The Lab

India Innovation Lab for Green Finance

FX Hedging Facility

Lab Instrument Analysis

October 2016

The India Innovation Lab for Green Finance is a public-private initiative in India that brings together experts from government, financial institutions, renewable energy, and infrastructure development to identify, develop, and accelerate innovative investment vehicles for green growth in India.

AUTHORS AND ACKNOWLEDGEMENTS

The authors of this report are Arsalan Farooquee, Saurabh Trivedi, and Dr. Gireesh Shrimali.

The authors would like to acknowledge the following professionals for their cooperation and valued contributions: Ravindra Rathee (RRC), Vivek Sharma, Amit Kumar Garg, Ankit Chhabra (CRISIL), Aman Gill (CPEC), Udit Mathur (BHC-UK), Parag Baduni (IL&FS), David Uzsoki (IISD), Harold Hirschoffer (TCX), Jeff Schubb (Coalition for Green Capital), Prof. Lars Göran Josefsson, Donovan Escalante, Charith Konda, and Labanya Jena Prakash (CPI), Rajesh Cherayll (Nereus), Anand Shah (Indi Corps), Stephen Morel (OPIC), Camille Severac (AFD), Alexandre Chavarot (Access Corporate Finance), Amit Rama (GIB), Piyush Mathur (Simpa), Alok Bhargava (ILFS), Nikunj Kathuria, Aasima Mirza (ReNew Power), Gaurav Karnik, Amish Behl (EY), and Tim Stumhofer (Climate Works Foundation), Jayant Prasad (cKers Finance).

The authors would also like to thank Rituraj Borah and Maggie Young for their continuous support, comments, and internal review, and Amira Hankin and Tim Varga for graphic design.

Analytical and secretariat work of the India Lab has been funded by Shakti Sustainable Energy Foundation, the David and Lucile Packard Foundation, and the UK Government. Climate Policy Initiative's team in Delhi serves as Lab Secretariat and analytical provider.

The Lab
India Innovation Lab for Green Finance

FX Hedging Facility

INSTRUMENT DESIGN AND ANALYSIS

October 2016

DESCRIPTION —

The FX Hedging Facility is a customizable currency hedging product comprised of a foreign exchange (FX) hedging facility backed by an FX tail risk guarantee. The mechanism targets a particular tranche of FX risk and allows allocation of risks to suitable parties, and also eliminates the credit risk premium otherwise charged in a commercial currency swap. This product has the potential to reduce the hedging cost by ~30% while mobilizing a minimum of $9 of foreign capital per dollar of subsidy with more than 50% probability that the entire subsidy will be recovered.

GOAL —

To facilitate foreign investment into clean energy in India by providing a cheaper currency hedging solution with optimum use of donor grant

SECTOR —

Renewable energy, clean energy, climate finance

PRIVATE FINANCE TARGET —

Foreign investment funds, foreign institutional investors, renewable energy investors including project developers, utilities, and banks

IMPLEMENTING AGENCY –

Hudson Clean Energy Partners (TBC)

1. Context

The Government of India has set a target to achieve 175 GW of installed renewable energy capacity by 2022. Meeting this target will require USD $189 billion from 2016 to 2022 (CPI, 2016a). It will be difficult to meet this investment requirement through domestic investment only. Foreign investment is a potential source of significantly more finance. However, foreign investors face a key barrier: currency risk. Clean energy projects in India generate revenues in local currency (in INR). Financing a renewable energy project with foreign capital (in USD) exposes foreign investors/project to the risk of currency devaluation over time.[1] This has resulted in reduced investments in India due to a high perception of currency risk.[2]

Foreign investment in clean energy in India requires the use of a currency hedge (or foreign exchange swap) to protect against currency devaluation. However, currently available commercial currency hedging instruments are perceived to be expensive.

The proposed FX Hedging Facility offers an alternative to commercially available currency hedging instruments which can reduce the cost of currency hedging and increase leverage – the amount of private investment that can be mobilized per dollar of subsidy. It is a common assumption, like in asset pricing, that the market is efficiently (or fairly) pricing currency risk. We investigate if it is possible to reduce the cost and increase the benefit of currency hedging without violating this efficient pricing assumption. Also, there are different arguments on whether currency risk should be subsidized or not. Whether currency risk should be subsidized or not is a separate question which is not the focus of this work. The main purpose of the FX Hedging Facility is to subsidize currency risk in the most efficient way.

While there are different arguments on whether currency risk should be subsidized or not, the main purpose of the FX Hedging Facility is to subsidize currency risk in the most efficient way.

Sections 1.1 and 1.2 discuss currency hedging instruments currently available in the market. They are not expensive, but potential investors and project developers perceive them to be expensive, which has limited their use. Section 1.3 highlights how the cost of currency hedging can be reduced via targeted risk reduction, an implicit subsidy, and a direct subsidy. This section also proposes a unique advantage of an upside benefit (the benefit to the donor/user when currency devaluation is less than expected) to be incorporated in the FX Hedging Facility which is not available in the commercial cross currency swaps. Section 2.1 discusses the design and pricing and market based validation of the FX tail risk guarantee component of the FX Hedging Facility as an alternative currency hedging instrument. Section 3 shows how the FX Hedging Facility reduces both the cost of currency hedging and the donor capital requirement compared to a cross currency swap without violating the efficient pricing assumption.

[1] In theory, INR has a market-determined exchange rate. However, the Reserve Bank of India (RBI) can intervene actively in cases of excessive volatility (HSBC, 2012)

[2] Currency risk is a major barrier to foreign investments in India and other developing countries. Currency crises, defined as a quick decline (more than 20% in one year) of a local currency vis-a-vis USD, have triggered regional economic crises such as in Latin America in 1982. Laeven and Valencia (2012) report 218 currency crises over the period 1970 to 2011 worldwide. While all projects with foreign investments face currency risk, infrastructure projects are exposed to greater risk because of their longer terms (20-30 years). Further, as infrastructure assets are difficult to re-deploy, exit is more difficult for investors. Currency risk is more severe for the power sector since its output is not only heavily regulated but also not tradable in international markets.

