KAZAKHSTAN: Derisking Renewable Energy Investment

Selecting Public Instruments to Promote Utility-scale Renewable Energy Investment in Kazakhstan

FULL REPORT

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Acronyms

ADB	Asian Development Bank
BAU	Business-as-usual
BOO	Build-Own-Operate
CCGT	Combined Cycle Gas Turbine
CDM	Clean Development Mechanism
CO_2e	Carbon Dioxide Equivalent
CoD	Cost of Debt
CoE	Cost of Equity
CTF	Clean Technology Fund, part of the Climate Investment Funds managed by the World Bank
DREI	Derisking Renewable Energy Investment
EIA	Energy Information Administration (US)
EBRD	European Bank for Reconstruction and Development
EPC	Engineering, Procurement and Construction
EU	European Union
EUR	Euro
FiT	Feed-in Tariff
FSC	Financial Settlement Centre
FTE	Full-time Employee
GDP	Gross Domestic Product
GEF	Global Environment Facility
IEA	International Energy Agency
IFC	International Finance Corporation
INDC	Intended Nationally Determined Contribution
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
JSC	Joint Stock Company
KEGOC	Kazakhstan Electricity Grid Operating Company

kW	Kilowatt
kWh	Kilowatt-hour
KZT	Kazakhstan Tenge
LCOE	Levelised Cost of Electricity
LLP	Limited Liability Partnership
m/s	Meters per second
m^2	Square meters
MBTU	Million British Thermal Unit
MRV	Measuring, Reporting and Verification
MW	Megawatt
MWh	Megawatt-hour
MIGA	Multilateral Investment Guarantee Agency (World Bank)
MOU	Memorandum of Understanding
Mtoe	Million tonnes of oil equivalent
NA	Not Applicable/Available
NAMA	Nationally Appropriate Mitigation Action
NREL	National Renewable Energy Laboratory (US)
O&M	Operations and Maintenance
PDD	CDM Project Design Document
PPA	Power Purchase Agreement
PRI	Political Risk Insurance
PV	Photovoltaic
R&D	Research and Development
TJ	Terajoule
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
VAT	Value-Added Tax

Foreword

Foreword

Key Points for Decision-Makers[1]

The objective of this report is to analyse the most cost-effective public derisking measures to promote private sector investment in utility-scale renewable energy in the Republic of Kazakhstan ("Kazakhstan"). Target sectors are wind energy and solar photovoltaic (PV). The report sets out the results from a quantitative, investment-risk informed modelling analysis. Modelling data has been obtained from structured interviews with private sector investors and developers. This report was prepared in collaboration with Kazakhstan's Ministry of Energy.

Context and Opportunity for Renewable Energy

Kazakhstan's power sector currently relies heavily on fossil fuels, reflecting the country's endowment with an abundance of oil, natural gas, and coal reserves. Total available capacity for electricity generation is 18.8 GW, with nearly 75% of the plants powered by locally-sourced coal. Rapid economic growth in the past decade has led to increases in electricity demand, but the country faces constraints in an aging generation and transmission infrastructure dating to the Soviet-era. Kazakhstan has some of the lowest retail tariffs in the world, a function of consumption subsidies for fossil fuels (estimated at USD 5.3 billion in 2014), low cost generation from fully-depreciated power plants, and non cost-reflective tariff pricing. Kazakhstan is also characterised by regional imbalances in generation, notably in the south, resulting in supply disruptions and electricity imports from neighbouring countries.

Assisted by international actors (ADB, EBRD, IFC, UNDP, USAID), Kazakhstan has adopted a range of public measures to support development of renewable energy and in turn is attracting private sector interest. There has been interest over time from a range of investors, with a variety of interests (both strategic and financial), including parastatal actors, oil and gas multinationals, and private sector international and domestic developers. Nonetheless, utility-scale investment has been limited to date, amounting to 71 MW in wind energy and 57 MW in solar PV.

The potential for renewable energy in Kazakhstan is strong. This report assumes investment targets for 2021 (5 years) of 1 GW in wind energy and 250 MW in solar PV. These targets can be viewed as the first, phased step to achieving the government's official 2030 targets of 5 GW in wind energy and 500 MW in solar energy, as set out in its *Green Economy Concept Note* (2013). Kazakhstan is well positioned for investment with abundant wind resources and a compelling case for solar PV in the south, around Almaty. Increased investment in renewable energy can contribute to Kazakhstan's long-term vision to establish itself as a regional leader in green economic development, to its goal to diversify electricity generation away from oil and coal, and to reducing greenhouse gas emissions in line with its Intended Nationally Determined Contribution (INDC) under the UNFCCC. The overall opportunity for renewable energy is fully aligned with Kazakhstan's green economic vision at Expo 2017.

[1] This 'Key points for decision makers' section summarizes the findings of the report in a succinct manner. As such, references have not been included in this section but are found later in the relevant sections of the full report.

Financing Costs and Risk Environment

The report's modelling performs a detailed analysis of the financing costs and risk environment for wind energy and solar PV in Kazakhstan today, assuming a project-finance structure.

- Financing costs (the cost of equity and the cost of debt) are high in Kazakhstan. Based on interviews with investors, the present study estimates, for example, that the cost of equity for utility-scale wind energy and solar PV in Kazakhstan today is 16% (USD), compared with 7% in Germany. Investors in utility-scale renewable energy projects in Kazakhstan are also hindered by less attractive capital structures (equity to debt ratios).

