's argument more urgent, not less true.

One Structure, Several Views

The reader who has reached this point has met an equity buffer fund in Chapter 10 as the Global Climate Risk Equity Fund, in Chapter 11 as the clean energy equity fund, and will meet it again in Chapter 18 as the policy-lending fund, in Chapter 19 as the Climate Investment and Insurance Fund, and in Chapter 20 as the Climate Incentives Trust. It is one idea, and the variations are real, so here is the map.

The idea is a pool of loss-absorbing equity, capitalized by donors and open to outside investors, that does three things: co-invests in the construction phase of standardized projects and sells out on completion; stands as second loss behind a sovereign first loss and ahead

of an AAA guarantor; and shares its profits with the countries that act earliest. Everything in Parts III and IV is an application of that pool to a different problem.

Chapter 10's fund is the *worked example* — a single project, a single option, the arithmetic of one deal. Chapter 11's is the *procurement framing* — the same fund described to a finance ministry as a public procurement instrument rather than a financial one. Chapter 18's fund is the pool applied to *policy lending*: it absorbs the risk of an additional lending envelope so that reform can be rewarded without consuming Bank capital. Chapter 19's Climate Investment and Insurance Fund is the pool given *institutional form* as a Financial Intermediary Fund under Bank management, with the three-layer guarantee stack made explicit. Chapter 20's Climate Incentives Trust adds the *international incentive* — beneficiary accounts held for future populations that grow with action and shrink with retreat — and the trust structure that separates control from benefit.

Five mechanisms were once listed separately as the ways this architecture could be delivered, and they fold into the same map. KPI bonds and the trusted intermediary model are the *lending* side: they tie a borrower's interest rate to its policy performance, and they route the borrowing through a safe institution so that the rate reflects the institution's credit rather than the borrower's. The Trust itself is the *equity* side. The clean energy financing model — the pool investing directly and, for the poorest countries, selling power as a service per megawatt-hour[13] — is the pool's *investment function* extended to countries without capital markets. And the risk absorption model, in which countries provide policy guarantees and receive a counter-guarantee from the pool and a AAA entity, is the *guarantee stack* of this chapter under another name.[14] All five are in the chapters that follow. None is a sixth fund.

13

100% Clean Energy Transition Program Assistance. Finally, we will consider whether WB, working with other international institutions, e.g. IRENA (International Renewable Energy Agency) and ISA (International Solar Alliance), could make a standard offer of comprehensive assistance to any countries willing to embark on a rapid transition to a (nearly) 100% clean energy economy and low-cost energy abundance (or even beyond that, to clean energy abundance and net negative CO_2 emissions in the context of future mid-century global demand for several billion tons per year of carbon dioxide removal to offset residual fossil fuel use). This paper will survey effective *pathways* and physical, regulatory, and financial *enabling conditions* for organizing and financing the *green infrastructure supply chain* in developing countries. Country-scale clean energy transitions will entail providing concessional financing in exchange for EMDCs' adoption of enabling conditions for clean energy buildout and fossil energy ramp-down. These enabling conditions will include *physical infrastructure* (e.g. power transmission and distribution network expansion), *enabling regulations* (e.g. power purchase agreement frameworks and renewable energy feed-in tariffs, speedy project approval processes, and rules governing land availability for utility-scale solar power projects), and *financial incentives* (e.g. tax breaks, carbon taxes, and low-cost financing of clean energy and other sustainable infrastructure projects via national development banks). The World Bank's ESMAP (Energy Sector Management Assistance Program) is already engaged in advising EMDCs along these lines, albeit not yet in the development of comprehensive country-scale transitions to post-fossil-fuels energy abundance (or of net carbon dioxide removal operations). ESMAP's remit could be expanded to encompass advising countries on such comprehensive transitions.

14

Multi-Tiered Sustainable Infrastructure Project Portfolio Loan Guarantee System. A system of multi-tiered risk protection for loan guarantees, such that the WB (or another multilateral institution backed by safe HDC sovereigns) can be the guarantor of last resort on loans to approved sustainable infrastructure project developers (or co-

The stack, read once and referred to thereafter:

1. **The contract.** An auctioned PPA or contract for difference, in a currency mix that matches revenues or is hedged, declining in real terms.
2. **The offtaker guarantee.** A SECI-like intermediary, or a sovereign guarantee routed through an MDB, that pays the generator on time and recovers from the utility over time.
3. **The two-stage financing.** Construction equity and short debt, refinanced on commercial operation into long-term guaranteed paper.
4. **The vehicle.** A ringfenced SPV receiving PPA payments directly and paying bondholders first.
5. **The first loss.** The sovereign, by indemnity, as a ledger obligation.
6. **The second loss.** The equity buffer pool.
7. **The final guarantee.** A AAA sovereign, an MDB, or a reinsurer, reserved against the correlated tail.

guarantor of cash flows from renewable energy Power Purchase Agreements) whose projects qualify to participate in a portfolio of sustainable infrastructure projects in participating EMDCs. This system of guarantees will achieve low financing rates for sustainable infrastructure projects, with the HDC sovereigns providing only the third and last tier of loan guarantee, without being subject to first- or second-line risk. This can be achieved by a system of triple guarantees: (i) the first line of loan guarantee is provided by the EMDC host government where the infrastructure project is located. If the project developer whose project has been approved for inclusion in the portfolio defaults on a loan, then the EMDC or LDC beneficiary country government guarantees to hold lenders harmless (either directly, or by agreeing to add any defaults on loans by sustainable infrastructure projects to the country's debt with the WB); (ii) the second line of guarantee is a buffer account allocated to that country within a special purpose vehicle we'll call the 'Climate Investment Trust' (CIT) (see further below) - with the funds in the country's CIT account supplied with money from sources to be determined, e.g. funds from net income generated by equity participation in a global sustainable infrastructure portfolio, or funds from a trust fund topped up by HDC carbon taxes, or by the IMF's Resilience and Sustainability Trust, or by contributions from wealthy sovereigns; and (iii) only if that buffer also fails will the WB (or another designated HDC-backed multilateral institution) step in to hold harmless lenders to a defaulting portfolio project. In that way, the WB or HDC sovereigns can mobilize their AAA ratings as a third line of defense, leading to lower capital costs for participating project developers, even as HDC sovereigns are well protected against exposure to defaults. The WB or rich sovereigns would only be subject to a final tier of financial risk if first and second buffers were exhausted.

The risk stack: each layer holds one risk, held by the party for whom it is cheapest

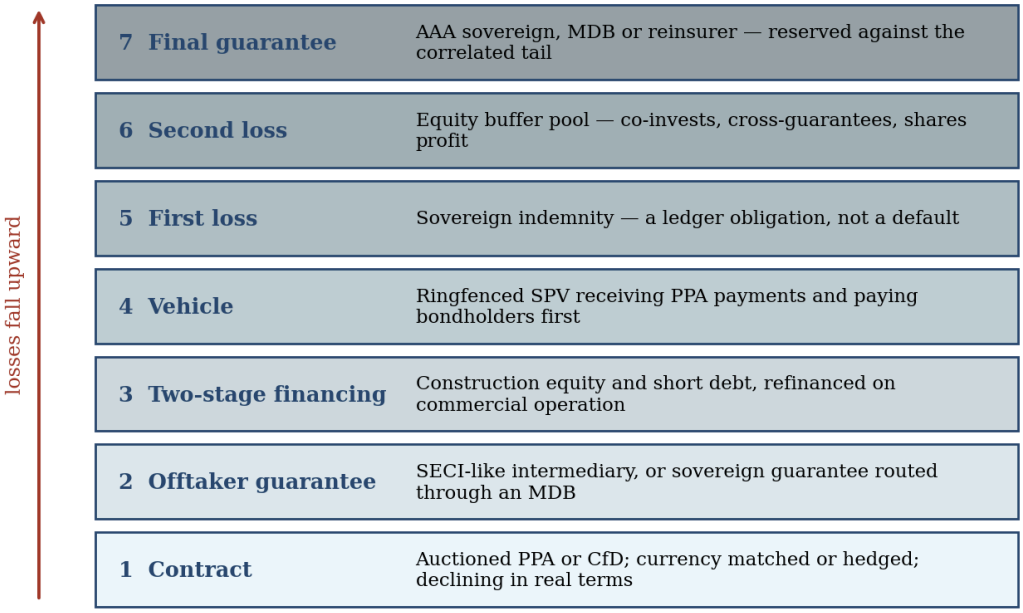


Figure 3. The seven layers, read from the bottom.

Each layer addresses one risk. Each is held by the party for whom that risk is cheapest. And the whole is a transaction in which cheaper capital is exchanged for commitment — which is, in the end, what the title of this book means by time and chance. The chance is the risk premium that an absent track record imposes. The time is what it takes, and what it costs, to build one.

6.2 15. Overcoming the Balance Sheet Limit

Part III described instruments. This part is about the institutions that would have to issue them, and about a problem that no individual instrument solves: how anything built out of guarantees gets past the balance sheet of whoever is doing the guaranteeing.

The Question

Scaling up green finance — closing a gap measured in trillions with institutions that operate in billions — will require governments, MDBs, other financial institutions and the private sector to work together. The question is how.

Three groups of problems have to be solved at once. The standardization and derisking of green projects has to be accelerated so that they become bankable. Low-cost finance has to be delivered to those projects at massive scale. And the policy change that creates the projects in the first place has to be incentivized. Solve only the first two and there is nothing to finance; solve only the last and the projects that emerge are unaffordable.

For all three, the financial structures need to be scalable to the trillions, to encourage standardization, and to reward the policies that generate projects. They must also meet a set of constraints that rule out most of what has been tried. The architecture should be fair and not concentrate wealth. It should reward early action. It should not require huge grants from rich countries or unrealistic action by developing nations. And it should be within the capabilities of institutions such as the World Bank to arrange, because an architecture that requires a new institution requires a treaty, and treaties take a decade.

What follows is a concrete structure offered as an example — not the only possible answer, but an illustration of the features any answer must embody. Its components are a new form of guarantee, derisked AAA-rated green debt, and a blended equity-insurance fund.

The Three Components

A guarantee that combines the best of MIGA and IBRD. From IBRD guarantees, take the sovereign indemnity: the borrowing state agrees to reimburse the guarantor, which converts a default into a debt rather than a loss and makes the long-term relationship do the work. From MIGA guarantees, take reinsurance of the residual risk, however small, which recycles balance sheet space rather than consuming it. The first mechanism reduces the risk; the second removes what remains from the guarantor's books. Existing practice uses one or the other. Using both is what makes the structure scalable.

Derisked AAA green debt. The guarantees create a new asset class investible by pension funds and central banks. This is the point that is easy to underestimate. The constraint on green finance is not the total quantity of money in the world but the quantity of money permitted to buy the instruments on offer. Manufacturing an AAA-rated green bond does not merely lower the interest rate; it makes the entire investment-grade universe eligible to participate.

A blended equity and insurance fund. Such a fund can co-invest in the same projects, taking advantage of the increased profitability and earning a fee. Once projects are complete and cash flows secured, the equity stakes can be sold and the proceeds reinvested. The fund is the recycling mechanism: the same capital finances one project after another rather than sitting under a single one for twenty-five years.

Put these together — a loss-absorbing green equity fund, derisked debt, and a smart guarantee structure — and they can be created *in parallel* to global, regional and national development banks, overcoming the balance sheet limitation of the MDBs. This maximizes the benefit from institutional advantages such as a strong credit rating while escaping the constraints of state and MDB balance sheets. It leverages information asymmetry, in that an MDB's assessment is worth more to outside investors than to the MDB itself, and it encourages financial learning through financial deepening.

The intended result is a reinforcing loop: a profitable yet fair scale-up of green wealth funds, with profits shared with the citizens of the countries that act earliest.

The same schema can be adapted by sector. For renewables in the power sector, it focuses on simplifying, securing and securitizing the power purchase agreement — the version worked through in Part III. For public infrastructure such as grids, the securable revenue is user fees or land charges. For private end-use technologies, it is long-term financing through property taxes with the fiscal authority, or a pay-as-you-go model. In each case the requirement is the same: find the contracted revenue stream, and build the structure on top of it.

Context: The Scale of the Gap

The investment needs and pace for a 1.5–2C world are daunting. The IEA suggests global energy-related investment must reach $3 trillion per year in the next decade to meet a Paris-compliant net-zero trajectory, with about a third of that in emerging markets excluding China.

To put those numbers in perspective: the World Bank Group delivered $21 billion in climate

finance between 2018 and 2022, about 40 percent of all MDB climate finance.[15] The largest single provider of multilateral climate finance in the world operates at roughly one percent of the required annual scale. No plausible increase in the Bank's capital closes that gap. Something structurally different is needed, which is the premise of this whole part.

Closing the gap requires three things. Sufficient *bankable projects* — projects, or financing structures, well enough understood and low-risk enough that domestic and international investors will invest. Adequate *finance* for those projects, scaled from billions to trillions, which means overcoming a set of specific barriers. And a way of encouraging action *now* rather than later, by showing how increased availability of finance promotes better policy — the complementarity between available finance and the projects and policies it requires.

Six Barriers to Scale

Six obstacles stand in the way in developing countries, and it is worth being blunt about each.

Growth. Funds and financing for the green transition appear unlikely to reach the required scale on their present trajectory. The question for the World Bank is how to ensure a scale-up rather than an increment.

Exhortation without incentives. Existing approaches have largely consisted of advocating that *others* change: governments should reform policy to enable private financing, developed countries should give more, MDBs should do more. These exhortations rarely come with sufficient incentives, rarely address the constraints the target faces, and are rarely sensitive enough to political economy for the change to actually happen. This is the failure mode the rest of this part is designed to avoid.

The fiscal capacity paradox. The state and the MDBs are typically essential to enabling investment in risky, poorer countries. But state and MDB fiscal capacities are limited, particularly at present. Detailed structural work — the guarantee-plus-reinsurance-plus-equity stack above — is how this gets solved.

The energy price problem. Most policies economists recommend involve raising energy prices. In an inflationary environment, that is close to politically impossible. How can incentives be created that do not put up energy costs? The companion volume's answer is feebates, and it applies here.

Bankability by design. Some policies, notably reverse-auction renewable contracts, produce at least partially bankable projects automatically. The question is how to design policies and derisking options that are *user-friendly to finance* — that generate a contracted cash flow as a by-product of doing the policy properly. Renewable auctions are the model.

Fiscal risk from financing. Some financing forms have historically created fiscal risks for developing countries. Can local capital be mobilized without creating budgetary risk? The answer is yes, but it depends on the first point and on a careful net cost analysis — a theme Chapter 24 returns to.

Project Availability and the Role of Risk

It helps to divide projects into three categories: those that are economic and are being financed; those that would be financed if low-cost capital were available, say at a weighted average cost of capital of 7 percent; and those that are not economic at any plausible cost of capital.

[15] https://www.devcommittee.org/sites/dc/files/download/Documents/2022-10/Final%20Achieving%20Climate%20DC2022-0006.pdf Total green finance in middle-income and poor countries is dominated by east Asia and public (state) investment, is higher, at around $300bn per year, but still far short of what is needed.

The distinction that matters here is between funding and financing. *Funding* means providing the revenue that makes a project happen. *Financing* means lending money against that revenue. A project that pays for itself over its life at a low cost of capital has a *financing* problem. A project that does not pay for itself over its life needs a *funding* source — grants or aid — and no amount of financial engineering will change that.