1.1 COMMERCIALLY AVAILABLE CURRENCY HEDGING INSTRUMENTS

When the INR interest rate is higher than the USD interest rate, risk-neutral and rational investors should expect the INR currency to depreciate against the dollar by the difference between the two interest rates. This way, borrowing at home and lending abroad or vice-versa produces a zero excess return. This is known as the uncovered interest rate parity (UIP) condition. There are currency hedging instruments available in the market that are priced using UIP or one of its variants. For example, a long term INR-USD cross currency swap costs around 750 basis points[3] (HSBC India 2012, and primary research) which is priced based on parameters such as long term interest rate differential (UIP component), volatility risk, liquidity risk and the cost of regulatory risk capital. Hence, the market cost of currency swap increases the cost of a dollar debt available at a rate of 4-5% to more than 12% (post hedging) or nearly equal to the domestically available loans.

Further, depending on the credit risk of the counterparty, the additional premium is around 50 basis points which takes the cost of currency hedging to ~800 bps. Counterparty credit risk is the risk that a party to the swap agreement will default on its obligations. Cross-currency swaps have high exposure to counterparty credit risk as they involve the exchange of notional amounts over an extended period of time. This risk increases with the length of the contract and can become a major barrier for long-term currency swaps. Swap providers assess the credit quality of the counterparty in determining whether or not to enter into a swap agreement. Hence, a premium is charged for this default risk. In a way, this leads to a double counting of credit risk as the counterparty already pays a premium for the underlying debt to the creditor.

There is a perception among the end-users that commercially available currency swaps are expensive, as discussed in Section 1.2.

1.2 PERCEPTION OF EXPENSIVE CURRENCY HEDGING

As discussed in Section 1.1, the market pricing of currency hedging instruments ensures that borrowing at home and lending abroad or vice-versa produces a zero excess return. However, foreign investors and renewable energy project developers perceive the market cost of currency hedging to be expensive. This perception is based on comparison of hedging costs with ex-post depreciation data. Ex-post data (~3.5% annual currency depreciation) is often cited by users while arguing for a cheaper hedging mechanism to support renewable energy deployment in the country (Livemint, 2015). However, this is unwarranted because the cost of currency hedging is based on ex-ante and not ex-post depreciation.

Project developers and foreign investors perceive commercially available currency hedging products to be expensive.

1.3 ADVANTAGES, RISK REDUCTION, DIRECT AND IMPLICIT SUBSIDIZATION

In this section, we discuss the ways by which the cost of currency hedging can be reduced and its benefit can be enhanced. In certain scenarios, the cost of risk can be reduced by reducing the risk, thereby not requiring any donor capital, for example, risk reduction through diversification or transaction structure. In other cases, reducing the cost of risk requires a direct or implicit subsidy. The optimal use of such direct subsidy requires appropriate transfer of any upside benefit[4] to the donors/user.

[3] The cost mentioned is the average cost of principal plus interest commercial currency swaps.

[4] Upside benefits will occur in the FX Hedging Facility when the FX depreciation is lower than the user's expectation.

We use commercially available cross currency swap as a reference to compare the cost and benefits of the proposed FX Hedging Facility. A cross currency swap has three different components of cost as shown in Table 1, out of which:

- The currency risk cost component can be directly subsidized[5]
- The counterparty credit risk[6] and the liquidity risk[7] cost components can be eliminated

This shall be explained in greater detail in the Section 3.1.

***Table 1**: Cost components of a commercial swap, in basis points (bps)*

Cost of currency Swap	=	Currency risk (principal + interest)	Counterparty credit risk	Liquidity risk	Transaction cost, dealer's margin etc.
~750 bps	=	650 bps[8]	50 bps[9]	30 bps	20 bps

While subsidizing a risk through public intervention or donor grant, there are certain criteria that should be considered (CPI, 2016b). If the currency risk is broken down into different tranches, then there may be a stronger argument to subsidize the FX tail risk rather than partially subsidizing the overall currency risk.

The FX Hedging Facility is an alternative currency hedging mechanism that incorporates components that aim to reduce the cost of currency hedging and increase leverage of private investment, specifically through:

- A direct subsidy for FX tail risk
- Elimination of the counterparty credit risk and liquidity risk
- Passing on benefits to the user/donor if currency depreciation is lower than expected

[5] Ignoring reduction in cost due to diversification such as in a portfolio of currency

[6] Counterparty credit risk is a measure of risk of the loss of the amount that would not be recovered in the event that a counterparty to a financial contract defaults in its payments.

[7] Liquidity risk is being implicitly subsidized but for simplicity it's assumed as eliminated here.

[8] Derived from the cost provided by a commercial bank

[9] Derived from the cost provided by a commercial bank

2. INSTRUMENT MECHANICS

The FX Hedging Facility aims to reduce the cost of currency hedging and increase the leverage of private investment through better targeting of public grants and elimination of credit risk and liquidity risk.

The FX Hedging Facility has the potential to mobilize additional foreign capital for clean energy in India. It can be structured for both debt and equity capital, depending on the user's requirement. The FX Hedging Facility would involve a risk capital facility ('hedging facility') backed by an FX tail risk guarantee. The hedging facility will hold the FX tail risk guarantee fee to be paid to the underwriter or the guarantor of the FX tail risk guarantee upfront. This facility will take certain annual payments from the project developer/investor for the risk coverage up until a certain currency depreciation rate and beyond this depreciation rate, the coverage will be provided by FX tail risk guarantee. The upside benefit due to the low currency depreciation (< 4.5% p.a.) will remain with the hedging facility and can be returned either to donor or the user after the tenor of the debt depending upon the actual agreement.

2.1 DESIGN AND PRICING OF THE FACILITY FOR A SAMPLE TRANSACTION[10]

2.1.1 *Transaction and stakeholders*

A sample entity[11] operating in the clean energy space and looking to raise foreign capital (dollar) wants a cheaper currency hedging solution and is willing to enter into a contract with a hedging facility for its return payment at a fixed depreciation rate of 4.5% per annum. The entity will absorb the FX depreciation until 4.5% (p.a.). If the FX depreciation is less than 4.5% say 3%, then the upside i.e. 1.5% will be transferred to the hedging facility. At the end of the hedging tenure, the accumulated capital in the facility can be shared between donor and user. However, we have assumed here that such an upside will be retained by the donor and hence, the effective cost of hedging will be fixed for the user. Beyond the FX depreciation of 4.5% per annum, an FX tail risk guarantee will be used to cover the FX risk till P99.7.[12] The rationale behind taking a 4.5% per annum depreciation rate is discussed in the next section.