- These higher financing costs reflect a range of investment risks for wind energy and solar PV in Kazakhstan (Figure 1, below). Four risk categories were found to contribute most to higher financing costs: (i) *power market risk,* related to limitations in the feed-in tariff mechanism and a lack of a bankable PPA, (ii) *counterparty risk,* that concerns the credit-worthiness of the Financial Settlement Centre, the electricity off-taker, (iii) *financial sector risk,* relating to the scarcity of capital from international and domestic markets, and (iv) *currency and macroeconomic risk,* related to the fluctuations in the Kazakh Tenge vis-a-vis hard currencies in which financing is denominated. A number of other risk categories also contribute to higher financing costs.

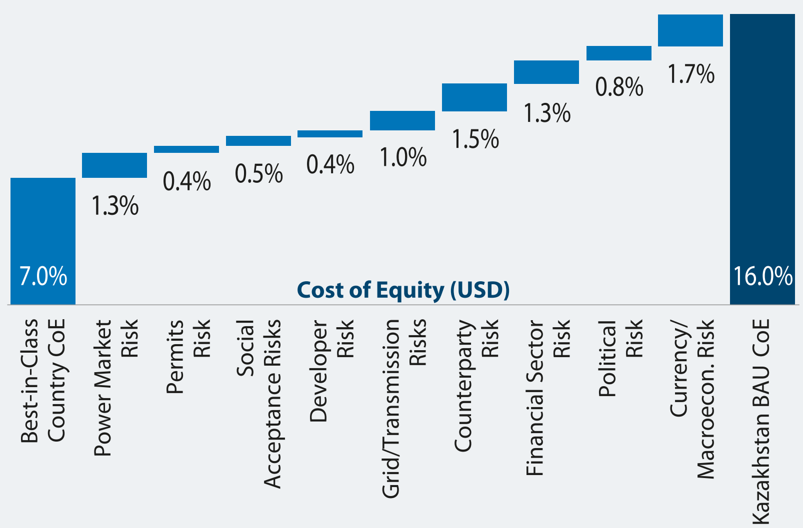
Public Derisking Measures

For wind energy and solar PV, the modelling examines the selection and cost-effectiveness of public derisking measures to meet the report's 2021 (5 year) investment targets. Public derisking measures can be understood as interventions by the government and its partners that address specific investment risks, in the form of policies, programmes or financial products.

A list of the targeted package of public derisking measures is set out and itemised in Table 1 (in body of the report). The modelling assumes the full package of measures is implemented, systematically targeting investment risks.

- For wind energy, (2021 investment target: 1 GW), the modelling estimates the cost of public derisking measures at USD 275.6 million until 2021. These derisking measures result in the following potential benefits:
  - Catalysing USD 1.6 billion in private sector investment in wind energy, while saving USD 310.6 million in avoided fossil fuel subsidies over the lifetime of the wind energy assets

Figure 1: Impact of risk categories on the cost of equity for wind energy and solar PV investments in Kazakhstan, business-as-usual scenario



Source: interviews with wind energy and solar PV investors and developers; modelling; best-in-class country is assumed to be Germany; see Annex B for details of assumptions and methodology.

- Lowering wind energy generation costs (LCOEs) due to derisking from USD 9.2 cents to USD 7.1 cents per kWh
- Creating economic savings related to derisking of wind energy of USD 804.7 million over 20 years[2]
- Reducing carbon emissions by 56.3 million tonnes of CO_2 over 20 years, relative to the baseline

• For solar PV, (2021 investment target: 250 MW), the modelling estimates the cost of public derisking measures at USD 54.1 million until 2021. When implemented, this results in the following benefits:

  - Catalysing USD 324.8 million in private sector investment in solar PV, while saving USD 33.3 million in avoided fossil fuel subsidies over the lifetime of the solar energy assets

- Lowering solar PV generation costs due to derisking from USD 16.9 cents to USD 13.0 cents per kWh
- Creating economic savings related to derisking of solar PV of USD 160.5 million over 20 years[2]
- Reducing carbon emissions by 6.0 million tonnes of CO_2 over 20 years, relative to the baseline

Investors further provided qualitative feedback identifying two priority derisking measures: first, a reformed feed-in-tariff or PPA bidding process, with a bankable PPA and tariffs indexed to a hard currency (addressing 'power market risk' and 'currency risk'); second, reform of the Financial Settlement Centre to increase its transparency and creditworthiness as an off-taker (addressing 'counterparty risk'). Investors communicated that these priority instruments are key to unlocking investment at scale.

Complementing the report's 2021 (5 year) investment targets, a summary of modelling results for the official 2030 targets can be found in the Annex A.

Conclusion

Today's investment environment for renewable energy in Kazakhstan reflects a number of investment risks that result in high financing costs. The report's methodology systematically identifies public derisking measures to target these risks, thereby lowering financing costs and resulting in lower generation costs.

The results demonstrate how investing in public derisking measures creates significant economic savings, both in meeting this report's 2021 (5 year) investment targets, as well as the official 2030 targets. The modelling clearly shows that investing in public derisking measures should in every case be more cost-effective for Kazakhstan, compared to an alternative of paying higher generation costs.