The reason this distinction has become so important is that the category boundaries have moved. Only recently has a low-cost alternative energy source existed at scale: solar power, cost-competitive on a levelized basis with fossil generation. A great many projects have therefore migrated from the third category into the second. They do not need subsidy. They need cheap money — which means the derisking agenda is now doing work that used to require grants.

So what makes projects available at scale? Renewables have close to ideal characteristics for low-cost financing, because they are typically built against an up-front tariff established by auction.

But there is a prior condition: *sufficient ambition*. Someone has to run the auctions, and enough of them. The question is how governments are encouraged to be ambitious — and the answer, developed through the rest of this part, is that finance itself must be a component of the incentive. A government that knows that ambition unlocks cheap capital behaves differently from one that is merely urged to be ambitious.

Achieving project availability therefore requires three things in sequence: the government policies; the project revenues defined and reasonably secure; and the risks to the financier minimized. Different strategies are needed for projects that are fundamentally economic but unfinanced because of risk or risk perception, and for those that are not economic at all. The first group has a financing problem, and this book is about solving it.

Finance Availability

The second half of the puzzle is whether the finance exists at the scale and interest rate required.

The interest rate matters enormously, for the reasons set out in Chapter 18. And in many developing countries there is simply no access to low-cost finance at scale. Developing country sovereigns borrow at a substantial premium to institutions such as the IBRD with its AAA rating, and the same premium — usually larger — applies to private sector borrowers within those countries.

Second, the international institutions themselves are constrained. The IBRD has a balance sheet limitation: it is capital constrained. This is the fact that motivates the entire architecture proposed here, and it is worth stating plainly, because much climate finance commentary proceeds as though the constraint did not exist. The World Bank *could* invest directly in solar projects. But every dollar it lends to a solar park is a dollar it does not lend to a hospital. What is needed is an *additional* source of low-cost funds, not a reallocation of an existing one.

Creating Parallel Institutions

The cost of finance and the bankability of projects are the barriers to deploying renewable energy at scale in developing countries. And the arithmetic of doing it the conventional way is forbidding: developing countries face a debt sustainability crisis if they attempt a big push while paying market interest costs. At IBRD rates, by contrast, debt rises somewhat but overall sovereign risk falls — because the assets acquired generate revenue and displace fuel imports.

The cost of capital depends not only on the inherent characteristics of a project but on the creditworthiness of the borrower, and creditworthiness can be enhanced by risk reduction measures. That is the lever.

Imagine finance could flow to developing country renewable projects at developed country financing costs. Three benefits follow. The overall cost of solar would be lower, because less money goes to banks and investors. The overall debt burden on developing countries would be lower than it would otherwise be. And part of the reduction in finance costs could be redirected into higher returns on the equity portion, which would both accelerate the pace of transformation and build up a global equity fund — the recycling mechanism described above.

Four elements are needed to resolve the green finance crisis.

1. A way of overcoming scale constraints on IBRD-rated lending for green projects.
2. A way to derisk at scale.
3. A way to organize projects in developing countries.
4. A *scaling dynamic* — a process that actually achieves the required scale.

The first is self-evident from the balance sheet argument above. The second matters because low-cost financing is only sustainable if investors are protected when things go wrong; cheap money without derisking is simply mispriced money, and it does not persist. The third is about platforms: projects need to be organized collectively, partly because of the fixed costs of due diligence and partly for information-asymmetry reasons — an investor who cannot assess one project can assess a standardized portfolio. The fourth is the one most often omitted. It is not enough for existing processes to trundle along at their present pace. What is needed is explosive growth in climate finance, and that requires a mechanism that grows by itself.

The Sum

The book opened with trillions and has since sized one $100 billion portfolio. It is time to add up.

Take the IEA's figure of around $1.35 trillion a year of clean energy investment needed in emerging and developing economies other than China over 2026–30. Roughly a third of clean energy investment goes to power supply; roughly half of new generation investment is solar. That puts the solar requirement at something like $200–250 billion a year, or $2–2.5 trillion over a decade, in the countries where this book's argument bites.

Now apply the structures. At 80 percent debt, that is $1.6–2 trillion of long-term debt to be placed at investment grade over ten years, which is large but not implausible against a global bond market measured in hundreds of trillions. Behind that debt sits a 5 percent equity buffer — $80–100 billion, built up over the decade, recycling as projects refinance — and behind the buffer a AAA reserve against the correlated tail, which on the arithmetic of Chapter 14 is around 10 percent of the guaranteed portfolio, or $160–200 billion of contingent commitment at full scale.

Item	Ten-year requirement	Note
Solar investment, EMDE ex-China	$2.0–2.5 trillion	~half of new generation spend
Of which investment-grade debt	$1.6–2.0 trillion	at 80% gearing
Equity buffer (second loss)	$80–100 billion	5%, recycling every 2–3 years
AAA contingent reserve (tail)	$160–200 billion	~10% of portfolio, drawn only in stress

Item	Ten-year requirement	Note
Offtaker intermediaries	20–30	SECI-scale, national or regional
Currency hedging capacity	$300–400 billion	for the non-local-currency share

Three things stand out in the table. The equity buffer — the money that actually has to be raised as loss-absorbing capital — is under a hundred billion dollars over a decade, which is within the range of what donors and sovereign wealth funds have committed to comparable purposes. The tail reserve is a contingent commitment, not cash, and is of the order of MIGA's and the IBRD's existing exposure combined. And the hedging line is the one that does not yet exist at the scale required: TCX's balance sheet is around $5 billion, and the table asks for a multiple of that, which is why Chapter 14's currency section leaned on local-currency finance and partial indexation as much as on hedging.

The number that is not in the table is the grid, for the reasons Chapter 23 gives. The generation can be financed on these terms. Whether it can be connected is a separate sum, and a larger one.

The Toolkit

Several concepts, drawn from the preceding chapters, combine to produce that dynamic.

Superseniority concerns the relationship between borrower and lender: the lender is treated in preference to other lenders, and therefore lends more cheaply.

Indemnification. Long-term ledgers allow defaults to be compensated by adjustments in parallel ledgers rather than being written off — the credit-relationship principle of Chapter 7.

Finance-ready policy is a policy that generates an investible proposition as a by-product. Renewable energy encouraged through agreements that guarantee the future price of power is the canonical example.

Project finance separates a project's financing from everything else on its sponsor's balance sheet.

Policy and contractual guarantees guarantee those policies. The SECI and World Bank models both work by interposing a strongly rated entity between the borrower and the credit market.

Securitization of policy guarantees creates strongly rated bonds on the back of those guarantees.

An equity fund provides the final layer, ensuring the sovereign and the World Bank retain no residual risk.

Credit lines to borrowers ensure that a default is short-term and does not damage the long-term relationship.

Off-balance-sheet treatment is what allows the whole thing to grow.

The critical element, and the one that distinguishes this from a conventional subsidy programme, is generating a financial profit, passing some of it to the equity part of the investment, and using that profit to grow a global fund. Without the profit there is no scaling dynamic, and without the scaling dynamic the architecture is just another facility.

Applied to renewable energy, the combination looks like this: auctioned renewable power purchase agreements denominated in a basket of hard currencies but declining over the contract term; an equity fund that does co-investment and derisking simultaneously; and, on the back of both, AAA-rated bonds issued at scale.

6.3 16. The Safe Intermediary Strategy: Toward a Theory of Concessionality

The previous chapter listed the elements. This one states the principle that organizes them, and answers the most serious objection to the whole approach.

The Principle

The strategy requires borrowing at low inflation-adjusted rates, and there are two keys to achieving it.

The first is that a *safe, AAA-rated institution should do the borrowing from the financial markets*. Not the developing country, not the project developer, not the state-owned utility — the safe institution. The money is then passed through.

The second is that *the long-term relationship between the safe institution and the borrowing entity does the risk reduction*. This is what makes the pass-through cheap rather than merely a transfer of risk to a stronger party.

Combining the two yields the central trick: guarantee a *state agency* — for example, the agency that sets the long-term contracts — rather than short-term private sector agents. The state agency is a repeat player with a relationship to protect. The private developer, having built its project, may never need the guarantor again. Guaranteeing the repeat player minimizes the real risk rather than merely relocating it.

Finally, the whole thing can be made self-sustaining through an equity fund that also profits from the reduced borrowing cost of the derisked debt.

This is what a theory of concessionality looks like. Concessionality is conventionally understood as money given up: a grant element, a below-market rate that someone subsidizes. The argument here is that a large part of it can be *manufactured* instead — out of credit ratings, relationships and diversification, which are institutional assets rather than budget lines. The World Bank's AAA rating is a resource. Used correctly, it can be lent without being spent.

The Objection, and the Answer

There is a serious criticism of derisking that has to be met: that it socializes risk and privatizes return. Public institutions absorb the downside, private investors keep the upside, and the arrangement amounts to a transfer from taxpayers to financiers.

The criticism is correct about conventional derisking. The structure proposed here answers it directly. If a *public* global equity fund — financed by small investors and by states, sharing profits with developing countries — captures some of those benefits, then the very profitability that makes the criticism bite becomes the mechanism by which the public captures the gain. The private investor still earns a return, because otherwise no private money arrives. But the public fund is sitting in the same capital structure, earning the same enhanced return, and recycling it.

This is why the equity fund is not an optional add-on to the guarantee architecture. It is what makes the architecture defensible.

What About Other Sectors?

This book has concentrated on renewables, and specifically on solar, because that is where the contracted revenue stream is cleanest. The same logic must eventually be extended to grids, to batteries and to the rest of the system, each of which needs its own securable revenue — user charges for grids, capacity payments for storage. That work remains to be done.

The Macroeconomics of Greening the Financial System

One further idea belongs here, because it points beyond finance into industrial strategy.

Green development is likely to be strongly stimulative to economic growth, and there is a way of making that stimulus pay for part of itself. Rapid installation of renewable energy could create *credits* that facilitate lending along the green supply chain. Every contract to install renewable generation or emissions-reducing end-use technology would earn credit toward financing the supply chain behind it — battery factories, PV factories, mineral mines. A megawatt of solar generation generates a defined quantity of credit.

The effect would be to link the deployment of clean energy to the financing of the capacity to build it, which is precisely the linkage that the trade balance discussion in Chapter 8 identified as missing.

One design warning. We should resist the temptation to make these credits part of the carbon market. Carbon markets have their own accounting problems, discussed at length in Part II, and folding a supply chain financing instrument into them would import every one of those problems while obscuring what the credit is actually for. The credit is a claim on financing capacity, not a claim about atmospheric carbon, and it should stay that way.

Four Questions a Finance Minister Would Ask

The strategy above invites four practical questions, and it is worth answering them briefly here before Part IV develops the institutions.

How can policies and projects be structured so as to be fundable by reasonably low-cost money? By designing them with financing in mind from the outset rather than financing them afterwards. In practice that means one thing: certainty over future cash flows. A feed-in tariff, an auctioned PPA, or a contract for difference produces a financeable asset as a by-product. A policy that achieves the same physical outcome without a contracted stream produces an asset that must be financed on the sponsor's balance sheet, at the sponsor's cost of capital. The two look identical in an emissions model and differ by a factor approaching two in the cost of the electricity.

How can low-cost financing be channelled to these projects? By understanding the risk and then allocating it — each risk to the party for whom it is cheapest, as Chapter 3 set out — and by tranching so that each class of investor holds the profile it wants. The channel itself is usually a special purpose vehicle receiving contracted payments directly and paying bondholders first.

How can the risks to investors be minimized? For the case this book treats — contracted solar — by guaranteeing the offtaker rather than the loan, separating construction risk from operating risk by refinancing on completion, and placing a first-loss equity buffer beneath the debt.

And how can the risks to the sovereign be minimized? By not signing obligations that mismatch the source of funds, and by attending to how commitments evolve over time. Concretely: do not denominate a twenty-year liability in a currency you do not earn without hedging it, and do not fix a real-terms tariff for twenty years against a technology whose costs are falling. A sovereign's risk comes less from the size of its commitments than from the mismatch between their shape and the shape of its revenues.

6.4 17. Why the World Bank

The previous chapters have been proposing things for the World Bank to do. This one steps back to ask what the Bank is for in a climate context, and why its particular shape makes it the right place for this architecture to sit — rather than a new institution, a regional bank, or the private market alone.

What Paris Compliance Requires

To stabilize global temperature, total global greenhouse gas emissions must reach net zero: emissions must fall to a very small level — under a ton per person per year — and be balanced by removal. Because some emissions are unavoidable, this amounts in practice to an economy that runs on low-carbon energy.

The expected temperature rise depends on *cumulative* emissions, so the path matters as much as the destination. The Paris Agreement commits the world to holding the rise to 2C above pre-industrial levels, with efforts toward 1.5C, typically measured at 2100. The limits matter because of tipping points in the Earth system — the collapse of the major ice sheets, or of the Amazon, whose disintegration is driven by deforestation as well as warming, since the forest generates its own rainfall. Even 1.5C does not guarantee that every tipping point is avoided.

Current temperatures are around 1.2C, and more warming is already committed: from existing concentrations, since the system takes a decade or two to equilibrate, and from the momentum of a fossil fuel system that cannot be shut down overnight. The minimum technically feasible peak without large-scale negative emissions is already at least 1.5C.

One further fact has to be faced. It is unlikely that all countries will decarbonize. Some — Russia is the clear example — are internationally significant and may perceive benefits from warming. Whatever architecture is built must work without universal participation, which argues for mechanisms that reward participants rather than penalize non-participants.

Why This Institution

The World Bank has a role here that is not interchangeable with that of any other institution, for four reasons.

It connects money to reform. Uniquely among development banks, the World Bank lends directly to governments' budgets on the condition that agreed policy changes are made — what it calls development policy financing. That is the instrument by which a country can be rewarded for running an auction programme or guaranteeing an offtaker, and it is why this book keeps returning to the Bank rather than to its regional counterparts. The Bank is also a provider of carbon market infrastructure, which the companion volume treats.

It has been more forceful before. The Bank's history includes periods in which it drove institutional change in client countries far more directly than it does today. A comparable assertiveness is arguably needed in climate mitigation.

It sets the template. As the largest development bank and the only one with global scope, what the World Bank does becomes the model that regional banks, bilateral agencies and private financiers follow. A structure that works at the Bank propagates; one that works only at a regional bank may not.

And it combines functions no one else combines: development knowledge across every sector, an insurance arm in MIGA, a private-investment arm in the IFC, and country offices with standing relationships in every place the projects have to be built. The guarantee stack of Chapter 14 needs all four, and the Bank is the only institution that houses them under one roof.

The Scale, and the Approach

The scale is daunting. Meeting a 1.5–2C target requires vast infrastructure investment, and a decarbonized economy is an electrified one, which means enormous quantities of generating capacity. The Bank's own analysis suggests that a decarbonized world is not, in the end, *more expensive* — but the shift required to get there is very large. The problem is transition finance rather than ultimate affordability, and transition finance is what financial structures address.

So how can the Bank meet its potential? The premise adopted here is that financial services can be profitable — they are for the Bank — but that the scale needed is far greater than the Bank's own balance sheet permits. The method, therefore, is to look for the institutions that are missing, and for the business models that could sustain them. That search produced the architecture of Chapter 14 and the funds described in the chapters that follow.

Why It Has Not Happened Already

If the case is as strong as the previous section suggests, a reader is entitled to ask why the World Bank has not already done what this book proposes. The answer is not that the argument has not been made. It is that four things stand in the way, and each is institutional rather than intellectual.