There can be several possible designs for the FX Hedging Facility to achieve the mentioned risk coverage. The one we discuss here is shown in Figure 1. In this transaction structure, the project developer enters into two contracts:

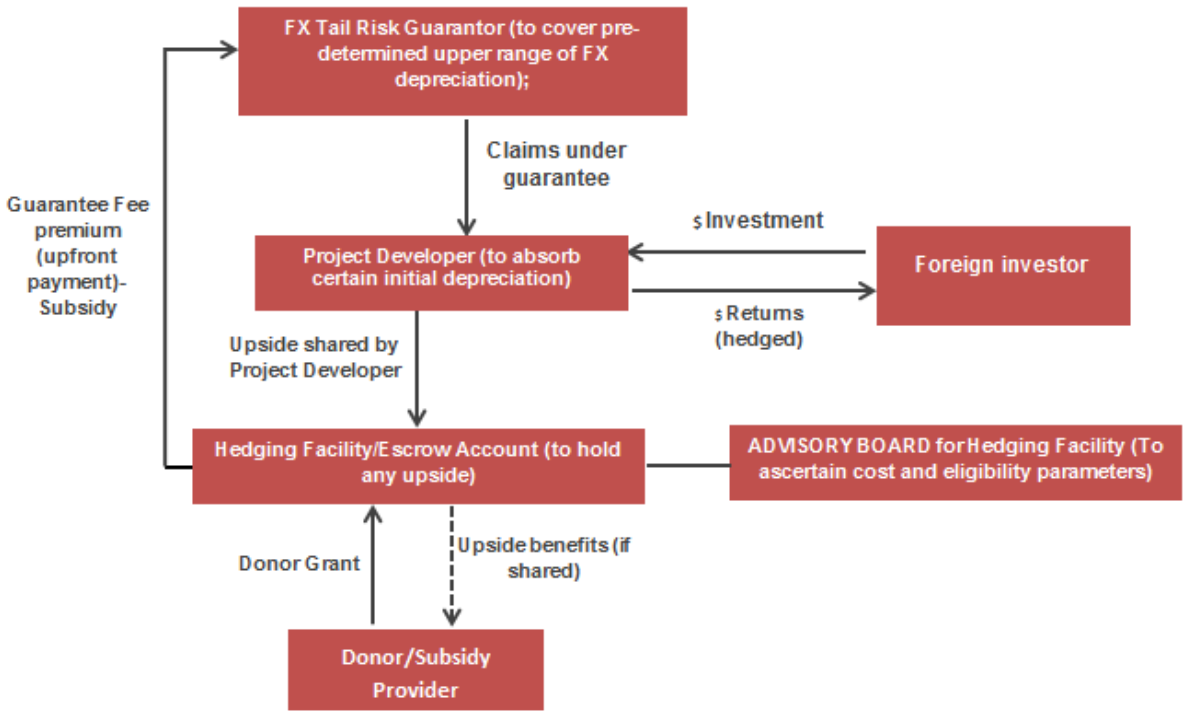
a) One with the hedging facility to cover currency risk up until 4.5% annual FX depreciation, and;
b) The other with an FX tail risk guarantor to cover currency risk beyond 4.5% till P99.7. The hedging facility component will keep the donor capital to pay the FX tail risk premium upfront to the guarantor and will also hold the payment from the project developer as the risk capital.

[10] The sample transaction used to do the analysis and calculations is a sample debt transaction. All the numbers mentioned in the subsequent section are based on the parameters assumed in this sample transaction.

[11] It can be a project developer or an NBFC raising bonds or foreign investor.

[12] P99.7 means that there is 99.7% probability that the INR-USD exchange rate would be 87.64 or lower in 2017 (based on CPI analysis). The FX Tail Risk Guarantee will cover all losses due to currency risk till P99.7 levels (3-sigma). It can be assumed that a rational guarantor will not provide unlimited risk coverage. However, the maximum guarantee coverage can be changed to any other level, example P99.7, based on the comfort of the guarantor and the investor.

Figure 1: *Transaction Structure of the FX Hedging Facility*



2.1.2 *Pricing of the Instrument*

As mentioned in the structure, the equivalent annualized cost of currency depreciation from 0% to 4.5% per annum will be paid by the entity to maintain the risk capital for the mentioned risk coverage. When compared to a commercial swap, this depreciation rate of 4.5% translates into an annualized maximum cost of ~528 basis points (bps)[13]. We arrive at this cost by calculating the annualized net present value[14] of the difference between the debt service payment at 0% and 4.5% per annum of FX depreciation and then dividing it with the notional size of the debt transaction.

Beyond the FX depreciation of 4.5% per annum till P99.7 level of depreciation, the risk coverage will be provided by the FX tail risk guarantee. The FX tail risk guarantee component will have two strike prices[15] (INR-USD FX rate) in each year, as shown in Table 2. The first strike price is derived from the minimum depreciation rate of 4.5% per annum and the second strike price is derived from FX depreciation at the P99.7 level.

Table 2: *Strike prices (INR-USD FX rate) for the FX Hedging Facility*

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Strike price @4.5% (p.a.)	71.04	74.24	77.58	81.07	84.72	88.53	92.51	96.67	101.02	105.57

[13] The maximum risk capital would be equivalent to the maximum cost of hedging sourced from project developer. The maximum cost to the project developer = Total currency risk cost (Table 1) - FX tail risk cost (calculated later) = 650-134 = 516 bps (~528 bps). This cost translates to maximum depreciation of ~4.5% (p.a.). This is for the cross validation of the pricing.

[14] Risk free rate = 6.77% (Source: Bloomberg), tenor = 10 years.