In recent years Kazakhstan has put in place a number of derisking measures to promote renewable energy. The opportunity for policymakers in Kazakhstan is to now pursue further derisking, both reforming the design of existing measures and implementing new measures, targeting unaddressed investment risks. By derisking the investment environment to meet this report's 2021 (5 year) targets, this can then kick-start the utility-scale investment flows necessary to achieve the official 2030 targets. The end result can be more reliable, affordable and clean power for Kazakh citizens.

[2] The savings figures quoted reflect the direct economic benefits from public derisking measures on utility-scale renewable energy, i.e. the aggregate difference in lower generation costs for renewable energy due to derisking over the 20 year lifetime of the asset. The savings figures do not include the indirect benefits accruing from avoided fossil fuel subsidies, assuming renewable energy substitutes for fossil-fuel based generation.

Executive Summary

Executive Summary

Introduction

The analysis set out in this report forms part of the United Nation Development Programme's (UNDP) support to the Republic of Kazakhstan in the implementation of the Global Environment Facility (GEF) financed project "Derisking Renewable Energy Investment". The project is expected to start implementation in the second half of 2017 and run through early 2022, targeting both utility-scale and small-scale renewable energy investments. The project aims to promote private sector investment to achieve the country's 2030 and 2050 targets for renewable energy.

This report focuses on the application of UNDP's "Derisking Renewable Energy Investment" methodology to utility-scale renewable energy investments. By systematically assessing the impact of investment risks alongside a menu of public derisking measures, the main objective of this study is to contribute to creating an enabled environment for wind and solar photovoltaic (PV) energy, two of the key technologies highlighted for achieving the government's long-term objectives. In doing so, the study also aims to enhance UNDP's collaboration with other international development organizations (including EBRD, IFC, ADB, and USAID) that are currently on the ground, working towards catalysing utility-scale renewable energy investments.

Context and Opportunity for Renewable Energy in Kazakhstan

Kazakhstan's power sector currently relies heavily on fossil fuels, reflecting the country's endowment with an abundance of oil, natural gas, and coal reserves. Total available capacity for electricity generation is 18.8 GW, with nearly 75% of the plants powered by locally-sourced coal (KEGOC, 2017). Rapid economic growth in the past decade has led to increases in electricity demand, but the country faces constraints in an aging generation and transmission infrastructure dating to the Soviet-era. Kazakhstan has some of the lowest retail tariffs in the world, a function of consumption subsidies for fossil fuels (estimated at USD 5.3 billion in 2014 (IEA, 2015), low cost generation from fully-depreciated power plants, and non cost-reflective tariff pricing. Kazakhstan is also characterised by regional imbalances in generation, notably in the south, resulting in supply disruptions and electricity imports from neighbouring countries.

Assisted by international actors (ADB, EBRD, IFC, UNDP, USAID), Kazakhstan has adopted a range of public measures to support development of renewable energy and in turn is attracting private sector interest. There has been interest over time from a range of investors, with a variety of interests (both strategic and financial), including parastatal actors, oil and gas multinationals, and private sector international and domestic developers. Nonetheless, utility-scale investment has been limited to date, amounting to 71 MW in wind energy and 57 MW in solar PV.

Kazakhstan is well positioned for investment with abundant wind resources and a compelling case for solar PV in the south, around Almaty. Increased investment in renewable energy can contribute to Kazakhstan's long-term vision to establish itself as a regional leader in green economic development, to its goal to diversify electricity generation away from oil and coal, and to reducing greenhouse gas emissions in line with its Intended Nationally Determined Contribution (INDC) under the UNFCCC. The overall opportunity for renewable energy is fully aligned with Kazakhstan's green economic vision at Expo 2017.

The Derisking Renewable Energy Investment Framework

In 2013, UNDP issued the Derisking Renewable Energy Investment report (the "DREI report") (UNDP, 2013). The DREI report introduced an innovative framework, with an accompanying methodology (the "DREI methodology") and financial tool in Microsoft Excel, to quantitatively compare the cost-effectiveness of different public instruments in promoting renewable energy investment. The analysis of Kazakhstan set out in this report is based on the DREI methodology.

A key focus of the DREI framework is on financing costs for renewable energy. While technology costs for renewable energy have fallen dramatically in recent years[3], private sector investors in renewable energy in developing countries still face high financing costs (both for equity and debt). These high financing costs reflect a range of technical, regulatory, financial and informational barriers and their associated investment risks. Investors in early-stage renewable energy markets, such as those of many developing countries, require a high rate of return to compensate for these risks[4].