The capital adequacy framework. The Bank lends against its callable capital and its paid-in capital under rules that its shareholders and the rating agencies set. In 2022 an independent panel commissioned by the G20 concluded that those rules were more conservative than the Bank's own loss record justified — its loan book shows extremely low non-accruals, thanks to preferred creditor status — and that the MDBs collectively could lend several hundred billion dollars more without threatening their ratings. The Bank has since taken steps in that direction, but every step requires the shareholders to accept a marginally higher probability of a capital call, and shareholders are treasuries, and treasuries do not volunteer for contingent liabilities. The "stretch every dollar" agenda is the institution working through this constraint, slowly.

The politics of the shareholders. The Bank is owned by governments whose interests differ. Its largest shareholders want it to lend to middle-income countries where the mitigation gains are largest; its poorest borrowers want concessional money for development; and the countries that would host the structures in this book want neither the Bank's conditions nor its risk aversion. Any expansion of climate lending that is not additional — that comes out of the existing envelope — is opposed by whoever loses the envelope. The additionality requirement of Chapter 11 is not a technicality. It is the condition under which the shareholders will agree.

Risk culture and incentives. A guarantee that is never called looks, inside the institution, like a guarantee that was never needed. A loan that performs looks like success. The Bank's staff are rewarded for volume disbursed and for projects that do not go wrong, and a guarantee programme designed to absorb losses in the tail is, by construction, a programme that will one day produce a loss that someone has to explain. Institutions that have never taken first loss do not acquire the appetite for it by being told it is efficient. They acquire it by being given a separate vehicle, with its own capital and its own mandate, whose success is measured differently — which is the argument for the funds and the trust of the chapters that follow, rather than for asking the Bank's existing operations to change their nature.

The missing functions. The IFC has an equity investment capability but has not, in recent years, prioritized it. MIGA reinsures its political risk cover but writes less of it than the market could absorb. No part of the Bank Group currently runs anything like a global equity

buffer fund, and no part is set up to. The capability has to be built, and building capability inside a large institution is slower than proposing it.

None of these obstacles is an argument against the proposals. Each is a reason why the proposals should be designed so that the institution can adopt them without transforming itself — off balance sheet, separately capitalized, additional to the existing envelope, and measured by their own results. That is the design principle behind everything in this part, and it comes from taking the institution's constraints seriously rather than from wishing them away.

6.5 18. Scaling Up Policy Lending

This chapter and the next set out two concrete institutional proposals. Both rest on the same insight: that an equity fund which absorbs risk can expand what the World Bank is able to lend without expanding what the Bank's shareholders have to contribute.

The Gap in Policy Lending

Meeting global climate-related financing needs will require scaling up low-cost lending for emerging markets and developing economies far beyond the existing capacity of the MDBs. The requirement is roughly $1.35 trillion invested annually in the green transition in emerging markets excluding China over 2026–2030, according to the IEA.

Against that, consider the distribution of what is actually spent. In 2020, only $100 billion of the $632 billion in total global climate finance was spent in the developing regions where the majority of humanity lives: $19 billion in sub-Saharan Africa, $16 billion in the Middle East and North Africa, $35 billion in Latin America and the Caribbean, and $30 billion in South Asia.[16] Roughly six-sevenths of global climate finance goes to roughly one-seventh of the world's people.

A key reason is the one this book has returned to throughout: the weighted average cost of capital is much higher for project developers in developing countries than in highly developed ones, because of foreign exchange risk and other country risk factors. Climate finance concentrates where capital is cheap, which is the opposite of where it is needed.

Bridging the gap will require well-designed policy reform *and* a strong private capital mobilization strategy that can deliver cheap lending at the required scale. The World Bank could play a key role in incentivizing the reforms.

The Proposal

This chapter proposes a financial structure for mobilizing impact investor capital for IBRD-rate policy and investment lending *beyond* the existing envelope of MDB finance.

It envisages a World Bank-managed global equity fund — and potentially also regional equity funds managed by regional MDBs on the same model — as part of a system of risk absorption for policy and investment lending. The fund performs three functions at once: it invests in the early stages of standardized projects, absorbs risk arising from additional policy lending, and provides profit-sharing incentives, via equity share distributions, to countries that act early on policy.

The perspective here follows Heine et al. (2023): policy incentives are best achieved through an *additional* envelope of lending for climate purposes, beyond the MDB-agreed overall country limits for development financing. This is the additionality requirement from

[16] According to the Global Landscape of Climate Finance 2021, global climate finance reached $632bn in 2020, most of it in East Asia, Western Europe, and USA-Canada (Climate Policy Initiative (CPI), Dec. 2021(https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2021/)). Yet this is far too little: CPI estimated that global climate finance must increase at least 590% if 2030 mitigation goals are to be met. The numbers are particularly dire in the developing world.

Chapter 11, and it is load-bearing. An incentive that displaces other concessional finance is not an incentive.

Scalability

The fund's defining characteristic is that it is designed to grow.

It would provide resources to climate-friendly public and private infrastructure projects in two forms, equity investment and loans, with equity exits and loan repayments expected to bring profits back into the fund. Carefully chosen private and public institutions would be invited to participate as limited partners as it grows.

Equity investment would be available for a selected group of strategic projects following thorough due diligence. Critically, the fund would invest *only in the early stage* of each project — construction plus a year or two of operations — cashing out once the project reaches a low-risk operational phase. This is the recycling mechanism, and it has a second effect beyond capital efficiency: investment by the fund serves as a signal of project quality, reducing perceived risk and helping attract additional private investment from local and international financiers.

Loans would be provided to carefully selected public and private projects at IBRD-level interest rates. Recipient projects would be eligible for a multiple-layer guarantee scheme built on international donor guarantees together with guarantees from the World Bank and the local government. The scheme's purpose is to reduce the financial risk of projects the fund has already vetted, thereby facilitating access to additional private finance at reasonable cost.

Risk Absorption as the Route to Cheap Policy Lending

The fund's most consequential function is not investment but risk absorption, because that is what unlocks lending capacity elsewhere.

The fund can itself be a risk-absorbing entity for policy lending, either by acting as a *guarantor* to policy lending in the manner of MIGA — so that policy lending does not consume scarce World Bank capital — or by providing risk-absorbing equity in a separate structure, similar to the SDR-funded investment accounts in the IMF's Resilience and Sustainability Trust.

There is a reason to expect this to be extremely capital-efficient. Thanks to the preferred creditor treatment enjoyed by MDBs, their loan books show extremely low non-accruals and economic losses (Capital Adequacy Framework Panel, 2022). The risk being absorbed is, empirically, small. A modest buffer can therefore support a large volume of additional lending — which means the risk-buffer function can help the World Bank provide additional climate-related policy lending at the lowest possible rate to countries critical to global decarbonization, India prominent among them.

Dynamic Incentives

Achieving policy reform requires policy lending *and* dynamic incentives — giving first movers a better deal than late movers. This is the mechanism that makes the whole thing more than a subsidy scheme, because it changes the strategic calculation of waiting.

Under this proposal, if the fund's return exceeds some target level, countries taking rapid mitigation policy action would be rewarded with share allocations in the global equity fund. Those allocations dilute the original impact investors' equity until they receive only the agreed maximum return — which is how the excess return is transferred without anyone writing a cheque.

Allocations to participating countries would be made into special national reward funds, conditional on policy actions, and including a requirement that each participating sover-

eign serve as the first line of risk absorption for portfolio losses in its own territory. That condition is what aligns the incentive: a government with equity in the fund and first-loss exposure on its own projects has every reason to maintain the regulatory environment those projects depend on. Dividends paid out of national reward funds could be used to purchase physical investments or to provide insurance against climate risks.

A Fund of Funds

The proposal is for a network approach: initially a global fund organized by the World Bank, and later regional funds developed with the regional MDBs. Together these have the potential to scale the green infrastructure lending capacity coordinated by the World Bank to the level required.

Governance of the global fund would remain with the World Bank — the distributed shares would not carry direct voting rights. However, any Bank-proposed *changes* to the workings of the fund would require agreement by a super-majority of shareholders at the time of the proposed change. This is a deliberate asymmetry: the Bank retains operational control, while participants are protected against having the terms rewritten after they have committed.

References: Climate Policy Initiative (2021), The Global Landscape of Climate Finance 2021. Heine et al. (2023), EFI Staff Discussion Note Proposing a Mechanism for Implementing the Evolution Roadmap on Climate (unpublished). IEA (2021), Financing Clean Energy Transitions in Emerging and Developing Economies. IEA (2023), World Energy Outlook 2022. Capital Adequacy Framework Panel (2022), Boosting MDBs' Investing Capacity.

Application to Green Infrastructure Projects

The proposal applies to investment lending for clean energy systems, green public infrastructure, critical minerals, climate-resilient food supply and other green supply chain elements.

For clean energy specifically, the structure would consist of MIGA-style guarantees, indemnified by the sovereign, supporting low-cost loans to qualifying private green infrastructure developers, plus a shared equity fund co-investing in the early stages of projects meeting standardized criteria — the co-investors being the equity fund or funds together with private developers. As above, the fund invests only in the early stage and cashes out once the project is operational, and the co-investment functions as a quality signal that lowers perceived risk. Projects qualifying for co-investment could also be associated with regional or national renewable energy development agencies on the model of the Solar Energy Corporation of India.

Under the proposed system, a specialized global or regional lending agency makes IBRD-rate loans to qualifying clean energy projects in countries that have committed to a framework agreement — a key component of which is a standardized format for multi-year contracts for difference or power purchase agreements.

Two features of this design deserve emphasis. The agency lends *directly to project developers*, so the loan portfolio does not accrue to the client government's balance sheet and does not consume fiscal space. But the loans are nonetheless backed by policy guarantees from the developing country government — not directly, but intermediated by the World Bank Group through MIGA and the IBRD. Governments contractually agree to indemnify the Bank for any portfolio losses caused by policy changes they themselves make. This is close to existing practice, and it is the sovereign indemnity of Chapter 7 doing its work: the government guarantees only what it controls.

It will also be important for the lending agency to be structured to absorb foreign exchange risk — hedged, priced, or avoided by local-currency finance, as Chapter 14 sets out. One possible design for such a specialized global lending agency was put forward in 2022 by Avinash Persaud as the Global Climate Mitigation Fund, part of the Bridgetown Agenda 1.0.

Solutions for Low-Capacity Countries

Cheap lending could have a very positive impact on developing countries' fiscal space relative to sovereigns and developers financing mitigation at market rates — especially where large-scale lending to developers goes through non-government financial channels and therefore stays off the sovereign balance sheet.

But some countries lack the institutional and financial machinery to use any of this. For them, clean energy development could be provided as a *service*. Such an offering would suit least developed countries with low fiscal capacity and poorly developed capital markets, particularly those that import fossil fuels. Under the aegis of the specialized lending agency, working with a qualified consortium of implementation partners, a country could pay for its clean energy at a rate that declines over time and is priced below what it would pay for fossil fuels.

The declining price is not a concession; it is a projection. The price per MWh can be expected to fall as renewables continue to decline in unit cost with scale, in accordance with Wright's law. The financial engineering would be provided by, for instance, the IFC, rather than by a domestic financial system that does not exist. What the country commits to is an energy bill, not a debt — which is the single most useful thing that can be offered to a government at its debt-sustainability limit.

Minimizing Currency Risk

For macro-risk reasons, local currency financing is the appropriate choice in some countries. But many least developed countries have little or no access to green bond markets, so local currency financing has nowhere to go.

There is a way through. Providing guarantees that eliminate debt-servicing risk on a defined portfolio of clean energy projects would allow the creation of *green savings accounts*: domestic savers place local currency savings in special derisked accounts whose aggregate deposits finance clean energy projects. This creates the functional equivalent of a green bond market in a country that has no bond market — the saver gets a safe local currency asset, the project gets local currency funding, and no one takes a currency position.

Why the Equity Fund Appreciates

A simple worked example shows where the fund's returns come from. The returns below are not necessarily feasible or sustainable, and the scheme does not depend on them; the example describes a reasonable best case given low-cost refinancing of projects in risky contexts. It also assumes the price paid per MWh in the original auction does not adjust downward to reflect the new profitability — in time, averaged across many projects, competition would drive both returns and power prices down.

A solar project costs $1 million to develop: $200,000 of equity and $800,000 of initial debt. The weighted average cost of capital is 10 percent and distributable net revenues from power sales are $100,000 per year. The project takes one year to build and lasts ten years thereafter.

The 10 percent WACC decomposes as:

- 80 percent debt × 8 percent cost of debt = 6.4 percent → $64,000 in interest
- 20 percent equity × 18 percent cost of equity = 3.6 percent → $36,000 in profit to shareholders

Once the project is built and operational — that is, once the higher-risk development phase is behind it — the AAA guarantees, and optionally central bank purchase of the debt, allow the debt to be refinanced at 4 percent.

Interest then falls to $32,000 per year, leaving $68,000 for equity holders. The return on equity has risen from $36,000 to $68,000, roughly doubling. The shares appreciate by a factor of two in a single year.

That doubling is the engine of the whole architecture. It is not created by a subsidy. It is created by the fact that a completed, contracted, operating solar park is a fundamentally different risk from a solar park under construction — and by the fact that conventional financing prices both the same because it cannot separate them.

6.6 19. The Climate Investment and Insurance Fund

The previous chapter proposed a fund to expand policy lending. This one proposes its counterpart for project lending, and works the institutional design out in more detail.

Context

The investment and financing needs for reaching net zero are enormous. The IEA has estimated that $4 trillion per year of clean energy investment is needed globally,[17] with about $1.35 trillion per year in middle-income and less-developed countries on average from 2026–30.[18]

The G20 independent expert group on Strengthening Multilateral Development Banks, in its June 2023 report "The Triple Agenda," estimated that additional spending of some $3 trillion per year is needed by 2030 — of which $1.8 trillion represents additional investment in climate action, a fourfold increase in adaptation, resilience and mitigation compared with 2019, mostly in sustainable infrastructure, and $1.2 trillion in additional spending to attain other Sustainable Development Goals, a 75 percent increase in health and education.

To make far more sustainable infrastructure projects financially viable, and to avoid compound interest debt traps, the cost of capital borne by project developers must be as low as possible — as low as the rates the IBRD charges governments.

One number captures the stakes better than any other in this book. A recent LSE study[19] estimated that fiscal debt-to-GDP ratios under a major green public investment push would rise by *70 percentage points* if governments paid current bond market interest rates — but only *10 percentage points* under the rates the World Bank charges them. The same physical investment programme is either a debt crisis or a manageable expansion, depending entirely on the interest rate. Everything in this part of the book follows from that gap.

Derisking sustainable infrastructure investment, through policy reform in host countries and through MDB-intermediated financial mechanisms, is therefore the key to reducing the cost of capital. Previous proposals to reform the World Bank and other MDBs have emphasized scaling up platforms to organize public and private investment; greater use of guarantees; and an originate-to-distribute securitization model allowing private banks to participate in Bank-organized lending or to buy Bank loans. The Bank's President has said it will adopt an approach that stretches every dollar,[20] and the Evolution Roadmap sets out options for private capital facilitation, including better use of guarantees.

[17]IEA (2021), *Net Zero by 2050*, IEA, Paris

[18]IEA (2021), *Financing clean energy transitions in emerging and developing economies*, IEA, Paris

[19]Songwe V, Stern N, Bhattacharya A (2022) *Finance for climate action: Scaling up investment for climate and development*. London: Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science.