[15] Strike prices are the future FX rate (INR-USD) at which the FX tail risk guarantee will be exercised by the entity. The pricing of the guarantee depends upon these strike prices.

Strike price @P99.7	87.64	96.54	105.01	113.38	121.80	130.37	139.13	148.13	157.42	167.01

We discuss the pricing methodology of the FX tail risk guarantee in Appendix 7.1. Table 3 shows the parameters and cost of FX tail risk guarantee based on two different methods: equivalence premium principle and market-based option pricing model. The FX tail risk guarantee component is envisaged as a guarantee product which can operate outside the purview of SEBI regulation thereby allowing entities other than commercial banks to provide such a guarantee; hence the cost of the product was estimated using equivalence premium principle. However, to validate the pricing we used a market-based option pricing method.

Table 3: *Cost of the FX tail risk guarantee*

Foreign debt tenure	10 years
Guarantee coverage horizon	10 years
Risk coverage	4.5% (p.a.) to P99.7
$ Return (after hedging)	4.50% (p.a.)
Annual guarantee fee (market cost)	134 bps

As shown in Table 1, the market cost of currency risk is 650 bps. The cost of currency risk in an FX tail risk guarantee transaction is 528+134 = 662 bps, which is quite close to the market cost of currency risk. Hence, it is not violating the efficient pricing hypothesis.

To summarise, the investor pays the annual payments equivalent to 528 bps to the hedging facility to maintain the risk capital for FX depreciation from 0-4.5% p.a. From 4.5% to P99.7 of FX depreciation, the FX tail risk guarantor provides the risk coverage and is paid the guarantee premium of 134 bps by the donor capital upfront through donor capital (direct subsidy). In the subsequent sections, we use the market cost of the FX tail risk guarantee. The cumulative fee of ten years will be held by the hedging facility upfront funded by donor grant thereby eliminating the credit risk.

Under the Facility, the investor pays annual payments equivalent to 528 bps to the Hedging Facility to maintain the risk capital for FX depreciation from 0-4.5% p.a. From 4.5% to P99.7 of FX depreciation, the FX tail risk guarantor provides the risk coverage and is paid the guarantee premium of 134 bps upfront through donor capital.

There can be special case for an equity transaction where a foreign equity investor wants to hedge a certain minimum return on its equity investment into Indian renewable energy project in India but is willing to share certain upside with the donors (or subsidy providers). For such cases, there will be slightly modified mechanism that will be required and will require further work. A brief mention of the approach is discussed in the Section 7.2.

3. INNOVATION AND RISK MITIGATION

3.1 INNOVATION

The FX Hedging Facility is innovative in its structure and in its allocation of the cost of currency risk to suitable entities. It is a new product which:

a) **Targets a particular tranche of currency risk:** The FX Hedging Facility breaks currency risk into two ranges. The lower range of FX depreciation (p.a.) from 0% to 4.5% will be covered by the user (project developer/investor) while the upper range (extreme depreciation) from 4.5% to P99.7 will be covered by the FX tail risk guarantor.
b) **Eliminates the cost of credit and liquidity risk**: With the donor making the upfront payment of the FX tail risk premium and no need for exchanging notional payments, the credit risk which otherwise gets charged in a currency swap gets eliminated. Also, the cost of liquidity risk gets implicitly subsidized without requiring any donor grant.
c) **Provides upside benefit to the user/donors:** Under a commercial swap, the upside benefit (when the currency depreciation is lower than expected, i.e. less than 4.5% p.a.) is kept with the swap provider. However, in the proposed structure of the FX Hedging Facility, if there is any upside benefit then that will be transferred to the donors or the users. The upside benefit reduces both the eventual cost of currency hedging significantly and donor capital required.

The FX Hedging Facility is an innovative hedging mechanism which targets a particular tranche of currency risk, eliminates the credit and liquidity risk and also provides an upside benefit to the user/donors when currency depreciation is less than expected.

3.2 BARRIERS ADDRESSED

The FX Hedging Facility has the potential to attract foreign investors who are ready to invest into the clean energy sector in India but have been reluctant due to the perception of the high cost of currency risk. The Facility may be especially beneficial to small and medium renewable energy project developers, who otherwise have difficultly accessing foreign capital, due to the higher cost of commercial FX hedging instruments and the smaller size of their projects. Thus the hedging facility will be addressing the following three barriers to foreign investments in renewable energy:

- High cost of currency hedging
- Non-availability of currency hedging: Small and medium entities are unable to access the hedging instruments in the market due to their credit risk.
- Tenure of the available currency hedging instruments: The hedging facility can provide hedging for longer tenure than the existing instruments in the market.

4. IMPACT

4.1 INNOVATIVE

4.1.1 *Reduction in the cost of currency hedging*

The FX Hedging Facility possesses the following benefits when compared to a commercial cross currency swap:

- **Elimination of counterparty credit risk and liquidity risk:** As mentioned earlier, with the upfront payment of the FX tail risk premium via donor capital, the credit risk gets eliminated leading to a reduction of ~50 bps in the total currency cost as compared to that in a commercial swap. The cost of liquidity risk gets removed implicitly i.e. without requiring any donor grant, thereby increasing the leverage, or amount of private investment raised per dollar of donor grant. Providing an implicit subsidy in a commercial swap is not feasible.
- **Targeted donor grants:** The Facility enables a more efficient use of public grants as it covers or targets only extreme currency depreciation. The annual cost of this subsidy is ~134 bps.

As a result, the FX Hedging Facility will reduce the cost of currency hedging when compared to a commercial currency swap. Table 5 and 6 compares the cost components between a commercial currency swap and the maximum cost of currency hedging with the FX Hedging Facility.

Table 4: *Cost component in a commercial swap*

Cost of currency Swap	=	Currency risk (Principal + Interest)	Counterparty credit risk	Liquidity risk	Transaction cost, dealer's margin etc.
~750 bps	=	650 bps	50 bps	30 bps	20 bps

Table 5: *Maximum cost of currency hedging when using the FX Hedging Facility*[16]

Cost of currency Hedging	=	Currency Risks		Counterparty credit risk	Liquidity risk[17]	Transaction cost, dealer's margin etc.
		Cost to Developer / Investor for Risk Capital	Cost of FX Tail Risk Guarantee			
~682 bps	=	528 bps	134 bps	0	0	20 bps

As shown in Table 5 and 6, under the FX Hedging Facility, **the cost of currency hedging decreases by approximately 9% without any donor capital**. However, the cost benefit of the whole transaction increases based on the actual currency movements.