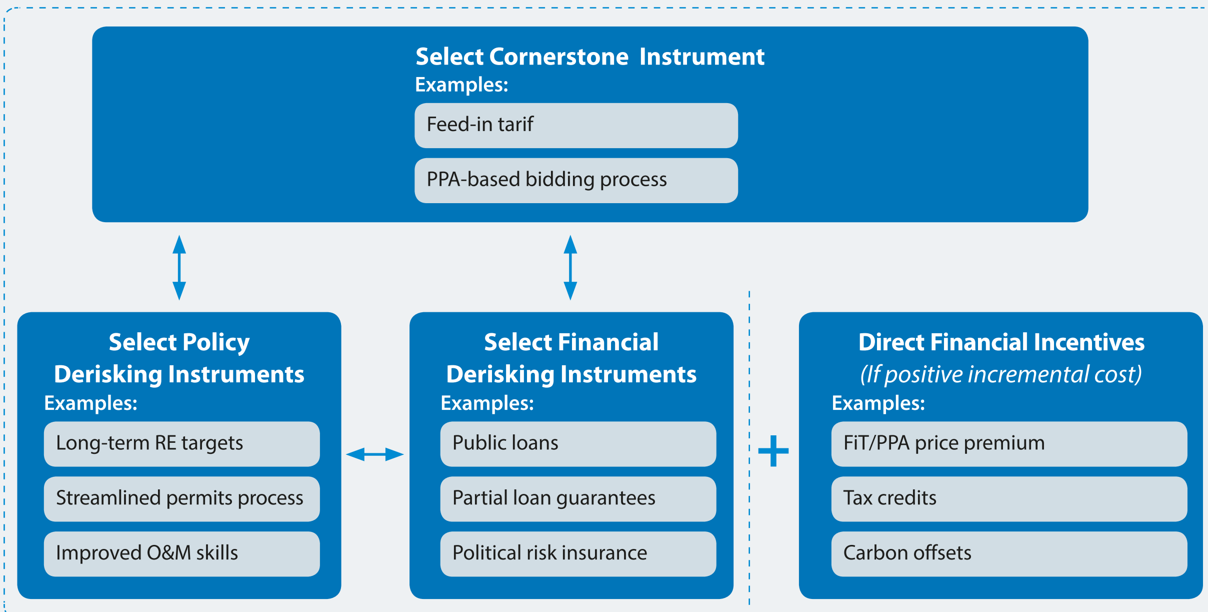
In seeking to create an enabled environment for private sector renewable energy investment, policy-makers typically implement a package of public instruments[5]. From a financial perspective, the public instrument package aims to achieve a risk-return profile for renewable energy that can cost-effectively attract private sector capital. Figure 2 below, from the DREI report, identifies the four key components of a public instrument package that can address this risk-return profile.

[3] For example, in the case of solar photovoltaic, module prices declined by around 80% between the end of 2009 and the end of 2015, while in the case of onshore wind energy, the installed cost went down by 7% each time that the cumulative installed capacity has doubled between of the of onshore wind between 1983 and 2014 (IRENA, 2016).

[4] Indeed, as is shown later in this report, interviews with project developers identified higher financing costs for wind energy and solar PV investment in Kazakhstan in comparison to Germany, a well-established market. For example, the cost of equity (USD-denominated) is estimated at 16% in Kazakhstan today, in comparison to 7% in Germany.

[5] Public instruments can be understood to be domestic government interventions in the form of policies and programmes. These instruments can be non-financial or financial in nature.

Figure 2: Typical components of a public instrument package for utility-scale renewable energy



Source: Derisking Renewable Energy Investment (UNDP, 2013)

The **cornerstone instrument** is the centrepiece of any public instrument package. For utility-scale renewable energy, the cornerstone instrument is typically a Feed-in Tariff (FiT) or a tendering process, either of which allows independent power producers (IPPs) to enter into long-term (e.g. 15-20 year) power purchase agreements (PPAs) for the sale of their electricity. The cornerstone instrument can then be complemented by three core types of public instruments:

- **Instruments that reduce risk,** by addressing the underlying barriers that are the root causes of investment risks. These instruments utilize policy and programmatic interventions. An example might involve a lack of transparency or uncertainty regarding the technical requirements for renewable energy project developers to connect to the grid. The implementation of a transparent and well-formulated grid code can address this barrier, reducing risk. The DREI methodology terms this type of instrument **"policy derisking"**.

- **Instruments that transfer risk**, shifting risk from the private sector to the public sector. These instruments do not seek to directly address the underlying barrier but, instead, function by transferring investment risks to public actors, such as development banks. These instruments can include public loans and guarantees, political risk insurance and public equity co-investments. For example, the credit-worthiness of a PPA may often be a concern to lenders. In order to address this, a development bank can guarantee the PPA, taking on this risk. The DREI methodology terms this type of instrument **"financial derisking"**.
- **Instruments that compensate for risk,** providing a financial incentive to investors in the renewable energy project. When risks cannot be reduced or transferred, residual risks and costs can be compensated for. These instruments can take many forms, including price premiums as part of the electricity tariff (either as part of a PPA or FiT), tax breaks and proceeds from the sale of carbon credits. The DREI methodology calls these types of instruments **"direct financial incentives"**.

Modelling Results

This report, using the DREI methodology, sets out the results of modelling to select public instruments to attract private sector investment in Kazakhstan to meet the report's investment targets for 2021 (5 years) of 1 GW in wind energy and 250 MW in solar PV. These targets can be viewed as the first, phased step to achieving the government's official 2030 targets of 5 GW in wind energy and 500 MW in solar energy, as set out in its Green Economy Concept Note (Republic of Kazakhstan, 2013)[6].