[20]World Bank to 'stretch every dollar' with new lending measures | Financial Times(https://www.ft.com/content/3b1928e3-5531-47a7-b11a-fbb9bd067fc7)

The Bank's Three Roles

The Bank has three crucial roles in enabling a major scale-up of green infrastructure investment, and it is worth distinguishing them because proposals often conflate them.

It can *enable low-cost finance* for green investment. It can *provide incentives* for more rapid policy action than would otherwise happen. And through appropriate financial instrument design, it can *mobilize* both international institutional investment and domestic savings within developing countries — helping those countries build buffers of financial wealth and increase their economic resilience.

The third role is the least discussed and possibly the most valuable. The instruments described here do not merely import foreign capital; they create domestic financial assets where none existed.

Situating the Proposal

Several policy discourses on scaling up cleantech infrastructure were already in play by autumn 2023, all discussed at the Paris Summit for a New Global Financing Pact in June of that year, and the proposal here builds on them and is consistent with their direction of travel. They are: the ideas for scaling clean energy and green infrastructure in the World Bank Roadmap; the Indian G20 Presidency's "Triple Agenda" independent experts' report; proposals for reforming the MDB Capital Adequacy Framework to enable increased lending for sustainable infrastructure; and the Bridgetown Agenda 1.0 and 2.0, in particular the Bridgetown proposal for a global Climate Mitigation Trust. Each is summarized in Appendix 1.

The proposals developed here follow a similar philosophy, asking: how can the scale-up of finance for clean energy and climate-resilient infrastructure be maximized — especially by derisking private institutional investment, providing compelling incentives for developing country governments to act early, and enabling financial access for everyday people in developing countries?

Two financing cases are treated. First, primary investment and policy lending to states along the lines of existing IBRD operations, where the proposal is a simple scaling-up of current activities together with a climate-related institution or vice-presidency in the Bank to coordinate. Second, projects generating predictable revenue streams in countries with suitable regulatory regimes — renewable energy independent power projects whose revenues are defined by power purchase agreements. For this second case the proposal is a clean energy equity investment fund,[21] which could also act as a derisking buffer in guarantee structures that mobilize the Bank's AAA rating without using up its lending capacity.

Additionality, Again

When the World Bank lends for climate, the money lent should be additional to what it lends for other goals. Why? Because climate needs *are* additional. The need for roads, schools and aqueducts does not go away now that we also need solar parks, desalination plants and seawalls.

There is a second reason, and it is about credibility rather than arithmetic. The Bank's lending aims to encourage policy action. It will not succeed in promoting climate policy change if what it lends with one hand it takes away with the other. A government that reforms and finds its overall envelope unchanged has learned that reform is unrewarded.

So where does the risk-absorbing capital for this expansion come from? Existing shareholders could expand their contributions. Alternatively, climate-related loans could be originated and then distributed, with the Bank organizing the lending and selling the loans

[21] Initially one fund, but expandable to a system of funds later.

on to banks or investment funds. But an easier route is guarantees: the loans could be insured by a World Bank-managed Financial Intermediary Fund. What follows is a possible design.

The Fund

The proposal is to establish a Financial Intermediary Fund called the Climate Investment and Insurance Fund, managed by the World Bank Group, with the specific goal of enabling climate mitigation in client countries, including clean energy supply expansion.

Consider the particular case of scaling up clean energy. A renewable project normally sells power at a specific price over a defined horizon — twenty years, say — under a power purchase agreement or contract for difference, with the price often set by auction. Long-term guaranteed prices derisk the *operating* phase of a project. This means the main higher-risk phase is project *development*. Once development is complete and the plant is operating, investing in it is generally a fairly safe bet.

The structure follows directly from that observation. Governments would guarantee the long-term contractually agreed price per MWh — and hence the revenues — for qualifying projects in their territory. The insurance/equity fund would provide a second guarantee. The World Bank would provide a final guarantee for the contracted price. This both uses and protects the Bank's credit rating: the loans carry the Bank's rating, but the buffer equity fund covers the risk.

The fund as co-investor. The CIIF would co-invest in new clean energy projects during the initial construction phase. To raise equity capital for these co-investments it would sell AAA-rated green bonds to regional and global institutional investors, and green deposit certificates to retail investors. Once a project's construction phase is complete and it is generating revenue from electricity sales, the fund's equity would be sold — generally at a profit — to investors, including institutional investors in developing countries.

The fund as insurer. The second function is to act as an insurer against non-performing loans made to power projects. The fund's stack of equity would insure lending risks, effectively distributing risk across a diversified portfolio of projects, in exchange for a fee charged to developers. This is the diversification benefit of Chapter 3, monetized.

Regional funds. Funds similar to the global CIIF could be established as for-profit instruments open to small private investors in developing countries. These could serve as secure infrastructure investment vehicles supporting government pension and social protection schemes. In emerging economies with a middle class and a sufficiently developed financial system, ordinary people could participate through government-encouraged saving — social security contributions invested directly in funds that support the contributors themselves. This would increase financial resilience in the population while encouraging green investment-led growth that builds up individual and national balance sheets.

Prioritization

The fund should prioritize investments with the highest social returns. A financial mechanism and transition planning capacity for *replacing* coal power stations with dispatchable clean capacity — renewable generation plus storage — must be among the first business lines developed. The reason is the one Chapter 27 develops: reducing climate risk does not only require expanding clean energy infrastructure, it urgently requires shutting down existing fossil-fuelled infrastructure, and almost no financial machinery exists for the second task.

Accordingly, a high priority is to systematize and scale up the Bank's Just Transition for All work and the multi-institutional Just Energy Transition Partnerships, so that JET-P offers

a transition package, including concessional financing, for *every* coal-fired power station globally — and expands to encompass gas-fired stations too.

The fund would also develop the specific know-how, standards and procedures supporting the global net zero objective. The proposal is for a global fund led by the World Bank alongside regional funds led by the respective regional MDBs, each enjoying administrative freedom over capitalization and operational decisions while adhering to common standards.

Financial Products for the Developing World

The CIIF equity fund would be an *equity buffer fund*: it acts as risk-absorbing equity invested in specific projects and simultaneously provides insurance products as part of risk absorption structures. Initially it would supply one layer within a set of guarantee structures; later it could guarantee other risky green products.

Once an equity buffer fund exists, it enables leverage — cheaper debt financing from both domestic and international sources. The mechanism is worth spelling out. The fund provides a risk-absorbing structure for loans, which allows cheap green bank deposits to be created, with lending to green projects financed by issuing green deposit certificates. This creates the equivalent of a green bond — a local currency financing mechanism — even in countries with no local currency capital market.

There are at least three reasons to enable local currency financing alongside dollar loans.

If loans are issued in local currency there is no risk of depreciation raising the local currency cost of debt, as there is with hard currency lending. Put differently: if revenues are in local currency, there is less risk of mismatch between the currency of the revenue and the currency of the repayments.

And many banking systems are inefficient, with a large spread between the rates charged to borrowers and those paid to depositors. This structure competes with the banking system: depositors receive a slightly higher rate and borrowers pay a lower one than capital markets currently offer. The intermediation margin is captured for the transition rather than by the banks.

Who Bears the First Loss

To involve developing country governments and strengthen their incentive to maintain sound regulatory regimes, the proposal is that they be the *first* guarantors of any losses incurred by the fund.

The CIIF would therefore have three risk-absorbing buffers. The first loss is guaranteed by the participating developing country government. The second layer is the equity fund. The third consists of AAA-rated guarantees from the World Bank or a strongly rated sovereign.

In other words, the primary risk absorption comes from developing countries guaranteeing themselves. In practice this means that if there is a default, payments are covered by the World Bank, but the government indemnifies — so the loss is added to existing sovereign obligations owed to the Bank. This is the credit-ledger principle again, and it is what keeps the guarantee cheap.

In exchange for that risk absorption, governments participate in profit-sharing: a share of net revenues from the fund's portfolio of clean energy projects, credited to national reward accounts in the form of shares in the fund. Early participation can be incentivized by allocating larger equity stakes to early movers — the dynamic incentive of Chapter 18.

What the CIIF Offers

This global fund, and potentially regional funds structured similarly, can provide an injection of additional equity at the scale the clean energy transition requires, and a climate-resilient financial buffer alongside it.

The same approach — an auctioned revenue guarantee plus derisked finance — could be applied to other contexts: the equipment supply chain for the transition, for instance integrated battery and solar gigafactories of the kind under construction in Gujarat, and the critical minerals transition. In those cases a revenue guarantee would be offered by governments or international organizations — a contract to sell minerals at a given price, or to buy solar panels at a certain price — and that guaranteed revenue provides the backing for bonds. The pattern generalizes: find the contract, secure it, securitize it.

In summary, this is a scalable solution that allows people in developing countries to participate financially in their own country's clean infrastructure development — through profit sharing on equity investments, through green deposit accounts, through government social security contributions, and via financial products on smartphone apps that compress the spread between loans and deposits.

The proposed system overcomes the financial constraint of the World Bank, which is limited by its capitalization. It incentivizes developing country governments to participate in the solution. It offers a secure investment option for small retail investors as well as institutions. And it implements the Roadmap's commitment to leverage guarantees in service of a financially scalable approach to investment-led growth.

6.7 20. The Climate Incentives Trust

This is the most developed of the five mechanisms, and the one that attempts most. Where the funds of the previous two chapters absorb risk so that lending can expand, the Climate Incentives Trust adds a third function — international incentives — and in doing so proposes an answer to the collective action problem that Part II left open.

Objective

The proposal aims to expand global, for-public-good, loss-absorbing capital: for mitigation finance before 2050, and for loss and damage protection after 2050.

More specifically, the objective is the *insurance* of risks in exchange for sovereign commitments, *investment* in early-stage blended project equity in renewable projects, and — through profit-sharing — *incentives* for countries to act early. It aims to create nationally-allocated beneficiary funds that protect against the long-term fiscal risks climate change will impose in the second half of the century.

That last element is what distinguishes the Trust from everything else in this book. It is not only a financing structure. It is an attempt to accumulate, now, the national balance sheets that will be needed later.

Summary of the Solution

The Trust would insure against risks so as to mobilize cheap debt financing — KPI bonds, or trusted intermediary investment finance — invest in renewable projects, and create incentives for countries to participate. It would partner with implementing agencies and initiatives such as Scaling Solar and the Energy Transition Partnerships.

At its heart, the Trust reduces borrowing costs and risks by maintaining national-scale accounts that can act as collateral for borrowing related to climate mitigation and adaptation. The accounts do two jobs at once: they are a reward, and they are security.

Like an insurance company, the Trust also makes financial investments, including blended project finance for the early stages of supported projects. The investment function is strictly non-core, but it adds both *financial return* and *impact*, which increases attractiveness to donors and is therefore vital to the transformative potential of the whole proposition. A pot of donor money that grows is worth qualitatively more than one that is spent.

The investment activities involve insurance contracts, MIGA-managed, and diversified green blended equity investments in the construction phase of projects, with implementation agencies worldwide including the IFC. The insurance and incentive functions are more straightforward to establish first, with investment added later.

In a trust structure, funding is separate from control and administration. Here the Trust would be funded by donor countries and managed by the World Bank Group. The *formal* end beneficiaries — the point at which investments become liquid and withdrawable — are the post-2050 populations of participating recipient countries. In the interim, those countries benefit through risk protection.

Incentives to join, and to reduce emissions once joined, come from the allocation of profits to the beneficiary accounts. Those accounts serve as buffer funds for the insurance of national policy guarantees and financing, and are also available to support national populations in the event of climate-related disasters after 2050. Some proportion would sit in a global benefit account not yet allocated to particular countries.

The structure also mobilizes additional private equity and debt. With Trust investment of $1 billion per fund, mobilized private equity of $100 billion, seven regional funds, and investment confined to the early stages of projects, the programme reaches the scale required for global net zero. The financial summary below sets out the arithmetic.

Introduction

Meeting the Paris temperature targets will require clean energy investment totalling more than $1 trillion per year in emerging markets and developing economies (IEA, 2021), far above what is currently achieved. The needed investment covers renewable generation and public infrastructure — grid, storage, electric vehicle charging — as well as the incentives that promote private sector action: sectoral feebates, regulatory policy and carbon pricing.

Scope Limitations

This document does not cover all aspects of implementation. In particular, there would need to be a net zero deal in each participating country, involving an overall plan of infrastructure and policy, and specific investment procurement auctions for renewables and required infrastructure.

In low-capacity countries lacking the relevant financial infrastructure, the project finance and investment functions would need to be provided as a service, with the goal of making the green transition fiscally sustainable while managing the overall balance sheet of the country concerned.

To avoid national indebtedness and to create capacity at international scale, one option is to offer a whole clean energy system deal to a small country or a municipality. So long as the price paid for the energy is below the price paid for fossil fuels, this could be an attractive proposition.

The document does not address the precise formula for profit sharing or for KPIs.

Finally, a green insurance scheme could fulfil several functions beyond those discussed — insuring foreign exchange risk, or reducing financing risk for critical minerals through price guarantees. Those are not covered here. The focus is on how to generate the required for-global-public-benefit equity capital at scale.

The Need for International Incentives

How could the necessary incentives be created? The task looks daunting, and it is worth working through why the obvious approaches fail, because that is what motivates the trust structure.

Existing institutions such as carbon markets and international carbon trading require *additionality*. But additionality creates a perverse strategic incentive: it pays countries to delay action until someone pays them to act. A country that decarbonizes on its own initiative forfeits the payment. *Universal incentives*, defined now for all countries, are one way around this.

Economists tend to favor internalizing externalities. Actions — policies — are required first at the national level, which requires incentives at the international level. But international norms of sovereignty preclude global taxation of national emissions.

The arithmetic makes this concrete. Suppose we need an incentive of $100/tCO2e. A putative international carbon tax at that level would raise nearly $5 trillion and require transfers, before any use of the revenue, of $1 trillion per year from China to the rest of the world. Even after redistribution, the net sums would be enormous. Why would China sign up to such an infringement of its sovereignty and such vast transfers of money? The answer is that it would not, and no amount of elegant mechanism design changes that.

Direct global subsidies also look difficult, requiring a pot of global money that is infeasibly large. Suppose $100/tCO2 of positive incentive reduced global emissions by 10 percent in the first year. That implies roughly $500 billion per year, rising as emissions fall. Positive subsidies also raise thorny questions about the baseline against which they are paid — the same perverse incentive as additionality.

To keep the required money manageable, the *scope* of universal incentives could be limited regionally or sectorally. Restricting scope to, say, coal power station retirement alone looks promising in combination with other measures, and it is what the Trust proposes to begin with.

Trade policy is another option — the EU's carbon border adjustment mechanism being the relevant example — but CBAM covers only major energy-intensive industries and can therefore play only a part. Relatively closed economies such as India may have the option of building their own supply chains and strategic industries, scaling up solar power and solar manufacturing simultaneously, but this looks inefficient for small countries unless they club together into larger trade blocs.

A further structure would combine a fee and a rebate for *countries*, such that there is an incentive to change behavior in aggregate. Countries would be rewarded for reductions in carbon intensity, with the overall pot netting to zero and better performers helping out worse ones. This is the feebate of the companion volume applied at the international level, and the required transfers would be much smaller. But the *negative* transfers — taxation of sovereign states — remain hard to imagine being feasible.

Unless, that is, they are deductions from funds held in trust. That is the pivot on which this whole proposal turns.

In the proposal, trust beneficiary accounts would allocate money to specific beneficiaries — the future populations of participating countries — on the basis of policy actions, and would *tax it back* if those actions were reversed. Deducting from an account a country does not yet control is politically achievable in a way that taxing a sovereign is not. Current finance could additionally be allocated according to the size of the beneficiary accounts, which gives the accounts immediate value rather than value deferred to 2050.