Table 7 compares the cost of currency hedging when using a cross currency swap with using the FX Hedging Facility, under different FX depreciation scenarios. As clear from the table, **the FX Hedging Facility has an upside benefit in cost which is not available in a commercial currency swap.** Assuming that any upside benefit will be kept by the donor, **the total cost of hedging that will be paid by the user will be 528 bps which is ~30% lower than the cost of a commercial currency swap**.

The FX Hedging Facility can reduce the total cost of hedging for the user, to 30% lower than the cost of an unsubsidized commercial cross currency swap.

Table 6: *Cost of a Commercial Currency Swap vs the FX Hedging Facility*

FX Depreciation Scenario (CAGR basis)	Cost of Currency Swap	Effective Cost of FX Hedging Facility	% reduction
0.00%	7.50%	1.54%	-79%
1.00%	7.50%	2.60%	-65%
2.00%	7.50%	3.76%	-50%
P50 (most expected scenario) ~3.14%	7.50%	5.01%	-33%
4.00%	7.50%	6.38%	-15%
4.50%	7.50%	6.83%	-9%
8.00%	7.50%	6.83%	-9%
10.00%	7.50%	6.83%	-9%

[16] There can be significant reduction in cost based on currency movements. Table 6 illustrates the maximum cost of currency hedging when using a hedging facility

[17] Implicitly subsidized i.e. without requiring any donor grant. However, this would require direct subsidy in a commercial swap.

4.2 CATALYTIC

4.2.1 *Private finance mobilization and optimal use of public finance*

In this section, we present the numbers only for a pilot transaction of a USD 10 million dollar investment. We have not calculated the private capital that can be mobilized at scale as it depends upon the availability of sufficient donor capital and also the market assessment of various types of clean energy projects looking to raise foreign capital.

If the currency depreciation is lower than expected, then the benefit remains with the hedging facility which can be transferred to the donors or user. This is a more optimal use of donor capital as compared to that would have been required in a commercial currency swap.

In Table 8, we show that the donor capital required in case of the FX Hedging Facility structure is far less than what is required for a currency swap to bring down the cost of hedging to a certain level of 5.28% of the notional (cost to the user). The negative subsidy shown in the below table shows the upside benefit to the FX Hedging Facility, which demonstrates that it will have additional capital instead of requiring a subsidy.

As shown in Table 8, the maximum subsidy required to bring down the cost of currency hedging for user to 5.28% is $ 1.1 million (for $10 million of investment). This subsidy will cover the full cost of the FX tail risk guarantee (134 basis points) and the transaction cost (20 basis points). As the user will pay a fixed hedging fee of 5.28% (sufficient to cover depreciation till 4.5% p.a.), the money (risk capital) will accumulate in the hedging facility if the depreciation is less than 4.5% p.a. The lower the depreciation, the higher will be the money in the hedging facility at the end of the tenure. Using the subsidy data from table 8, if the depreciation is 4% p.a., then the hedging facility will have $1.1 minus $0.78 i.e. $0.32 million as the money accumulated.[18] Similarly, if the average depreciation is 3.20% (p.a.) over the tenure of the facility then the money accumulated would be $1.1 million i.e. the entire subsidy would be recoverable. The depreciation of 3.2% p.a. is slightly above the P50 level of depreciation value. This means that there is more than 50% probability that the subsidy will be fully recovered at the end of the tenure. This also means that there is more than 50% probability that cost of currency hedging will reduce by 30% without any subsidy.

There is more than 50% probability that the subsidy will be fully recovered at the end of the tenure. This also means that there is more than 50% probability that cost of currency hedging will reduce by 30% without any subsidy.

Table 7: *Subsidy Requirement*

	Subsidy (for USD 10 million of foreign investment) required to bring the total cost of hedging to 5.28% for the project developer (USD million)	
FX Depreciation Scenario (CAGR)	**Cross Currency Swap**	**FX Hedging Facility**
0.00%	1.58	-2.65
1.00%	1.58	-1.90

[18] Ignoring the time value of money as the money accumulated in the initial years will also earn a risk free rate of return till the end of the tenure of the facility which has been not accounted for.

2.00%	1.58	-1.08
3.14%(P50)	1.58	-0.19
3.20%	1.58	0
4.00%	1.58	0.78
4.50%	1.58	1.10
8.00%	1.58	1.10
10.00%	1.58	1.10

The direct (targeted) subsidy or the grant capital required to pay the premium to the FX tail risk guarantor (including the transaction cost) upfront for a USD 10 million bond with a coupon of 4.5% (p.a.) and tenor of 10 years equals to USD 1.1 million. Hence, the leverage factor of the instrument is ~9. This is the minimum leverage to mobilize foreign debt and will be further higher if the recoverable subsidy and domestic private capital mobilized are also taken into account. To put it in comparative perspective, **the FX Hedging Facility has a leverage factor of 9 with more than 50% probability that the entire subsidy will be recovered while a cross currency swap has a leverage factor of 6 with no option of any recovery of subsidy.**

The FX Hedging Facility has the potential to reduce the cost of currency hedging by ~30% while mobilizing a minimum of ~$9 of foreign debt investment per dollar of donor grant with more than 50% probability that the donor grant will be fully recovered

4.3 TRANSFORMATIVE

4.3.1 *Capacity Addition*

For a pilot transaction of USD 10 million foreign capital (a sample transaction), assuming a capital structure with 35% of foreign debt, 35% of domestic debt and 30% domestic equity, an equivalent of ~36 MW[19] solar PV project can be installed.