Risk Environment

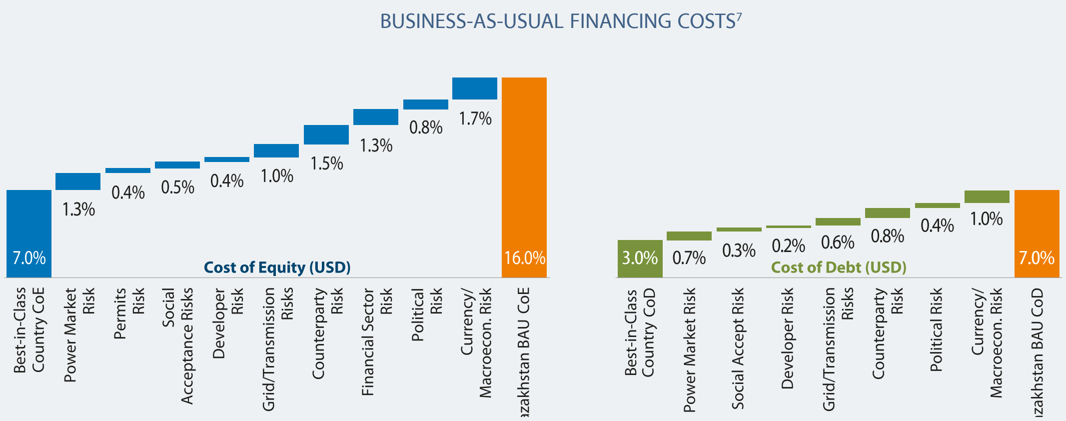
Data on the risk environment were obtained from 12 structured interviews held with domestic and international project developers and debt investors who are considering, or actively involved in, utility-scale wind energy and solar PV opportunities in Kazakhstan.

Based on the data from interviews, the report estimates that financing costs for wind energy and solar PV in Kazakhstan today are 16% (USD) for the cost of equity (CoE) and 7% (USD) for the cost of debt (CoD). These are substantially higher than in the best-in-class country, Germany, which are estimated at 7% CoE, and 3% CoD. Investors in utility-scale renewable energy projects in Kazakhstan are also hindered by less attractive capital structures (equity to debt ratios). Given the longevity of energy assets in general as well as the capital intensity of renewable energy investments in particular, the impact of Kazakhstan's higher financing costs on the competitiveness of wind energy and solar PV is significant.

[6] Adopted in 2013, the "Concept for Transition to a Green Economy", sets out the path for achieving Kazakhstan's "2050 Strategy," published in 2012, and covers various sectors, spanning from the power sector and energy efficiency to water and agriculture. In the power sector, the government's goal is to diversify its electricity generation sources away from coal and oil, and increase the share of alternative sources (e.g., solar, wind, hydro, and nuclear) to 30% by 2030 and 50% by 2050. For wind and solar PV, the 2030 targets are provided as 5GW and 500 MW, respectively.

Figure 3 shows how a range of investment risks currently contribute to these higher financing costs. The risk categories with the largest impact on elevated financing costs are (i) power market risk, relating to limitations in the feed-in tariff mechanism and a lack of a bankable PPA, (ii) counterparty risk, that concerns the credit-worthiness of the Financial Settlement Centre, the electricity off-taker, (iii) financial sector risk, relating to the scarcity of capital from international and domestic markets, and (iv) currency and macroeconomic risk, related to the fluctuations in the Kazakh Tenge vis-a-vis the currency in which financing costs are denominated. A number of other risk categories also contribute to higher financing costs.

Figure 3: Impact of risk categories on financing costs for wind energy and solar PV investments in Kazakhstan, business-as-usual scenario



Source: interviews with wind energy and solar PV investors and developers; modelling; best-in-class country is assumed to be Germany; see Annex B for details of assumptions and methodology.

[7] The financing cost waterfalls shown here are calculated by differentiating between the answers from equity and from debt investors, but not distinguishing further between investors with focus on wind energy and investors with focus on solar PV. It is recognized that the risk profiles of utility-scale wind energy and solar PV can differ, particularly with regard to technology risk. However, the results of the interviews with wind energy and solar PV investors made clear that these differences are minimal in the Kazakh context. As such, the interview answers from equity and from debt investors were not further split into 'wind energy focus' and 'solar PV focus' sub-groups, in order to bring simplicity to the analysis and to avoid multiple result sets.

Public Instrument Selection

The modelling then analyses the implementation of a package of public instruments, containing both policy and financial derisking instruments, to promote investment to achieve the report's 2021 (5 year) investment targets. The instruments are selected in order to specifically address the risk categories identified in the financing cost waterfalls. A list of these public derisking instruments is shown in Table 1. For wind energy, the costs until 2021 for policy derisking instruments are estimated as being USD 6.3 million, and for financial derisking instruments USD 269.3 million[8]. For solar PV, the policy derisking instruments are estimated as being USD 0.9 million, and the financial derisking instruments USD 53.2 million[9].

Table 1: The selection of public instruments to achieve the investment targets for wind energy and solar PV

RISK CATEGORY	POLICY DERISKING INSTRUMENTS	FINANCIAL DERISKING INSTRUMENTS
Power Market Risk	• Update transparent, long-term national renewable energy strategy • Establish and run IPP bidding process, with bankable PPA • Establish a renewable energy office in the regulator	NA
Permits Risk	• Streamlined process for RE permits (dedicated one-stop shop) • Contract enforcement and recourse mechanisms	NA
Social Acceptance Risk	• Awareness-raising campaigns	NA
Developer Risk	• Technology R&D • Support for industry associations	NA
Grid/Transmission Risk	• Strengthen KEGOC's grid management capacity • Transparent, up-to-date grid code • Policy support for long-term national transmission/grid road-map	• Take-or-pay clause in PPA[10]
Counterparty Risk	• Reform and maintain creditworthy Financial Settlement Centre structure	• Government guarantee for PPA payments • Public loans to IPPs
Financial Sector Risk	• Fostering financial sector reform towards green infrastructure investment • Strengthening financial sector's familiarity with renewable energy and project finance	• Public loans to IPPs
Political Risk	NA	NA
Currency/Macroeconomic Risk	NA	• Partial indexing of the PPA tariff to hard currencies[11]

Source: modelling. See Annex B for a full description of these instruments. "NA" indicates "Not Applicable".