Relating to incentives, the theory of dynamic incentives puts them in a time context: act now or miss out. Renewable auctions for guaranteed prices provide the model. Because such auctions tend to clear at lower prices over time, they give developers an incentive to act early, which in turn drives the competition that pushes prices down.

Finance is also promising. The World Bank can borrow cheaply and holds preferred creditor status with respect to countries, which means that when dollar rates are low it can lend to countries more cheaply than they can access their own capital markets. But it lacks the scale, and we would not want the Bank to do all this lending in any case. So incentive and financing objectives can be linked — as in the KPI bond proposal (Estevao, 2023), which offers cheap financing in exchange for achieving key performance indicators. What is then crucial is derisking both the investors and the Bank or other intermediary.

The Need for Risk-Absorbing Global Equity

Equity held in national-scale beneficiary accounts has many possible uses. Three are treated here:

1. equity for investment in projects, multiplying private sources and adding a halo effect;
2. equity to protect international institutions such as the World Bank from guarantee losses; and
3. collateral at national scale, reducing national borrowing risks and costs.

Equity capital is needed to invest in green projects in developing countries and to absorb the risks that would otherwise deter investors — policy reversal, currency fluctuation — either through the capital structure directly or through insurance contracts and guarantees. This is only the start; there are many other useful financial products for the transition. The focus here is on guarantee structures that are themselves protected.

It is worth noticing how interchangeable these options are, because it explains why an equity fund can substitute for so many different instruments. To protect against credit loss on a loan, a bank can deploy capital, or insure the loan with a credit default swap or third-party guarantee. A company can keep foreign exchange risk on its balance sheet using equity, or insure it with a swap, forward or option — which then requires someone else's capital. The World Bank can make a loan using its scarce capital, or MIGA can insure the risk and enable private investment instead. In every pair, capital and insurance are substitutes. A pool of loss-absorbing equity is therefore a general-purpose instrument.

One approach to enhancing globally available risk-absorbing capital is simply to scale up the World Bank's capital so it can lend more for climate purposes. This is to be supported. But it is likely to be limited, for two reasons. The needs of the transition are enormous — more than an order of magnitude greater than the Bank's current capacity. And an increase of that size, while possible, is unlikely, given institutional conservatism and the political dynamics among shareholders.

The alternative is to offer guarantees from the World Bank or an equivalently rated entity while *protecting against all the risks the Bank incurs*. That is the approach taken here.

One promising structure is an *intermediary* that reduces risk for investors. The World Bank itself is one, through preferred creditor status. The Solar Energy Corporation of India is another. A similar structure could create lower interest rates for countries achieving key performance indicators, or offer low-cost infrastructure lending.

Critical in all these schemes is derisking the investor via guarantees *and* guaranteeing the guarantor. One option is dual indemnification with a credit line: a AAA guarantee protected twice or three times — first by the government itself, as with IBRD guarantees; second by the global equity fund; and third by the World Bank or another AAA-rated entity.

The Need for High Returns and Leveraged Effectiveness

What is missing at the global level is sheer scale. Existing institutions are not large enough, and there is no residual pot of spare for-public-benefit capital available to incentivize policy action and absorb risk.

Increasing the size of global institutions such as the World Bank would be worthwhile, for two reasons: the Bank plays a key role supporting existing global climate funds and carbon markets and in incentivizing policy action through development policy financing, and it can access global capital markets. But politics and institutional conservatism may preclude the scale of capitalization increase required. There are also missing functions within the Bank's otherwise impressive capabilities — the IFC has traditionally had an equity investment function, but it has recently sat low in the list of priorities.

Another source of agency, apart from governments, is the initial investors in projects. Among all the financiers of a project's various stages, the *initial equity investors* are the ones who determine whether the project happens at all. Such initial equity can also be blended, mixing private developers with for-public-benefit donor-investors.

Achieving scale will require high returns in both a financial and an effectiveness sense, and project equity supplies something that is otherwise missing. If equity stakes can be sold on once a project is complete, high *returns* become possible — important for mobilizing private investment and for growing the pot organically — and high *effectiveness* becomes a way to mobilize donor funds.

How can one create high-return investments that also absorb risk? There is an existing model. Insurance companies, particularly reinsurers such as Swiss Re, are typically very well capitalized, holding ample buffer against the risks they insure. They do not keep their net assets in cash; they invest them in bonds, equity and other products. Their returns are therefore the sum of underwriting returns and investment returns. Berkshire Hathaway is a financial group combining insurance and investment in which the investment returns came to dominate. The same combination is available here, and the very scale of a global operation should create insurance possibilities — though not against systemic risks such as a global recession or a pandemic.

To summarize: there is a need for benevolent capital that accumulates net wealth for public good, at both global and national scale, to incentivize action, absorb risk, and build wealth against the natural disasters climate change will bring. Three gaps therefore exist:

1. capital for global public institutions — equity for public benefit, able to leverage low-cost borrowing including domestically;
2. high-return equity investment options capable of creating the dynamism and scale needed; and
3. structures creating dynamic incentives for countries to act early.

The proposal aims to fill all three.

The Proposal: Insurance Buffer Funds for Policy Commitments

The proposal is a trust with three core functions: *insurance* of contractual policy guarantees made by governments; *investment* in the early stages of renewable energy projects; and *incentives* through profit-sharing toward countries that take beneficial action.

Insurance and incentives are the core, minimum functions needed to start. The investment function is intended to create a positive scaling dynamic, given the potentially high returns available from projects that can be refinanced at low rates once construction is complete and they are connected to the grid — the arithmetic of Chapter 18.

Such a scheme requires a *deal*. The deal would be a broader version of a typical renewable auction. Where in a renewable auction the government commits to a price for renewable energy, what could be accomplished instead is a *schedule*, or sequencing, for net zero in a country, with associated procurement auctions and sectoral pricing policies — feebates and fuel taxation — attached.

Supporting such a deal requires further capabilities: project finance, blended finance, relationships with governments, planning reform and grid connections. Those are not strictly part of the proposal and could be supplied by partnering with existing initiatives such as Scaling Solar, the Transition Partnerships or the Indian global solar initiative, with the IFC filling in the remaining elements.

So, in exchange for hard policy commitments by governments — commitments that include guarantees, for example renewable auctions backed by annual auctions of guaranteed prices plus grid investment — donors would create a system of buffer funds providing second-line insurance. Those funds would also invest in the early stage of supported investments.

The accounts would be held in trust, with the final beneficiary being the mid-century population of each country that commits to mid-century net zero. At mid-century the accumulated wealth converts into capital available to support those populations. That is the point at which the accounts become fully liquid — but the populations benefit immediately, because the accounts serve as collateral in the meantime.

The first investors would be donate-for-invest donor countries, incentivized by the high effectiveness of the structure. Such a fund can achieve high leverage and effectiveness, and can be open to co-investment by countries and by small private investors themselves.

For implementation it will be easier to begin with the insurance function, with the fund acting purely as a buffer. While it is acting as collateral it would not invest in renewable projects. Even so, such a fund would be extremely useful on its own.

Financial Summary

The trust structure separates control from beneficiary. Voting shares are held by donors; the beneficiary is the post-2050 population of each participating developing country. Developing countries and their own populations could also contribute as donors, with their own future populations as beneficiaries. Regional child funds could be established later in collaboration with regional and national development banks, and national-scale funds of the same type could be set up as climate investment pension funds.

The structure can be compared to the investment accounts within the IMF's Resilience and Sustainability Trust. In both cases the donation comes from rich donor countries — in the IMF's case through allocation of SDRs, in the CIT's case directly. The CIT's insurance and blended project equity functions are designed to maximize both financial return and impact, and so to present an attractive option for donors.

Private investment — by pension funds and sovereign wealth funds such as Norway's — is permitted, provided such stakes pay a fee of about 25 percent of investment returns to the trust, and provided those stakes carry voting rights only in the investment part of the scheme and not in the fee, insurance or incentive functions.

An illustrative capital structure: $5 billion in the trust, comprising $1 billion of donor funds and $4 billion of co-investment from developing countries financed by long-term development policy financing, alongside $95 billion of equity investment from, for instance, sovereign wealth funds. This could leverage an additional $400 billion of debt financing.

These numbers and leverage factors are tentative and indicative, and would need to be justified by formal modelling.

On that basis the global trust could leverage private investment of about $500 billion. Because the trust invests only in the initial stages of projects, the money is recycled by selling equity stakes into the market. With an average construction phase of two years, total investment leveraged would be around $250 billion per year.

Seven regional child funds — China, South Asia, Europe and Central Asia, East Asia and Pacific, Africa, North America, South America — of the same size and initially managed centrally could contribute an additional $1.75 trillion per year, giving $2 trillion of total annual investment, or a balance sheet of $4 trillion.

Given the eight funds together and an average project construction time of two years, total leveraged investment would be about $4 trillion after two years, on an equity balance sheet of $800 billion, of which $40 billion is the total size of the trust beneficiary accounts. Assuming a total return on the equity component of 10 percent on $800 billion, with payments to the trust of 2.5 percent, or $20 billion per year, the trust component — and thus the overall structure — would double every two years.

The allocation of beneficiary accounts depends on performance. The proposal is to commence sectorally, focusing only on global coal phase-out and rainforest protection. The incentive structure aims to reduce emissions by 10 percent per year with an incentive of $100/tCO2 against total emissions of around 10 billion tons CO2 equivalent, costing roughly $100 billion of allocation and profit sharing.

This can be achieved through profit-sharing provisions based on defined baselines, or, more radically, through development policy financing with KPI-oriented *repayment amounts* rather than merely KPI-oriented interest rates. In all cases there must be an incentive to join the scheme — net national beneficiary returns must always be positive — as well as an incentive within it to outperform one's counterparts.

Where the incentives needed exceed the funds available for profit sharing, the concept of *notional capitalized value* can be used. This would define the value of, say, the remaining Amazon rainforest as a very large number — $1 trillion — and pay into the beneficiary account the *interest* on that number rather than the capital sum. Countries would then hold two accounts: the beneficiary account and the notional capitalized value account. This is the mechanism developed in Chapter 21; its full treatment is beyond the scope of this proposal.

Financial and Effectiveness Leverage

Two forms of leverage operate here, and both matter.

Financial leverage is the amplification described above: a $5 billion trust capital structure, $95 billion of additional private equity, a total equity investment of $100 billion, and $400 billion of enabled debt financing. Because the trust invests predominantly in the early stages of two-year utility-scale renewable developments, funds recycle through the sale of equity stakes once development is complete and the project is grid-connected, bringing leveraged investment to around $250 billion per year.

Effectiveness leverage is about sequencing and selection. The insurance and incentive functions are easiest to establish first. The Trust would set strategic priorities for both investment and incentives, starting with coal phase-out and rainforest protection. And because the capital recycles every two years along with the profits, the whole structure compounds: with a 15 percent return on the equity component of $100 billion and a 10 percent fee on profits redirected to national beneficiary accounts, the trust generates around $1.5 billion annually, doubling the total size of the beneficiary accounts roughly every three years.

Synergies with the Beneficiary Accounts

The beneficiary accounts are multipurpose, and that is the source of much of the design's efficiency. The funds allocated to them serve two purposes simultaneously: they reward countries for positive action, and they function as loss-absorbing collateral for additional national loans. The same dollar does both jobs.

National loan protection follows from this. Countries, acting as donors themselves, contribute to their own future populations' beneficiary accounts — and those accounts then serve as collateral, safeguarding against long-term fiscal risk and financing needs. The intertwining of financial and effectiveness leverage is what produces an impact at both global and national scale.

Expanding to Regional Funds

Extending the model, seven regional child funds with identical structures can be initiated, managed centrally at first in collaboration with regional MDBs and large countries. Combining the central trust with the seven regional funds gives the global system an annual investment potential of around $2 trillion, and, over an average two-year project horizon, total leveraged investment of about $4 trillion. Doubling the size of each fund every three years leads to sustained growth in the incentives created and a steadily expanding impact.

Who Speaks for 2050

A reader will ask, and should, who represents a population that does not yet exist. The beneficiaries of the trust are the post-2050 populations of participating countries; the accounts are controlled in the interim by the trust's managers and, through them, by the donors who hold the voting shares. Three things have to be true for that arrangement to be legitimate rather than merely convenient.

The rules for allocation and deduction must be written down in advance and be very hard to change — the super-majority provision of Chapter 18 is the model, and it should apply here with at least equal force. The accounts must be transparent: each country's balance, and every movement in it, published. And the country whose future population is the beneficiary must have a standing seat at the table — not a vote on the trust's investments, which would reintroduce the political risk the structure exists to remove, but a voice on the rules, and a right to audit. Capture by the trust's managers is the obvious hazard, and the protection against it is the same as for any endowment: independent trustees, published accounts, and a mandate that cannot be quietly rewritten. None of that is novel. All of it has to be built in from the start, because a trust that begins informal never becomes formal later.

FAQs

How are high financial returns achieved? Through low-cost derisked refinancing once projects are complete — after construction is finished and the project is connected to the transmission grid. Derisking allows newly built renewable projects to be refinanced with synthetic AAA-rated bonds or bank loans, which lets central banks and national pension funds contribute to green growth at low financial risk. That refinancing is what creates high returns for the construction-stage equity.

What partnerships are needed? The trust would partner with project developers, with global initiatives such as Scaling Solar and the Energy Transition Partnerships, and with implementing institutions such as MIGA and the IFC.

What about poor countries — how is indebtedness avoided? In low-capacity countries the entire architecture of project finance would be provided as a service, so that the country

commits only to an overall declining charge for its energy system, with no direct debt. This is a substantial advantage for countries with debt-sustainability concerns.

What are the Trust's other derisking applications? The trust could insure against many risks. The initial intended applications are: providing surety on power purchase agreements, on the SECI model; derisking KPI-related sovereign bonds; and enabling cheap infrastructure lending through trusted intermediaries. Derisking could also give access to cheap mobile-app bank deposits with low financing costs. Other capital-requiring risk- or rate-reducing activities are possible, such as arbitrage between DFI-issued and sovereign bonds.

The Underlying Development Challenge

It is worth stating the problem the Trust is ultimately addressing: *standardizing and enhancing the accessibility, to developing country governments and to small investors, of sophisticated financing products for the green energy transition.*

Meeting the Paris temperature goals requires large and rapid investment in clean energy. Renewable energy is cost-competitive with fossil alternatives and deployable at scales from utility down to the individual house. What is needed is financing that reduces both energy and financing costs and risks, for governments and investors alike, with governments and MDBs derisking the cash flows through long-term contracts.

The trouble with the existing instruments is that they are built for participants who already have access. Financial structures for motivating policy action, such as sustainability-linked bonds, and for financing green energy, such as green bonds, have focused on capital markets rather than on accessibility to borrower and investor. Many small island developing states cannot issue bonds at all. Many poor individuals are excluded from high-return investment products entirely. An instrument that only works for countries with a functioning bond market is not a solution to a problem concentrated in countries without one.

This proposal therefore aims to standardize and widen access to the financing and risk-reduction structures needed, so that all governments can participate cheaply in the clean energy transition, and so that the investor side is likewise broadened to include savers in developing countries. The overall goal is risk reduction strategies that let the green transition happen at low fiscal risk and low financing cost.