4.3.2 *Environmental Impact*

We calculated the environmental impact of the instrument which can be achieved through a pilot transaction of a USD 10 million foreign investment whose investors would be interested to use the FX Hedging Facility. Assuming the new capacity of 36 MW (capacity addition through pilot) replaces the next cheapest alternative source of coal-fired generation, we could estimate the resulting abatement of carbon, SOx and NOx emissions as shown in Table 9.

Table 8: Environmental Impact

	Net emission reductions (million metric ton) / year
	Foreign investment
CO2	**0.06**
SOx	**0.18**
NOx	**0.26**

[19] Assumption: Cost of 1 MW typical Solar PV project in India = INR 53 million

4.4 ACTIONABLE

The Facility scores 2 (a simple average of the rating of the individual metrics) on a 3-point scale determining its feasibility and is therefore moderately actionable. On a 3-point scale <1 indicates low feasibility, 1-2 indicates moderate feasibility, and >2 indicates high feasibility.[20] Please refer to Section 5 for further detail on this.

5. IMPLEMENTATION PATHWAY

The FX Hedging Facility scores a 2 out of 3 for implementation feasibility.

Criteria	Reason for Rating	Implementation Feasibility Rating
Precedent	This is new instrument and has not been used in India or any other geography/sector	1
Institutional framework	The FX tail risk component can be mimicked using existing call spread options provided by several commercial entities and the other main component i.e. the hedging facility to hold the donor capital and the risk capital can be managed through an escrow account.	3
Conformity with existing financial regulations	Only issue that we have identified so far is the size of the user (project developer/investor) which can use this instrument. However, this issue can be overcome by the pooling of multiple projects to achieve the required size.	2
Dependence on financial markets	If the FX tail risk guarantee component of the FX Hedging Facility is replaced with a similar product using call spread options which are fairly liquid in Indian capital market then there will be no significant issue as far as this parameter is concerned.	3
Implementing agency	We have identified the underwriter of the FX tail risk guarantee (call spread underwriter) of the product. However, an independent Advisory Body is still to be created which can manage the several independent stakeholders and separate transactions among them.	1
Involvement of stakeholders	The success of the Facility depends on a number of different stakeholder groups including different classes of investor, project developers, facility manager, and escrow account service provider.	2
Timelines	The timeline is contingent upon the signing up required stakeholders. We expect that the facility can become actionable within 8-10 months	2

[20] The rating is based on CPI's internal analysis (as shown in the table), secondary research, and discussion with experts in the relevant field

The FX Hedging Facility will be deployed in two stages. During the first stage, the focus will be on piloting the FX Hedging Facility with potential foreign investors. If successful, the product will be scaled up in the second stage. We have completed the basic design, transaction structure and pricing, and are already in the advanced stages of discussion with two separate sets of potential users of this instrument and the implementer of the hedging mechanism.

a) Potential identified users of the FX Hedging Facility

- An non-banking financial company (NBFC) that is planning to raise foreign debt of approximately USD $5-10 million to provide loans to various clean energy projects, particularly for mini-grids, distributed rooftop solar and energy efficiency.
- A foreign private equity investor who is interested in investing $500 million into utility scale renewable energy projects in India.
- For a larger pilot transaction, we are also considering including the projects that will be shortlisted through India Clean Energy Finance (ICEF) initiative. This is a combined initiative of OPIC[21] and Indian government which will focus on India's distributed solar market through leveraging public and private capital flows into the market.

b) Implementer of the FX tail risk guarantee component:

- A commercial entity which provides FX hedging products in the Indian capital market has agreed to provide the bull call spread[22] which exactly mimics the proposed FX tail risk guarantee to cover the FX tail risk.
- A development finance institution (DFI) has agreed to provide the proposed FX tail guarantee given certain conditions such as the size of the underlying project.

c) Management of the FX Hedging Facility:

As mentioned earlier, the FX Hedging Facility will be an escrow account, to hold the risk capital from the user (project developer/investor) and also to keep the donor capital to pay the upfront premium to the FX tail risk guarantor, and can be managed by any commercial bank or any suitable third party which provides such services by charging minimal fees. This can also be managed by the user internally.

d) Management of the whole transaction and stakeholders:

The FX Hedging Facility has several independent stakeholders. This might require a third party or an Advisory body to manage the operation of the whole transaction and stakeholders.

[21] Overseas Private Investment Corporation

[22] A bull call spread is an options strategy in which a call option with a lower strike price is purchased and another call option with a higher strike price is sold with same expiration date. This strategy is mostly used as a hedging cost reduction strategy. Similar results can be achieved using combination of put options.

5.1 MILESTONES TO IMPLEMENTATION

The FX Hedging Facility is in a late conceptual phase, with a high-level transaction structure and pricing/valuation already defined. We anticipate the following milestones to make the pilot fully operation by mid to late 2017.

	Milestones	Timeline/ Comments
1	**Setup of the FX Hedging Facility**	
	Finalize the FX tail risk guarantor	By end of 2016
	Sort out any regulatory issues which may affect implementation	By end of 2016
	Governance of hedging facility/risk capital/escrow account which will keep the donor capital and also receives the yearly upside benefit (if any).	By end of 2016
	Setup of an advisory body which will manage the whole transaction, operations and stakeholders.	By end of 2016
	Finalize operational and financial structure	First quarter of 2017
	Any remaining analysis on pricing, especially for equity transactions (if required)	First quarter of 2017
2	**Raise foreign capital and the donor capital requirements**	
	Issuance and closure of a low cost dollar bond to be raised by the NBFC (user). The proceeds of the bond will be lent to clean energy project developers.	To be finalized by the user
	Setup of a foreign equity fund (expected size of USD 500 million) which will invest into utility scale renewable energy projects in India.	To be finalized by the user
3	**Donor capital closing**	
	Donor contributions secured, for debt and equity transactions separately.	To be finalized depending on Milestone #2
4	**First transaction completed**	To be finalized depending on Milestone #3
5	**Scaling Up**	Once proven, scaling up will be possible