[8] Different methodological approaches (e.g., face value, reserve, cost, no-cost) may be taken to costing financial derisking instruments. Here, a cost approach has been taken for the 'take or pay clause in PPA', 'government guarantee for PPA', and 'currency indexation', totaling USD 116.5 m; a reserve approach has been taken for 'public loans', totaling USD 152.8 m.

[9] Like in the case of wind energy (see previous footnote), for solar PV, too, a cost approach has been taken for the 'take or pay clause in PPA' , 'government guarantee for PPA', and 'currency indexation', totaling USD 22.7 m; a reserve approach has been taken for 'public loans', totaling USD 30.4 m.

[10] *A take-or-pay* clause is a clause found in a Power Purchase Agreement (PPA) that essentially allocates risk between parties in the scenario where transmission line failures or curtailment (required by the grid operator) result in the IPP being unable to deliver electricity generated by its renewable energy plant.

[11] *Partial indexing* involves tariffs in local-currency denominated PPAs being partially indexed to foreign hard currencies, such as USD or EUR. In this way, IPPs are partially protected against currency fluctuations. If a PPA tender process is used, IPPs can be asked to specify the minimum degree of partial indexing they require, thereby minimizing the public cost of this instrument.

Investors further provided qualitative feedback identifying two priority derisking measures: first, a reformed feed-in-tariff or PPA bidding process, with a bankable PPA and tariffs indexed to a hard currency (addressing 'power market risk' and 'currency risk'); second, reform of the Financial Settlement Centre to increase its transparency and creditworthiness as an off-taker (addressing 'counterparty risk'). Investors communicated that these priority instruments are key to unlocking investment at scale.

Levelised Costs

The modelling is then performed for two risk environment scenarios; first, *a business-as-usual* scenario, representing the current risk environment (with today's financing costs); and second, *a post-derisking scenario*, after implementing the public instrument packages (resulting in lower financing costs).

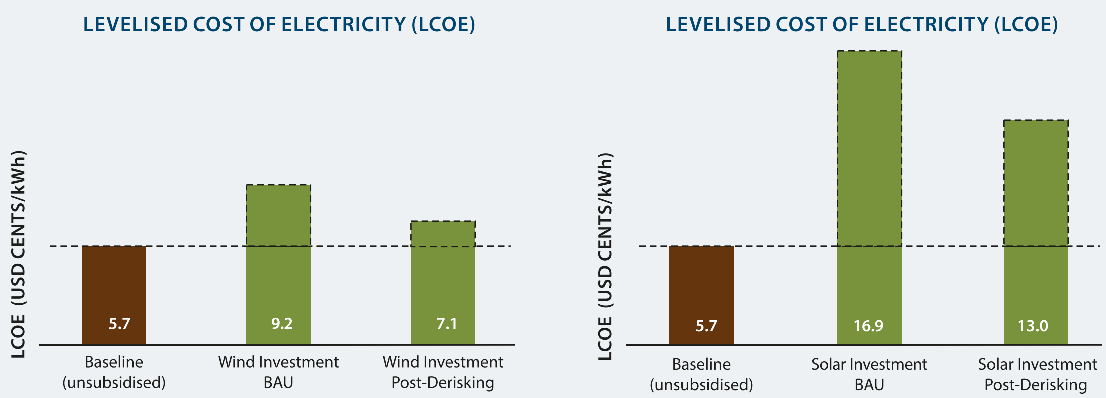
The results for generation costs, expressed as the Levelised Cost of Electricity (LCOE), are shown in Figure 4 below:

- In the *business-as-usual scenario*, wind energy and solar PV are more expensive than the baseline.
  - The baseline technology mix considers a 50:50 combined margin approach, representing 50% operating margin (existing coal plants) and 50% build margin, (new supercritical coal and combined cycle gas turbine (CCGT) gas plants)[12]. This approach results in baseline generation costs of USD 5.7 cents per kWh, assuming unsubsidised fuel costs (see Annex B)[13].
  - In comparison, wind energy LCOE in the business-as-usual scenario is estimated at USD 9.2 cents per kWh, and solar PV LCOE at USD 16.9 cents per kWh. This means that both wind energy and solar PV require a price premium (USD 3.5 cents per kWh and USD 11.2 cents per kWh, respectively) over the baseline energy technology mix.
- In the *post-derisking scenario,* the cost of wind energy falls to USD 7.1 cents per kWh, and the cost of solar PV falls to USD 13.0 cents per kWh. As such, following government interventions to derisk the investment environment, and with resulting lower financing costs, the price premium for wind energy and solar PV is reduced by roughly 60% and 35%, respectively.

[12] In doing so, the model assumes that Kazakhstan will add new super-critical coal and CCGT plants to increase its electricity generation capacity, and existing sub-critical coal plants could be partly replaced by wind energy or solar PV. In other words, renewable energy is compared to a generation mix that is partly composed of yet-to-be-built new technology (build margin) and of existing technology that were to be replaced (operating margin).