Three ideas carry the weight, and each has appeared in this book: standardized two-stage project finance structures for the green energy transition, of the kind set out in Chapter 18; a solar payment guarantee enabling low-risk green asset-backed debt instruments for final financing, from Chapter 8; and a high-accessibility, rapid-scaling, diversified initial-stage equity fund — the idea that Chapter 13 pursued in its most radical form.

Conclusion

This chapter has described the need for incentives between countries and the dilemmas facing designers of global incentive mechanisms. Most proposals for pricing the externality are proposals for carbon pricing, which is a national policy rather than an international one. The existing institutions for international carbon pricing are weak and, because of the additionality requirement, potentially create perverse incentives and strategic delay. And there is a scale problem: there is insufficient willingness to commit funds to countries that today appear very risky, on the scale that would incentivize them to act at the necessary pace.

The response proposed is a financial structure — the Climate Incentives Trust — that acts as an effectiveness multiplier for donor funds. As a trust, control rests with the donors while the *beneficiaries* are the post-2050 populations of recipient countries.

It has three functions. *Insurance*, acting as a second-loss buffer in exchange for governments taking the first loss. *Investment*, blended with the private sector, in the early stages of project equity. And *international incentives*, meaning the allocation of beneficial ownership to countries according to their participation.

The reason the trust form matters, and the note on which this part should end, is that it solves a problem no contract can. A payment to a government can be reversed by the next government. An account held in trust for a country's future population, which grows when the country acts and shrinks when it retreats, creates a constituency for persistence — and persistence, more than ambition, is what climate policy has lacked.

6.8 21. Rewarding National Carbon Stocks: The Notional Capitalized Carbon Value

Carbon in a standing forest is worth considerably more than the offset market pays for it — an argument developed at length in the companion volume. This chapter proposes a mechanism for paying for it that requires almost no new money — by converting natural wealth into a lower cost of capital rather than into a cash transfer.

Democratizing and Derisking Clean Energy Finance

Start with how development lending actually works. At the heart of the traditional World Bank business model is a relationship with governments. The Bank accesses finance cheaply on international credit markets and lends it on to governments. Through that relationship, the Bank's preferred creditor status, and the project due diligence of its staff, the risk borne by the Bank is materially lower than the risk priced in the wider capital markets.

That gap — between the risk the Bank actually bears and the risk the market charges for — is the resource this proposal spends. It is not a budget appropriation, and it does not need to be voted through a legislature.

The Problem

Countries with large carbon stocks, or other natural resources such as fossil fuel reserves, generally lack any mechanism for converting that natural wealth into tangible financial benefit. Worse, where the socially valuable act is *not* extracting — leaving fossil fuels in the ground — there is typically no incentive to do so at all.

Existing climate finance tools reward emissions reductions. They rarely reward large-scale carbon preservation. The result is an accounting system in which a country that has kept its forest standing for a century has earned nothing, while a country that clears it and then partially replants can be paid for the replanting.

The Notional Capitalized Carbon Value framework links carbon stocks to concessional financing, creating an incentive for conservation while lowering borrowing costs for sustainable investment.

Why This Matters

Forests are critical for global climate stability, yet the countries that protect them receive limited financial recognition. Valuing carbon stocks and tying that value to concessional finance offers three things:

- Direct financial incentives for conservation, which reduce the pressure to exploit forests for short-term revenue.
- Lower borrowing costs for sustainable projects, enabling green growth and climate resilience.
- A transparent, rules-based system that rewards stewardship and penalizes emissions.

The last of these is the most important politically. Discretionary climate finance is negotiated, slow and unpredictable. A rules-based entitlement can be planned against, which means it can change investment behavior rather than merely rewarding it after the fact.

Defining the NCCV

The construction is deliberately simple. Suppose a country has 100 MtCO2 stored in its forests and emits 1 MtCO2 per year from fossil fuels. Assign a notional value of $100/tCO2. The country's NCCV is then $10 billion.

Each year, the NCCV is adjusted downward by the notional cost of net emissions — so 1 MtCO2 of emissions reduces it by $100 million. The result is a balance-sheet-like figure, the country's carbon capital, updated annually.

Two features of this design are worth noticing. It is a *stock* measure, which is what makes it reward preservation rather than change. And it is *notional*: no one is claiming the forest could be sold for $10 billion, only that this is a defensible basis for allocating an entitlement.

How the Balance Sheet Is Used

Suppose the $10 billion NCCV is made available over a ten-year horizon, implying roughly $1 billion of NCCV capacity per year. If MDB guarantees reduce the cost of capital by around 3 percent per dollar guaranteed, then the World Bank and other international financial institutions could deploy $1 billion in guarantees per year, generating $30 million in annual interest-cost reductions on qualified projects. Across the full ten-year envelope, the total concessional effect would be $300 million.

Because that $300 million is tied to carbon stocks, a portion — say one-third — could be earmarked specifically for forest protection. Projects benefiting from the earmark might receive a 3 percent reduction in weighted average cost of capital, offset by a 1 percent fee, for a net 2 percent reduction. The fee matters: it makes the scheme partly self-financing and it screens out projects that do not really need the support.

There is a refinement for the cases that matter most. In regions approaching ecological tipping points, the next 10 to 20 percent of forest area could be assigned a *leveraged* value, reflecting its amplified role in preserving the broader ecosystem through the forests-feed-rain-feeds-forest dynamic. This is the same insight as the argument that the marginal hectare at an ecological threshold is worth a large multiple of the average hectare, expressed here as an entitlement rather than a price: the marginal hectare at the threshold is worth a large multiple of the average hectare, and a mechanism that ignores this will spend its money in the wrong place.

Why This Works

The mechanism translates carbon wealth into lower financing costs, leveraging the MDBs' preferred-creditor status to deliver interest-rate reductions on well-structured projects. The total allowable volume of interest reductions is tied to the NCCV and adjusts dynamically with emissions.

This makes the NCCV three things at once:

- a reward for maintaining forests and keeping fossil stocks unburned;
- a tax-like signal against burning carbon, since emissions shrink the entitlement; and
- an allowance for further cost-of-capital reductions on eligible projects, renewables in particular.

All of it is achieved at relatively low fiscal cost, because of the indemnification structure of MDB guarantees. That is the crux, and it connects this chapter to the whole of Part III: a guarantee is not a grant. It consumes balance sheet capacity and expected loss rather than

cash, which is why an institution with a strong credit rating and a long-term relationship with its borrowers can deliver a great deal of concessionality from very little money.

7 Part V — The Hard Cases: Utilities, Grids, Debt, and Coal

7.1 22. The Offtaker's Own Economics

Every structure in Parts III and IV routes around a utility that cannot be trusted to pay. None of them has yet asked why it cannot. This chapter follows the money to the point where the book has so far stopped: the balance sheet of the offtaker itself, and the reason it is in the state it is in.

The Utility That Cannot Pay

The state-owned distribution utility in a typical developing country is insolvent for one reason before any other. It sells electricity for less than electricity costs it. The retail tariff is set politically, below the average cost of supply, and the gap is covered — or not — by the treasury.

India's distribution companies are the clearest case, because the numbers are published. Their aggregate technical and commercial losses were 15 percent in 2022–23, down from 17 the year before; but the underlying problem is the gap between what they pay for power and what regulators let them charge for it, and that gap is why they owed generators 779 billion rupees in early 2024. Vietnam's EVN, rated BB, bought solar at a 9.35-cent feed-in tariff while selling to consumers at a regulated price below it, and the difference accumulated as a burden the government then tried to unload by retroactively cutting the tariff. Eskom's PPAs needed a Treasury guarantee because Eskom itself had been operating below cost recovery for a decade.

The pattern is the same everywhere. A guarantee makes the generator whole. It does not make the utility solvent, and it does not change the fact that someone — the consumer, through a higher tariff, or the treasury, through a subsidy — must eventually fund the gap between what the power costs and what it sells for.

Why This Is Not a Reason to Stop

It would be easy to read the last paragraph as fatal to the book's argument: the guarantees are papering over an unfunded liability, and the liability is the real problem. That reading is half right, and the half that is wrong matters.

The utility's gap has two components, and cheap solar shrinks one of them. Part of the gap is the difference between an economic tariff and a political one, and no financial structure addresses that. But part of the gap is the cost of the power the utility buys — and that cost is exactly what the derisking architecture reduces. A utility buying solar at 3.6 cents instead of 6.5 has a smaller gap to fund at any given retail tariff. In the extreme, and it is not a rare extreme, cheap solar brings the cost of supply below the political tariff, and the utility becomes solvent without the tariff moving at all. The IEEFA analysis of Vietnam makes exactly this point: had Vietnam procured through auctions rather than fixed tariffs, as India did, the burden on EVN would have been a fraction of what it became.

So the causation runs both ways. A weak utility raises the cost of capital, which raises the cost of power, which weakens the utility. A guarantee breaks the loop from the financing side. It does not fix the tariff. But it makes the tariff problem smaller, and it buys the time in which the tariff problem can be fixed.

What Has to Happen on the Other Side

That said, the book's structures have a precondition on the offtaker side, and it should be stated as plainly as the preconditions on the financing side were.

The utility must be on a credible path to cost recovery. Not at it — few are — but on a path, with a regulator that adjusts tariffs on a known schedule and a treasury that funds the residual gap explicitly rather than by letting arrears accumulate. India's payment security mechanism works because behind it stands a central government that can withhold transfers from a defaulting state; that threat is credible only because the centre has, in fact, funded the Discoms' gap twice through liquidity packages. The guarantee and the fiscal transfer are the same policy seen from two sides.

This is where development policy financing — the Bank's instrument for rewarding reform, described in Chapter 17 — connects to the rest of the architecture. The conditions attached to a policy loan can include tariff reform, regulatory independence, and the establishment of a payment security fund. The guarantee structures of Part III then become the reward for meeting them. A country that will not put its utility on a path to solvency should not receive a guarantee against that utility's default, because the guarantee would be insuring a loss that is certain rather than a risk that is contingent. The distinction between the two, drawn in Chapter 14, is what keeps the guarantor's tail exposure from becoming a subsidy programme in disguise.

The Consumer's Share

There is a distributional point here that the book has so far left implicit. Below-cost tariffs are usually defended as protection for poor households. They are, in most countries, nothing of the kind: the subsidy goes disproportionately to those who consume most, which is the better-off, and it goes to no one at all in the households that lack a connection. The households a political tariff most protects are the ones that least need it.

Cheap solar changes the terms of that argument. If the cost of supply falls, a cost-reflective tariff can be lower than the political tariff was, and the reform that regulators have spent twenty years unable to make becomes a reform that lowers bills. That is the practical consequence of the cost-of-capital argument for the utility: it is the difference between asking a regulator to raise prices and asking a regulator to pass a saving on.

7.2 23. The Other Half

Chapter 14 said that roughly half of required generation investment is solar and characterized its risk. This chapter is about the other half — wind, hydro, storage and, above all, transmission — and about whether the book's central move, "find the contracted revenue stream," extends to assets that have no power purchase agreement.

Wind and Hydro: The Same Logic, Rougher Edges

Onshore wind is financed the way solar is. It has an auctioned PPA, a two-year construction phase, and an operating phase in which the main risk is the offtaker. Two things make it rougher. Its output is less predictable year to year, which lenders price as a modestly higher operating risk, and its construction involves larger civil works and longer supply chains, which raise the construction-phase premium. South Africa's programme procured wind and solar side by side, with wind attracting the larger share of investment by value; the same guarantee structures served both. The logic of Parts III and IV carries over directly.

Hydro is different in kind. Its construction phase is not two years but five to ten, its cost overruns are notorious, and its output depends on rainfall over which nobody has a contract. Two-stage financing helps less, because the risky stage is so long that construction lenders become the long-term lenders by default. The book's structures apply to hydro's operating phase, once built, and to the smaller run-of-river plants whose construction resembles a wind farm's. They do not solve large hydro's fundamental problem, which is that its risk is in the building rather than the running.

Storage: A Contract Without Energy

Batteries are the fastest-growing item in the other half, and they show how the contract logic adapts. A battery earns from three things — arbitrage between cheap and dear hours, capacity payments for being available, and grid services such as frequency regulation — and none of those is a PPA in the ordinary sense. But each can be contracted. South Africa's first solar-plus-storage project to reach financial close, in early 2026, was structured around a capacity-and-availability contract rather than an energy tariff: the offtaker pays for the battery to be there and ready, not for the electrons it discharges. That is a contracted revenue stream, and it is financeable on the same terms as a PPA once the offtaker's credit is addressed. The IEA Observatory's 2023 survey added utility-scale batteries and found their cost of capital in emerging markets tracking solar's — high, and for the same reasons.

The design lesson is that the revenue stream has to be *created* by the buyer through a contract form that did not exist a decade ago. Where regulators have not written a capacity-payment framework, storage cannot be financed cheaply, however good the economics. The other half needs new contract types as much as it needs money.

Transmission: Where the Argument Is Hardest

Transmission is the binding constraint on solar in most of the countries this book is about, and it is the asset for which the contracted-revenue logic is weakest.

Vietnam is the proof. Between 2018 and 2023 the country built over 21,000 megawatts of solar and wind, faster than any Southeast Asian neighbour, and then curtailed a substantial part of it because the grid in the sunniest provinces could not carry it. Solar projects that had reached commercial operation halted production and could not service their loans. South Africa's sixth bid window awarded only six solar projects; the twenty-seven others earmarked for the Cape could not be procured because there was no grid capacity to connect them. The generation was financeable. The wires were not there.

A transmission line has no PPA. Its revenue is a regulated charge, recovered from all users of the grid through the tariff, and set by a regulator who is also setting the retail price too low. So the transmission investment sits on the same insolvent utility's balance sheet, financed at the utility's cost of capital, in competition with everything else the utility cannot afford.

Three responses exist, in rising order of ambition.

The first is to *contract the wire*. Independent transmission projects — private lines built under concession and paid by an availability charge — have been used in Brazil, Chile, Peru and India, and they turn a regulated asset into a contracted one. Availability charges are financeable in the way capacity payments are, and the same offtaker guarantee structures apply. This is the book's logic extended by one step, and it is proven.

The second is to *bundle*. A generation auction can include the connection: the developer builds the line to the substation and the tariff covers both. This shifts transmission risk into the PPA, where the book's structures reach it, at the cost of a higher tariff. It works for the last few kilometres and fails for backbone lines.

The third is to treat backbone transmission as what it is — public infrastructure with a regulated return — and finance it the way the book proposes financing the utility's own gap: with development policy lending conditioned on tariff reform, and with the concessional component of Part IV directed at the asset that unlocks the most generation per dollar. A transmission line that lets 2,000 megawatts of already-contracted solar dispatch is, by any measure of mitigation per dollar, one of the best investments available. It does not have a PPA. It has something better: a queue of projects that have already found their financing and are waiting for the wire.

What This Means for the Book's Claim

The honest summary is that the contracted-revenue logic extends completely to wind, largely to storage, partially to hydro, and to transmission only where the wire can be contracted or bundled. For backbone grids the book's argument reverts to a more conventional one: that public infrastructure with a regulated return should be financed at the sovereign's best available rate, which means through the safe-intermediary structures of Part IV rather than the project-finance structures of Part III.

That is not a small qualification. It means that the cheap financing of generation, which this book has made its subject, buys nothing unless the more conventional financing of the grid keeps pace — and that the place where a development bank's scarce concessional capital does the most is very often not the solar park at all, but the line that connects it.

7.3 24. Avoiding the Non-Renewable Energy Debt Trap

Every chapter of Part IV eventually confronted the same objection: that borrowing for the transition adds to debt that developing countries cannot carry. This chapter answers it directly. The objection rests on treating all borrowing as equivalent, and it is not.