5.2 IMPLEMENTATION CHALLENGES

The following challenges are likely to be faced in the implementation of the FX Hedging Facility:

a) **Size of the NBFC:** If the interested commercial entity becomes the FX tail risk guarantee, then this guarantee will possibly be a bull call spread (mimicking the FX tail risk guarantee). In that case, the NBFC entering into the call spread transaction must be either listed or its net worth must be at least INR 200 crore (USD 30 million). The NBFC interested to take part in the pilot is an unlisted NBFC with a net worth of only INR 10 crores (USD 1.5 million). However, this can be taken care if multiple NBFCs can form a pool to reach the required criteria of the net worth. Also, if required, an open call[23] for interest to avail subsidized currency hedging can be made and it is expected that multiple entities will be interested to avail this facility due to the cost benefits.
Also, in case the interested DFI becomes the implementer and provides the actual proposed FX tail risk guarantee then, as per our discussion, it can do so if the project or the portfolio of the project (or pool of projects) is at least USD 100 million.

b) **Operational issue with equity transactions:** The pricing of the guarantee fee depends upon underlying cash flows. In the case of debt transactions, we know the exact payments on a yearly basis but in the case of equity transactions, these payments/cash flows are not fixed and also there is no fixed period to actually make these payments. Further work on the design of the FX Hedging Facility will be required. While a hedging facility has already been designed for debt, the design of such a hedging facility for equity can be completed by January 2017.

6. KEY TAKEAWAYS

The proposed alternative FX Hedging Mechanism is a customizable currency hedging product comprising of an FX hedging facility backed by an FX tail risk guarantee. The mechanism targets a particular tranche of foreign exchange (FX) risk and allows allocation of risks to suitable parties and also eliminates the credit risk premium, otherwise charged in a commercial currency swap. This product has the potential to mobilize a minimum of $10 of foreign debt per dollar of subsidy with more than 50% probability that the subsidy will be fully recovered. Also, supporting the proposed mechanism is a more optimal use of subsidy as it requires lesser subsidy compared to a cross currency swap.

The FX Hedging Facility product scores well on different criteria:

- **Innovative:** It is a new product which targets a particular tranche of currency risk and also reduces the cost of credit and liquidity risk in currency hedging. Such a guarantee product does not exist in the market and hence, any transaction (pilot project) involving such an instrument will set a precedence in itself. The upside benefit reduces the cost of currency hedging significantly which is not available in existing currency hedging products.
- **Catalytic:** The FX Hedging Facility has the potential to mobilize a minimum of $10 of foreign debt investment per $1 of subsidy with more than 50% probability that the subsidy will be fully recovered.
- **Transformative:** If the market for such a guarantee product becomes commercially sustainable, then it has the potential to mobilize a large amount of foreign equity and debt into the clean energy industry in India. The product is highly customizable and can be utilized by several types of clean energy projects looking to raise foreign capital. For small and medium entities in the renewable energy space, this product can help provide access

[23] This has been not done so far as pre-identified users have been given a preference for the pilot transaction.

to foreign debt at affordable rates. For foreign equity investors it can set a precedence and provide a template for the cost and risk sharing arrangement for hedging which can unleash the flow of large foreign equity investments that has remained untapped due to currency risk.

- **Actionable:** The pricing of the proposed product has been commercially validated. A development finance institution and a couple of commercial entities are ready to provide the FX tail risk guarantee component or a similar hedging product subject to certain conditions which are not significant implementation barriers. Another requirement will be to manage the hedging facility to hold the risk capital which can be easily managed using escrow account.

7. APPENDIX

7.1 VALUATION OF FX TAIL RISK GUARANTEE

There are different methods that can be employed to price a guarantee product (Embrechts, 1997). In this section, we discuss two methods: Equivalence Premium Principle and Black Scholes Option Pricing model.

7.1.1 *Equivalence Premium Principle:*

The equivalence premium principle (Kaas, Goovaerts et al., 2008) can be used regardless of the characteristics of the guarantor to arrive at the minimum commercial guarantee fee[24]. Hence, we discuss the application of the equivalence premium principle.

The guarantee fee, π[Y] is equal to the present value of E[Y], where Y is the distribution of the claims under the guarantee.

$$\pi[Y] = \text{Present value of } E[Y] \qquad \ldots\ldots\ldots(1)$$

Based on the distribution of exchange rates (X) discussed later, we generated Y for each year i.e. the distribution of claims under the guarantee using the trigger points (T) as following-

$$Y = \begin{cases} X-T & \text{if } X > T \\ 0 & \text{if } X < T \\ P99.7 - T & \text{if } X > P99.7 \end{cases} \qquad \ldots\ldots\ldots (2)$$

Using equations (1) and (2), the cost of the FX Tail Risk Guarantee was estimated. Table 3 shows the cost and parameters of the FX Tail Risk Guarantee for a foreign debt transaction. The guarantee fee of 70 bps is the minimum commercial fee. Taking approximately 30 bps as the risk premium above this minimum cost, the commercial cost may be around 100 bps[25].

Table 9: *Cost of FX Tail Risk Guarantee using Equivalence Premium Principle*

Foreign debt tenure	10 years
Guarantee coverage horizon	10 years
Risk coverage	4.5% (p.a) to P99.7
Debt rate ($)	4.50%
Annual guarantee fee (% of notional)	100 bps

To generate the distribution of the claims (Y) under the guarantee, we first need to generate the distribution of exchange rates (X) in each year. We used geometric Brownian motion to generate the distribution of future exchange rates. The same methodology is used here. As the first step, we chose the geometric Brownian motion (GBM) as an appropriate stochastic model, based on its properties of log-normal distribution of returns and a Markov process. Under a

24 The guarantor would charge a fee above this minimum guarantee fee which will depend on various factors such as the cost of its internal risk capital, diversification, ruin probability etc.