[13] Fuel costs are unsubsidised and are calculated following the IEA's opportunity cost approach. This approach does not use actual fuel prices in a given country, but rather considers the value of that fuel if it was sold on the global market (see Schmidt et al, 2012).

Figure 4: LCOEs for the baseline, wind energy (left) and solar PV (right) investment in Kazakhstan



Source: modelling; see Annex B for details of assumptions and methodology

Evaluation of public instruments' effectiveness

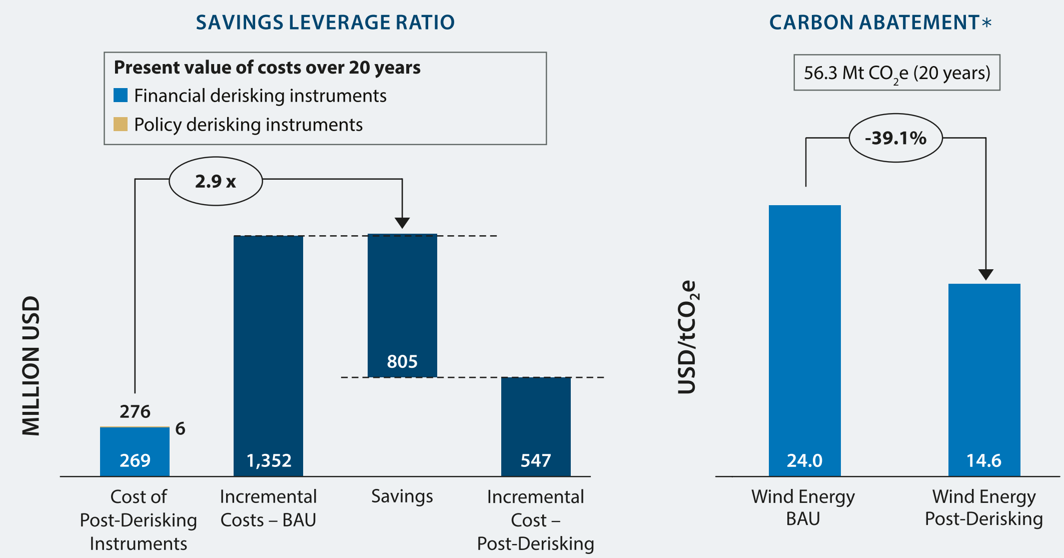
The DREI methodology uses four performance metrics to analyse the impacts of the selected public instrument package to promote investment, each metric taking a different perspective: the ability to catalyse investment (leverage ratio); the economic savings generated for society (savings ratio); the resulting electricity price for end-users (affordability); and the efficiency in mitigating greenhouse gas emissions (carbon abatement).

Figure 5 shows the results for two out of the four performance metrics, namely the savings leverage ratio and carbon abatement for wind energy:

- *The savings leverage* ratio compares the cost of derisking instruments deployed to the economic savings that result from deploying these instruments. In the *business-as-usual* scenario, the modelling estimates that a price premium (incremental cost) totalling USD 1.4 billion will be required over the next 20 years to achieve the report's 2021 (5 year) target. In the *post-derisking* scenario, the incremental cost falls to USD 546.8 million, saving the economy USD 804.7 million over the 20-year lifetime of the investments. Given that public derisking instruments costing USD 275.6 million are required to achieve this, this equates to a savings ratio of 2.9x, demonstrating that the benefits of lower price premiums outweigh the cost of derisking.

- The *carbon abatement ratio* is an environmental effectiveness indicator. Achieving the 2021 target of 1 GW in wind energy is estimated to result in a total reduction of 56.3 million tonnes of CO_2e over the lifetime of the wind plants. In the *business-as-usual* scenario, the abatement cost of the investment in wind energy is USD 24.0 per tonne of CO_2e. Or, in other words, the cost of public instruments (the price premium for wind) equates to USD 24.0 for every tonne of CO_2e reduced by the investment in wind energy. In the *post-derisking* scenario, this cost falls to USD 14.6 per tonne of CO_2e. This performance metric is helpful in terms of understanding a carbon price that is necessary to promote investment, and in comparing the relative costs of different low-carbon options.

Figure 5: Performance metrics for the selected package of derisking instruments in promoting 1 GW of wind energy investment in Kazakhstan