Fossil Fuels Are a Liability Too

Energy costs and prices constitute both a cost and a macroeconomic risk. A developing country paying for imported coal to generate power is not merely spending money; it is holding an open position in the coal price. Every fluctuation in that price passes into its electricity costs, its inflation rate and its current account.

This is rarely counted as a liability, because it does not appear on the balance sheet. But a commitment to buy fuel for twenty-five years at an unknown price is economically a liability, and a riskier one than a fixed-rate loan of equivalent present value.

Why Green Debt Is Different

Clean alternatives are increasingly cost-competitive with fossil fuels, but financing costs make up a large part of their total cost. Clean energy needs up-front financing — not necessarily government investment — because it is capital-intensive. Solar is expected to be cost-competitive with fossil fuels in places with liquid financial markets and well-developed supply chains, India being the standard example, where solar-generated electricity in many cases beats the *variable* cost of coal generation.

The crucial point is what the borrowing is for. Clean energy financing is typically *covered* by electricity payments. Bonds issued to pay for generation capacity are therefore a different economic object from government debt issued to fund current expenditure.

Consider the difference between paying for power from a coal station and from a photovoltaic park. For the coal station, most payments are ongoing — fuel, year after year, at prices set elsewhere. For the solar park, they are up-front. Borrowing moves those up-front payments back a few years, but that kind of borrowing does not consume fiscal space in the way an unfunded deficit does, because it is matched by an asset that generates the revenue to service it and displaces the fuel bill that would otherwise have been paid.

A country that borrows to build solar is converting a variable, open-ended, foreign-currency fuel liability into a fixed, finite, amortizing debt. That is a reduction in risk, not an increase, even though only one of the two shows up in the debt statistics. The debt-sustainability frameworks discussed in the next chapter do not currently make this distinction, which is a serious analytical gap and one with real consequences: it makes the safer choice look more dangerous.

The Real Liability Is in the PPA

Power purchase agreements are usually how new clean generation gets built, and they are where the genuine long-term liability sits. These agreements constitute the envelope of long-term commitments, and if the tariff paid does not decline in real terms, they can become a substantial liability for governments — the problem set out in Chapter 17.

So the analysis comes back to minimizing the financing cost of these PPAs, through derisking, in order to reduce the long-term liability they represent. The tariff a government must contract is a direct function of the developer's cost of capital; cut the cost of capital and the liability shrinks proportionally.

The basic dilemma that would have arisen with borrowing arises instead with the PPA. Should it be denominated in dollars, with lower financing costs but exposure to devaluation, or in local currency, with higher borrowing costs but no currency mismatch? A diversified approach is key — a basket rather than a single currency — combined with two design features. There must be *certainty* over the PPA, because certainty is what buys the low financing cost. And the PPA should *decline in real terms*, commensurate with the falling price of renewables, so that the tariff paid under old contracts stays close to that of new ones. Get those two right and the PPA is an asset. Get them wrong and it is the next generation's problem.

7.4 25. Debt Sustainability and Green Investment

Chapter 24 argued that green borrowing differs in kind from ordinary borrowing. This chapter examines the machinery that currently fails to recognize the difference, and the practical consequences for countries caught by it.

Developing countries are in a more vulnerable position than developed nations when responding to climate shocks, which is precisely why investing in green technology matters for them: it helps mitigate the impacts of extreme weather. But green investment is often impossible in these countries because of debt burdens that have only grown since the pandemic.

The scale is considerable. Before covid-19, total debt reached $253 trillion, representing 322 percent of global GDP (Picolotti and Miller, 2020), and the figure has risen since as governments increased spending and health budgets. Against that, it is estimated that extreme weather events will cost $6 trillion over this century if no mitigating action is taken (Maldonado and Gallagher, 2022) — which reinforces rather than resolves the urgency, since the countries least able to borrow are the ones facing the largest losses.

Developed nations need to honor the financial commitments they made to developing countries. Left unaddressed, the situation risks an unprecedented debt default crisis.

Barriers to Financing Renewable Projects

High debt leaves governments in developing countries with very tight budgets and frequently no available capital to finance the green investment required. Other barriers include high costs, high risks, a lack of competition among private or public firms willing to finance the investment, and a shortage of savings at the national level (Pueyo, 2018). The question is therefore how nations in this position can afford the transition at all.

There is a further, less obvious obstacle. Renewable projects in developing countries are often brought forward by new small and medium-sized enterprises. This creates a credibility problem: financing is frequently denied because such firms have a poorer repayment track record than larger enterprises (Hee Ng and Tao, 2016). The problem is not the technology but the balance sheet of whoever is proposing it, which is an argument for the platform and standardization approaches of Chapter 15.

Tenor is the third obstacle, and possibly the most damaging. Banks are often reluctant to lend where a project takes more than five to seven years to complete. This is particularly problematic because green transition projects tend to be knowledge-intensive, capital-intensive and long — typically twenty to twenty-five years. In India, because most banks apply these constraints, fewer than a third of domestic banks are willing to invest in projects supporting a green transition (Shrimali et al., 2013). A lending market that will not extend past seven years cannot finance an asset that pays back over twenty, whatever the returns.

Possible Solutions

Concessional flows. Future flows of foreign aid could play a major role in helping heavily indebted countries finance the investment needed, as in Kenya, where aid arriving at close to zero interest allowed the country to finance geothermal plants and begin its transition (Pueyo, 2018). But the Kenyan case came with a precondition — the region was already rich in renewable resources — that does not hold everywhere.

Green bonds. These can be issued in two forms. Labeled bonds are marketed as green and their proceeds are restricted to green projects. Non-labeled green bonds fund environmentally beneficial projects without the label. A combination of both was introduced to the market by bond banks and public sector agencies, and in 2015 the Asian Development Bank raised $339 million entirely dedicated to financing low-carbon growth in Asia (Hee Ng and Tao, 2016).

Green bonds also have an intergenerational justice argument in their favor, since their cost is borne by present and future generations together, and they are especially effective combined with carbon pricing (Heine et al., 2019). But they carry demanding preconditions: stable government, good quality information, adequate institutions for issuance, and a certain level of technical knowledge. Some developing countries may therefore prefer carbon pricing, where the only information required is the social cost of emissions. This is a general pattern worth noting — the more sophisticated the instrument, the more institutional capacity it presupposes, which is exactly backwards from where capacity is scarcest, and is the problem the accessibility agenda of Chapter 20 is meant to address.

Fossil taxation. Increasing taxes on fossil-fuel-intensive businesses is needed to incentivize renewable investment (Hee Ng and Tao, 2016), with the additional benefit of creating capital that governments can invest in green energy projects.

Public participation. Beyond the private and public sectors, ordinary citizens can be involved. In sub-Saharan Africa, solar crowdfunding has been implemented at small scale, with people providing zero-interest loans to organizations or projects they support (Shi, Liu and Yao, 2016). A secondary benefit is political: engaging public support makes future policymakers more likely to advocate financing the transition.

How Much Finance Is Needed

Developing countries were forced to increase spending because of the pandemic, raising their debt levels. Of the ten most climate-vulnerable countries, seven are in Africa. Because of the continent's history of debt default, interest rates are higher than elsewhere, and debt levels currently total $400 billion (Shipalana, 2020).

The African Development Bank estimates the continent needs to mobilize between $20 and $30 billion per year until 2030 to finance the transition to green growth (Shipalana, 2020). Private sector participation is vital for the climate-resilience programs the continent needs, but governments must improve the policy and regulatory environment for that participation to materialize.

Set against the costs, the savings are large. According to a Stanford study, the world could save $12.2 trillion on fuel costs and $11 trillion per year on the health and ecological programs currently needed to address the effects of fossil fuels.

The distribution of climate finance is starkly uneven. In 2014 the UNFCCC estimated total global climate financing in 2012 at between $340 and $650 billion, of which developing countries spent only $22.5 billion on climate mitigation programs (NGFS, 2021).

On adaptation, estimates of the annual investment needed by developing countries range between $140 billion and $300 billion by 2030 (UNEP, 2016), with projections rising to between $280 billion and $500 billion by 2050 given the increasing severity of climate change. And the Eliasch Review suggests annual investment of $17–33 billion in the forest sector by 2030 if forest sector emissions are to be halved — a figure worth comparing with the carbon stock valuations in Chapter 21.

Ten Recommendations

The literature surveyed here converges on a fairly consistent list of measures for developing countries moving to a green economy. It is reproduced as the literature's list, not the book's: of the ten, this book argues directly for the second, the seventh and the ninth, and treats the first as the equity pool of Part IV in another guise.

1. **Establish or strengthen green and environmental funds**, using them to attract investment from the private sector and from donors.
2. **Improve the policy and regulatory environment** and create market-based mechanisms to incentivize business. Investment should be derisked and the private sector encouraged to participate, particularly in large projects.
3. **Create green and ethical banks.** Ethical banks have the added benefit of attracting ethical investors and help create a competitive market, since banks are currently competing for the green finance space.
4. **Accelerate investment in renewable energy**, which can be deployed into projects rapidly.
5. **Accelerate infrastructure investment as a driver of growth.** Adapting existing infrastructure can stimulate economic activity.
6. **Focus stimulus investment on green energy**, with green stimulus packages designed to reduce carbon intensity.
7. **Undertake green fiscal reform.** Carbon taxes and the removal of fossil fuel subsidies can support economic recovery sustainably.
8. **Redirect existing funding.** Reallocating current spending can advance multiple Sustainable Development Goals at once.
9. **Green the financial sector.** Central banks must develop regulations oriented toward greener lending.
10. **Develop green market segments.** Green legislation is vital to encourage green finance.

The Debt Sustainability Framework

Finally, the framework used to assess whether a country may borrow is itself part of the problem, and this is where the analytical gap identified in Chapter 24 becomes operational.

The current framework prevents countries that need capital from accessing it, and it is especially problematic for small states, which are already more vulnerable to climate shocks than other developing nations. The reason the LIC debt sustainability framework — used by multilateral institutions including the World Bank — is problematic is that it fails to account for the *size* of the borrowing country. The threshold for debt distress is the same for

small states as for large ones, which constrains smaller states from borrowing what they need (Rustomjee, 2017).

Following criticism, the IMF reviewed its framework, and the 2018 report introduced four additions (IMF, 2018):

1. an indicator assessing debt-carrying capacity that accounts for factors such as domestic institutional strength;
2. analysis of debt and debt dynamics that accounts for possible shocks;
3. tailored stress tests evaluating risks including natural disasters, market-financing shocks and volatile commodity prices; and
4. closer examination of domestic debt and market financing.

These are improvements, particularly the stress testing for natural disasters. But they do not address the point of Chapter 24: that debt incurred to build revenue-generating assets which displace fuel imports is not economically equivalent to debt incurred to fund consumption, and that a framework which treats them identically will systematically prevent the investment that would reduce a country's long-run fiscal risk.

Conclusion

Previous debt default is one of the main reasons developing nations struggle to find the capital to finance the green transition. Yet the investment is vital both to adapt to extreme weather and to develop mitigation capacity. There are solutions that let these countries afford the projects — green bond issuance among them — but developed nations must also play their part and honor the economic commitments they made. And the debt framework analysis used by multilateral agencies should be updated to account for the different sizes of nations and therefore different sustainable levels of debt.

Suggestions for moving economies from brown to green energy ultimately depend on the involvement of governments, the private sector, and donors providing the liquidity to fund the transition. The architecture of Part V is an attempt to arrange all three at once.

References for this chapter: Hee Ng and Tao (2016); Heine et al. (2019); IMF (2018); Maldonado and Gallagher (2022); NGFS (2021); Picolotti and Miller (2020); Pueyo (2018); Rustomjee (2017); Shi, Liu and Yao (2016); Shipalana (2020). Full citations appear in Appendix 1.

7.5 26. Phasing Out Coal: New Investment

Building clean capacity is only half of what a climate strategy requires. The other half is closing the fossil capacity that already exists — and, as this chapter and the next argue, the financial machinery for the second task is far less developed than for the first.

There are two aspects to phasing out coal in the power sector: halting construction of new plants, and managing the decline in emissions from existing assets. The first is much the easier, and it is largely being achieved.

The Pipeline Is Collapsing

There has been a considerable slowdown in the construction of new coal plants in recent years, with many planned projects cancelled outright. Some 1,175 gigawatts of new coal projects have been cancelled since 2015 — an amount greater than China's entire current coal capacity. That is a remarkable figure, and it deserves more attention than it receives: the single largest climate achievement of the past decade may be the power stations that were never built.

Several forces produced it, and they are worth separating because they have different durability.

Development finance has withdrawn. Multilateral development banks committed to end new coal investment and have implemented that commitment. 2020 was plausibly the first year in which there was no project financing for coal from the MDBs at all.

Private finance is following. Over a hundred globally significant banks, insurers, asset managers and asset owners have announced divestment from fossil fuels including coal, oil, LNG, gas, oil sands and Arctic drilling. Many have also committed to reducing fossil exposure in line with the Paris emissions reduction targets.

And the economics have turned, for the reasons set out throughout Part IV. A new coal plant must now compete against solar whose cost has collapsed, in a market where the coal plant's own cost of capital has risen because lenders fear stranding.

The Exception

China, however, is still building. About half of the world's coal plants operate within China, and it has plans to add around 100 gigawatts of new capacity. In a recent year it built over three times as much new coal power capacity as all other countries in the world combined.

This matters for how one reads the cancellation figures. The global pipeline outside China has largely been stopped by the combination of finance withdrawal and adverse economics. Inside China, where construction is financed domestically by state-directed lending and justified on system reliability grounds, neither of those levers operates. The instruments that closed the pipeline elsewhere do not reach the place where most of the remaining building happens — which is an argument for the incentive mechanisms of Chapter 20 rather than for more of the same divestment pressure.

7.6 27. Retiring Existing Coal Assets

The second and much harder component of a coal phase-out is closing plants that already exist. New coal can be stopped by withholding finance. Existing coal has already been financed, and withholding nothing changes it.

Why This Is the Harder Half

An operating coal plant is somebody's asset, generating somebody's revenue, employing somebody's workforce, and frequently locked into a take-or-pay contract that obliges an offtaker to buy its output whether or not cheaper power is available. Closing it early means writing off capital that has not been fully recovered, which someone must bear.

The one genuinely helpful condition is that phasing out existing coal assets becomes easier when alternatives are being scaled up rapidly. This is not incidental: the replacement capacity is what makes closure technically feasible, and the low cost of that replacement capacity is what makes it financially feasible. The two halves of the coal problem are therefore linked — the more successful the build-out, the cheaper the shutdown.

The Buy-and-Retire Model

The instrument that follows from this is straightforward in principle: purchase the plant and close it, compensating the owner from the savings generated by cheaper replacement power.

The Asian Development Bank has identified a portfolio of coal power plants to buy and retire across Southeast Asia, with an initial budget of USD 4 million for the design phase. The relationship between those two numbers — a portfolio of power stations, and a design budget of four million dollars — indicates how early this work still is.

Chapter 27 set out the financial mechanics that make it possible: where the total cost of new renewables plus storage beats the variable cost of existing coal, replacing the coal plant generates a surplus that can pay off every party to the transaction, including the plant's

owner. The binding constraint is the cost of capital on the replacement, which is why the derisking architecture of Parts III and IV is also the coal retirement architecture.

What Still Needs Work

Several strands remain underdeveloped, and they are listed here as an honest statement of gaps rather than as conclusions.