25 Based on rough estimates.

GBM, the foreign exchange rate is characterized by a trend (deterministic) component and a random (stochastic) component. The following stochastic differential equation represents a GBM for a foreign exchange rate:

$$dS_t = \mu S_t dt + \sigma S_t dW_t, \ldots (3)$$

where μ is the drift rate and σ is the standard deviation; μStdt is the trend (deterministic) component and $\sigma S_t dW_t$ is the stochastic (random) component. The solution of equation (i) gives the following process representing a foreign exchange rate:

$$FX_t = FX_o \exp[(\mu - \sigma^2/2)t + \sigma * W_t], \ldots. (4)$$

where FX_t is the foreign exchange rate at time t, FX_o is the foreign exchange rate at time t= to, and W_t is a Weiner process. In equation (ii), $(\mu - \sigma^2/2)t$ represents the trend component and $\sigma * W_t$ represents the stochastic component of the foreign exchange rate movements. W_t can be further written as:

$$W_t = Z * \sqrt{t}, \ldots. (5)$$

Where Z is normally distributed random number between 0 and 1. To find μ and σ that yield the best fit to a historical dataset[26], we used the commonly used maximum likelihood estimation (MLE).

For the USD-INR foreign exchange rate forecast for years 2017-2026 (t = 1 to 10 years), we used: FX_o (current foreign exchange rate) = 66.5, μ = 3.19%, σ = 7.37%. Using Monte Carlo simulations, we generated 10,000 foreign exchange rate samples (X) for every time period – that is, for t = 1 to 10 years.

According to the Equivalence Premium Principle, the present value of E[Y] provides the minimum guarantee fee per $ which is then adjusted according to the cash flows being guaranteed.

7.1.2 *Market based pricing of the FX tail risk guarantee*

In this section, we discuss an alternate pricing methodology for the FX tail guarantee which is based on commercial transactions. Most of the commercial entities use currency options pricing model known as the Garman-Kohlhagen option model which is a variation of the famous Black-Scholes model. There are six fundamental variables that determine the price of an option on an exchange rate: the current (spot) price, the strike price, the time to expiration, forward points, the domestic currency interest rate, and the implied volatility. These inputs establish the value of a currency option as the combination of its intrinsic value and its time value:

$$\text{Call Premium} = S * N(d_1) * e^{R}_{ft} - E * N(d_2) * e^{R}_{dt},$$

Where,

$$d_1 = \underline{ln\ (S / E) + (Rd - R_f + \sigma^2 / 2 * t}$$

[26] 20 years INR/USD FX rate times series data was used

$$\sigma * \sqrt{t}$$

$d_2 = d_1 = \sigma * \sqrt{t}$,

t = time to expiration (measured in percent of a year),

E = option exercise price,

R_d = risk free domestic interest rate,

R_f = risk free foreign interest rate,

ln = natural log function, .

N = cumulative normal density function,

σ = variance of the rate of return on the underlying exchange rate,

S = currency spot rate,

and e = exponential function.

Obtaining the FX call option prices from a commercial bank for the series of strike prices mentioned in the Table 10 below, we created a bull call spread mimicking the FX tail risk guarantee.

Table 10: *Strike prices (INR/USD) for the FX Hedging Facility*

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Strike price @4.5% (p.a.)	71.04	74.24	77.58	81.07	84.72	88.53	92.51	96.67	101.02	105.57
Strike price @P99.7	87.64	96.54	105.01	113.38	121.80	130.37	139.13	148.13	157.42	167.01

If the commercial bank becomes the implementer, then the FX tail risk guarantee will be basically 10 call spread options of tenor 1,2,3…10 years. Table 11 shows the price of the FX tail risk guarantee estimated using FX call options prices:

Table 11: *Market Based Pricing of FX tail risk guarantee*

Foreign Debt tenure	10 years
Guarantee coverage horizon (10 Call spread	10 years
Risk coverage	P99.7
$ Return (after hedging)	4.50%
Annual guarantee fee (% of notional)	134 bps

7.2 DESIGN AND PRICING OF THE FACILITY FOR A SAMPLE EQUITY TRANSACTION (SPECIAL CASES)

In an equity transaction, suppose a foreign private equity investor is looking to invest USD 500 million into utility scale renewable energy projects in India and wants to hedge its return from FX risk. It is willing to pay a fixed premium of 300 basis points as a cost of currency hedging and will also share a fraction of the upside equity returns with the hedging facility. This is different from the debt transaction discussed earlier where the user is expected to pay a fixed premium of ~500 basis points.

For optimal use of subsidy and for robust risk management of the hedging facility, the fraction of the upside equity returns to be shared by the equity investor is to be estimated using advanced risk-return assessment of the hedging facility. Such an assessment will simultaneously account for the distribution of equity returns and its volatility, the distribution of power generated and currency risk. Different investors have different views on equity returns in renewable energy in India. The hedging facility for equity will be designed while taking care of the expectations of individual investors but at the same time ensuring robust risk management of the hedging facility. Further work will be required to arrive at the numbers for such an equity transaction.

8. REFERENCES

Embrechts P. (1997), Actuarial versus Financial Pricing of Insurance, http://fic.wharton.upenn.edu/fic/papers/96/9617.pdf

CPI (2016a), Reaching India's Renewable Energy Targets: The Role of Institutional Investors (WIP)

CPI (2016b), Farooquee A. and Shrimali G. (2016), Driving Foreign Investment to Renewable Energy in India: A Payment Security Mechanism to Address Off-Taker Risk, Climate Policy Initiative Working Paper, http://climatepolicyinitiative.org/wp-content/uploads/2016/04/Driving-Foreign-Investment-to-Renewable-Energy-in-India_Technical-Report.pdf

CPI (2016c), Farooquee A. and Shrimali G. (2016), Making renewable energy competitive in India: Reducing financing costs via a government-sponsored hedging facility, Energy Policy, http://www.sciencedirect.com/science/article/pii/S0301421516300465

HSBC (2012), Emerging Markets Currency Guide, http://www.hsbcnet.com/gbm/attachments/rise-of-the-rmb/currency-guide-2012.pdf?WT.ac=CIBM_gbm_pro_rmbrise_pbx01_On

Kaas, Goovaerts et al. (2008), Modern Actuarial Risk Theory, Springer

Laeven and Valencia (2012) Systemic Banking Crises Database: An Update, IMF Working Paper, https://www.imf.org/external/pubs/ft/wp/2012/wp12163.pdf

Livemint, 2015, http://www.livemint.com/Politics/ZfmQqAhTj0YR6epa7DS53J/India-may-leverage-clean-energy-fund-to-hedge-foreign-loans.html?utm_source=copy