Carbon pricing interacts with retirement decisions directly, since a credible price floor is what keeps a retired plant from being restarted and what makes early closure economic — the argument of Chapter 5.

Coordinating the transition is a distinct problem from financing it. Closing a plant requires replacement capacity, transmission, and a workforce plan, all in sequence.

Financial analysis and assumptions need to be made explicit, since whether buy-and-retire pays depends sensitively on the discount rate, the residual life assumed, and the replacement cost.

The risks facing recipient countries deserve emphasis. Countries that have recently received coal power finance face substantial socio-economic and environmental risks associated with newly commissioned, carbon-intensive assets — assets with thirty years of accounting life ahead of them and a shrinking economic case.

The persistence of fossil fuel subsidies is the background condition that makes all of this harder, and the reasons they are so hard to remove are political rather than economic: they are visible, immediate and distributed to a constituency that notices their withdrawal.

Success stories need documenting, because the buy-and-retire model will be adopted by imitation rather than by argument.

Even When a PPA Is in Place

The techniques of the previous chapter were developed to build new renewable capacity. This short chapter shows that the same techniques solve a problem that looks unrelated: coal plants that are uneconomic and yet cannot be closed.

The Lock-In Problem

One of the central difficulties in phasing out coal is the existence of take-or-pay power purchase contracts, under which existing coal plants are contracted to produce power long into the future. The contract, not the economics, determines what runs.

And the economics have frequently moved. In some contexts the *total* cost of renewables now beats the *variable* cost of coal alone — which means the fuel and operating cost of running an existing, already-paid-for coal plant exceeds the full cost of building and running a new solar park.[22] When that is true, closing an inefficient plant early is not a sacrifice for the climate. It is a saving.

Yet even where coal is uneconomic, it remains locked into its power purchase agreements. A contract is an asset to whoever holds it, and the holder will not surrender it for nothing.

Securitization as the Solvent

Securitization structures can replace existing take-or-pay contracts with fossil fuel plants. The mechanism is the same as Chapter 7's: a contracted revenue stream is a financeable asset, and if one contracted stream can be exchanged for another of equal value, the underlying physical asset can be changed underneath it.

Such agreements provide the essential context for advancing renewables with modest amounts of storage, so that new capacity can replace the generation capability lost when the

[22]Shrimali, "Making India's Power System Clean: Retirement of Expensive Coal Plants."

coal plant closes. In this case, the power purchase agreement with the coal plant is replaced by a new contract with a renewable park plus storage.

The financial arithmetic is what makes this workable rather than merely desirable. At a sufficiently low cost of capital, the total solar cost beats the coal variable-only cost. When that holds, there is a financial gain available to *all* parties from replacing the coal plant with renewables — the plant owner can be paid to exit, the offtaker can pay less for power, and the financier can earn a return, all out of the same saving. Nobody has to be expropriated and nobody has to be subsidized.

Note what this makes the cost of capital responsible for. Whether a coal phase-out is a distributional fight or a mutually profitable transaction depends on the discount rate. That is a striking amount of political economy resting on a financial parameter, and it is the strongest possible argument for the structures in the rest of this part.

7.7 28. Vietnam: The Whole Argument in One Country

The evidence in this book has been scattered across chapters. One country contains nearly all of it — the contract that creates an asset, the boom that follows, the unbankable clause, the grid that cannot cope, the utility that cannot pay, the government that tries to take back what it promised, and the international finance that stalls because no one will guarantee the offtaker. Vietnam did all of this in six years.

The Contract

In 2017 Vietnam introduced a feed-in tariff for solar of 9.35 US cents per kilowatt-hour, fixed for twenty years, for any project reaching commercial operation by mid-2019. It was generous by the standards of the time and far above what auctions elsewhere were clearing. But it did what Chapter 4 says a contract does: it created an asset. A solar park in Ninh Thuan with a twenty-year tariff at 9.35 cents was something a bank could lend against, in a country that had almost no solar at all.

The Boom

What followed was the fastest deployment in Southeast Asia's history. Ninety-one solar farms with 4,550 megawatts came online in 2019 alone. By the end of 2020 Vietnam had around 9 gigawatts of grid-connected solar and was the world's third-largest solar market that year. By 2023 it had over 21 gigawatts of solar and wind combined, and had overtaken Thailand as the region's largest producer. Nearly 58 percent of the investment was purely domestic, another 27 percent domestic-foreign joint ventures. The demand-side dynamic the preface described operated: speed created an industry.

The Unbankable Clause

But the contract had a flaw that international lenders had identified in 2017, before the boom began. The standard power purchase agreement, issued by the state utility EVN, contained no international arbitration clause, no adequate termination compensation, and no limit on curtailment — the utility could decline to take the power for technical reasons and owe nothing. The Vietnam Business Forum concluded that the tariff was investable but the PPA was not bankable.

The consequence was exactly what Chapter 8's curtailment section predicts. Foreign lenders largely stayed out; the boom was financed domestically, by Vietnamese banks and developers with Vietnamese balance sheets and a higher tolerance for the country's own risk. The cost of capital was higher than it needed to be, and the risk sat with the parties least able to diversify it. When the take-and-pay clause bit, they were the ones who bore it.

The Grid

It bit in 2020. Solar was concentrated in the two sunniest provinces, and the transmission network there was built for a fraction of the capacity that connected. Projects that had reached commercial operation were curtailed — instructed to halt production — and could not service their loans. Nothing about the plants had failed. The wire was not there, and the contract left the loss with the generator.

This is the other half of Chapter 23 made concrete. Vietnam financed 21 gigawatts of generation and could not use a meaningful part of it, because the transmission investment that had no PPA and sat on EVN's balance sheet was not made in step.

The Utility

EVN, rated BB, was buying solar at 9.35 cents and selling electricity to consumers at a regulated price below its average cost. The feed-in tariff, set high to attract investment, placed a heavy financial burden on a utility that was already loss-making. The burden did not appear as arrears to generators, as India's did. It appeared as pressure on the government to make it go away.

The Government Takes It Back

In 2024 and 2025 the government moved to revise, retroactively, the tariffs of 173 solar and wind projects — the "transitional projects" that had been built under the feed-in tariff but connected after its formal expiry — cutting their revenues by 25 to 46 percent. IEEFA's assessment was that the revision risked bankruptcies across the sector and the investor confidence needed to reach the country's 2030 targets of 73 gigawatts of solar and 38 of wind.

This is Chapter 14's second case in its purest form. The government traded flexibility for a boom, and then, when the boom's cost landed on its utility, tried to reclaim the flexibility. South Africa did the same in 2017 and paid for it in years of stalled procurement. The flexibility a government surrenders in a contract is precisely what makes the contract worth financing, and the attempt to recover it is the single most expensive thing a government can do to its own cost of capital.

The Finance That Stalled

In December 2022 Vietnam signed a Just Energy Transition Partnership with an international group of donors: $15.5 billion of public and private finance to accelerate the shift from coal. Three years later, little of it had been deployed. The reason, according to those trying to deploy it, was that the government was not willing to guarantee agreements between investors and EVN — and without an offtaker guarantee, the international money could not be lent at the rates it was offered at.

That is the book's argument in one sentence, spoken by the market. The money existed. The projects existed. The demand existed. The missing element was the guarantee on the offtaker that Chapters 7 and 8 describe — and without it, $15.5 billion sat on the shelf while domestic banks carried a risk they could not diversify and generators were curtailed by a grid nobody had financed.

What Vietnam Would Have Looked Like

Run the counterfactual with the book's structures in place.

Procurement by auction rather than fixed tariff, as India did — where solar fell from 9.72 cents in 2014 to 3.04 in 2024 — would have cut the cost to EVN by half or more and removed the burden that drove the retroactive revision. A bankable PPA — international arbitration, termination compensation, and a take-or-pay clause or a curtailment cap — would have brought in international lenders at a lower cost of capital and moved the curtailment risk to the party that controlled the grid. An offtaker guarantee, routed through a SECI-like inter-

mediary or a sovereign indemnity to a development bank, would have let the JETP money lend. And transmission procured alongside generation — bundled into the auction for the last mile, and financed through policy lending for the backbone — would have meant the 21 gigawatts could dispatch.

None of this is hindsight in the unfair sense. Every one of these elements was proposed to Vietnam by lenders, advisers and development institutions between 2017 and 2020, and each was declined or deferred. The boom happened anyway, which shows how powerful a contract is even when it is badly drafted. The reckoning happened afterwards, which shows what a badly drafted contract costs.

7.8 29. Two Worlds

This book opened with two countries and one solar panel. It is time to return to them.

In the first country, the panel is financed at 4 percent. Electricity from it costs around 3.6 cents a kilowatt-hour, of which less than a third is the cost of money. Every project that is built lowers the cost of the next, because lenders who have seen five contracted parks perform price the sixth differently. The programme grows; the auctions clear lower each round; the equity returns compress from 17 percent to 9 as the track record accumulates; and within a decade the intervention that started it is no longer needed, because the market has taken over. Investment is fast enough that the demand-side multiplier operates. The country's fuel import bill falls with each park commissioned, and the liability it has taken on to build them is finite, amortizing, and matched by an asset that earns.

In the second country the same panel, under the same sun, is financed at 12 percent. The electricity costs 6.5 cents, of which more than three- fifths is the cost of money. Each project is negotiated from scratch, because no standardized structure exists into which it can be slotted. The programme is small, so the learning effects do not catch. Each year of delay leaves the coal plant it should have displaced with another year of sunk capital, employment and political claim. The subsidy needed to make each project viable remains a subsidy, because nothing compounds. And the country's debt sustainability framework counts the borrowing it did undertake as a burden, while the open-ended fuel liability it did not replace goes unrecorded.

The difference between these two countries is not technology, ambition, or sunshine. It is eight percentage points of interest — and eight points of interest is not a fact of nature. It is the sum of an offtaker nobody trusts, a currency nobody will hold, a policy nobody believes will last, and a track record nobody has been given the chance to build. Each of those has a remedy, and this book has been an attempt to set the remedies out.

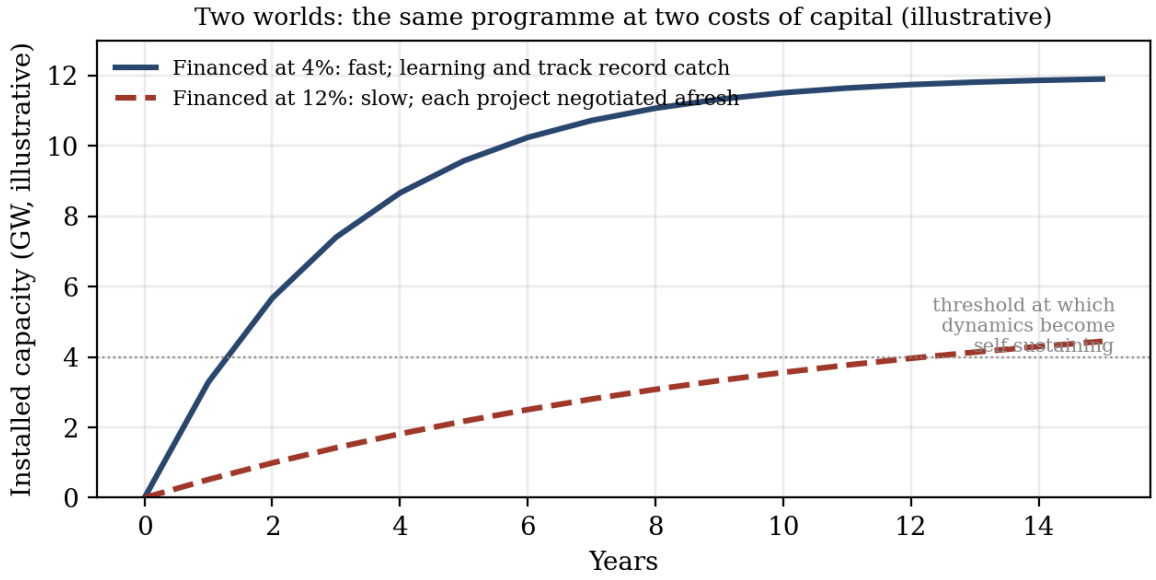


Figure 4. The same programme at two costs of capital. Only one crosses the threshold at which the dynamics become self-sustaining.

What the Argument Has Been

The remedies come in four layers, and it is worth stating them once more in order.

The *contract* comes first, because without a contracted revenue stream there is nothing to finance. Reverse auctions and power purchase agreements do something a carbon price cannot: they create an asset. Contracts for difference and price floors make the government's commitment credible. This is where pricing policy enters the book, and it enters as a foundation rather than as an alternative.

The *guarantee* comes second, and it belongs at the offtaker rather than the loan. A SECI-like intermediary, or a sovereign indemnity routed through a development bank, pays the generator on time and recovers from the utility over time. It does not fix the utility. It moves the utility's credit to a party for whom it is cheap to bear, and it converts a default into a ledger entry.

The *structure* comes third: two-stage financing that confines construction risk to two years; a ringfenced vehicle that receives the contracted payments and pays bondholders first; a sovereign first loss, an equity buffer second, and a AAA guarantor reserved against the correlated tail. Each layer holds one risk. Each is held by the party for whom that risk is cheapest.

The *institution* comes last, and it is the part that makes the whole thing scale. The World Bank's credit rating can be lent without being spent; concessionality can be manufactured out of relationships and diversification rather than paid for from aid; an equity pool open to outside investors can grow past the limit of what any treasury will contribute; and a trust that holds accounts for future populations can make a country's own commitment costly to reverse.

What It Costs

None of this is free, and the book has tried not to pretend otherwise.

The government gives up the ability to change its mind — and South Africa's 2017 renegotiation attempt shows what the attempt to reclaim that ability costs. The offtaker gives up dispatch flexibility. The developer gives up the upside. The guarantor commits balance

sheet in the tail, and Chapter 14 sized that tail rather than wishing it away. Currency risk does not vanish; it is hedged at a price that can run to twelve percentage points in the poorest markets, or avoided by local-currency finance where the savings pool allows.

And the risk that is dissolved rather than moved — the premium for an absent track record — is only part of the whole. Between a third and a half of the premium in a typical emerging market, and less in the poorest. The rest is sovereign risk, and it yields only to routing the borrowing through an institution whose credit is not the country's.

Why Timing Is the Argument

What the book has tried to establish, above all, is that a transition financed at 12 percent is not simply a dearer version of one financed at 4. It is a different kind of thing. The cheap transition is fast, and speed triggers the dynamics — technology learning, financial learning, political constituency — that make the intervention temporary. The expensive transition is slow, and slowness means those dynamics never catch: it stays a subsidy programme, negotiated deal by deal, in perpetual competition with an incumbent that grows more entrenched each year it is not displaced.

The evidence, such as it is, points the same way. Where auction programmes have run long enough to build a record, risk premia have compressed by roughly half. Where the growth effects of renewable deployment have been measured, they appear only above a threshold of investment — which would mean that small, cautious programmes incur the costs of transition without reaching the scale at which the benefits arrive. Half-measures, on this reading, are the worst option available.

Time and chance. The chance is the risk premium that an absent track record imposes, and much of it — not all — is the price of lenders' ignorance rather than of losses that will occur. The time is what it takes to build the record that dissolves it, and what it costs each year that the building is delayed. The instruments in this book are ways of compressing that time. Whether they are used is a question of institutional will, not of economics. The economics, as the preface said and this book has tried to show, are settled: the same panel, the same sun, and the price of money decides which world a country lives in.

8 References

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