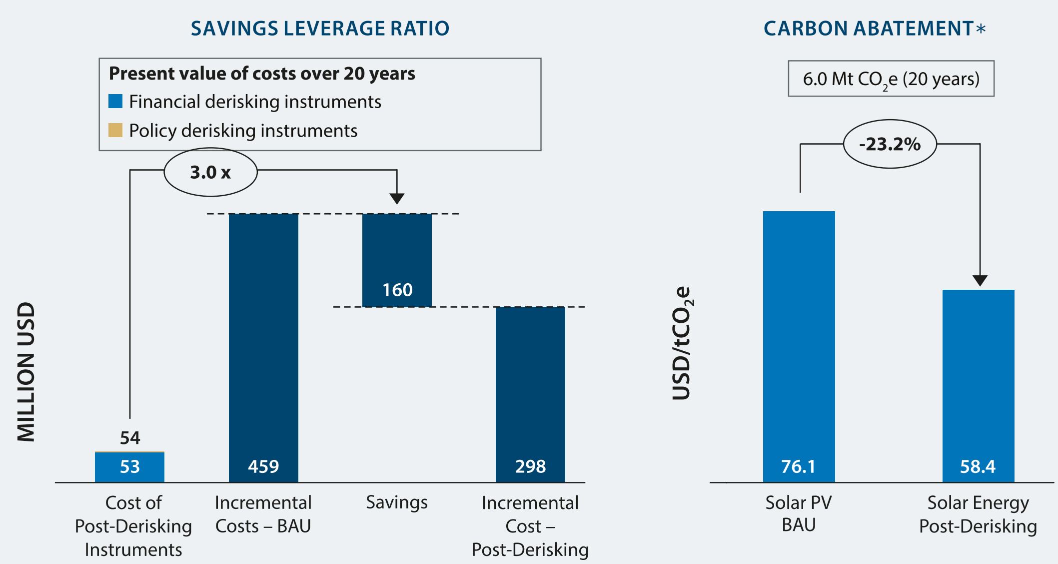


Source: modelling; see Annex B for details of assumptions and methodology

* The Carbon Abatement metric can be broken down into the costs of policy derisking instruments, financial derisking instruments and the price premium. While in the BAU scenario, the total of USD 24.0 per tCO_2e is due to the price premium, in the post-derisking scenario, this breakdown for the total of USD 14.6 per tCO_2e is USD 0.1, USD 4.8 and USD 9.7, respectively.

Figure 6 shows selected results for solar PV in Kazakhstan, with the 2021 target of 250 MW of utility-scale solar PV private sector investment. The savings leverage ratio is at 3.0x, once again indicating that derisking measures are efficient, resulting in savings of USD 160.5 million. Carbon abatement costs also fall by 23% from USD 76.1 to USD 58.4 per tonne of CO_2e.

Figure 6: Performance metrics for the selected package of derisking instruments in promoting 250 MW of solar PV investment in Kazakhstan



Source: modelling; see Annex B for details of assumptions and methodology.

* The Carbon Abatement metric can be broken down into the costs of policy derisking instruments, financial derisking instruments and the price premium. While in the BAU scenario, the total of USD 76.1 per tCO_2e is due to the price premium, in the post-derisking scenario, this breakdown for the total of USD 58.4 per tCO_2e is USD 0.2, USD 8.8 and USD 49.5, respectively.

Sensitivities

Sensitivity analyses can assist in gaining a better understanding of the robustness of the outputs and to be able to test different scenarios.

Highlights from the sensitivity analyses are the following:

- *Avoided fossil fuel subsidies*. Renewable energy investment have the opportunity to displace a significant amount of fossil-based power, and in this way Kazakhstan can benefit from avoided subsidies that would otherwise be made to fossil-fuel based power. According to the IEA, in 2014, Kazakhstan's subsidies to coal and natural gas were USD 1.7 billion and USD 0.5 billion, respectively (IEA, 2015). For instance, if 1 GW of wind energy is installed, the present value of avoided fossil fuel subsidies over the lifetime of the wind energy assets is estimated at USD 310.6 million. For wind energy, the savings from avoided subsidies can meaningfully offset the cost of public derisking instruments.

- *Baseline approach.* The methodological approach to baselines – whether a combined, operating or build margin – is highly impactful on the modelling results. The base case approach is a 50:50 combined margin baseline, with 50% operating margin (existing coal plants) and 50% build margin (new coal and new gas plants). Alternative approaches lead to different results:

    - If a build margin baseline of 50% new coal and 50% new natural gas plants is selected, the present value of premium payments for 20 years for wind energy is reduced from USD 546.8 million (combined margin) to USD 54.5 million.

    - If a build margin with 100% new coal plants is selected, wind energy's LCOE becomes lower cost than the baseline, removing the need for premium payments.

- *Instrument cost-effectiveness.* The sensitivities on public instrument selection show how implementing public derisking instruments is always more cost effective than paying higher generation costs, across all scenarios.

Conclusions

The results in this report should not be interpreted as a definitive quantitative analysis of wind energy and solar PV in Kazakhstan but, rather, as one contribution to the larger policy decision-making process.

The results confirm that financing costs for wind energy and solar PV in Kazakhstan are currently high, particularly in comparison to countries with more favourable investment environments. The cost of equity for wind energy and solar PV in Kazakhstan today is estimated at 16% (USD), and the cost of debt at 7% (USD). The modelling evaluates nine different risk categories regarding their contribution to these higher financing costs in Kazakhstan. Five of these risk categories contribute to more than 1% point (100 basis points) to high financing costs. These include power market risk, grid/transmission risk, counterparty risk, financial sector risk, and currency and macroeconomic risk.

The results identify a comprehensive package of public derisking measures to achieve the report's 2021 (5 year) investment objectives for wind and solar PV in the near-term. These targets can be viewed as the first, phased step to achieving the government's official 2030 targets of 5GW in wind energy and 500MW in solar energy, as set out in its *Green Economy Concept Note* (Republic of Kazakhstan, 2013). These public derisking measures, consisting of a collection of policy and financial instruments, systematically target the identified investment risk categories. Table 1 itemises each of the measures. The modelling also estimates the public cost of these measures until 2021.

A key conclusion from the modelling is that investing in derisking instruments is a cost-effective approach for achieving Kazakhstan's wind and solar PV investment objectives. The derisking measures that are modelled bring down the generation cost of wind energy from USD 9.2 cents per kWh to USD 7.1 cents per kWh, and solar PV energy from USD 16.9 cents per kWh to USD 13.0 cents per kWh.

- For wind energy, in the *business-as-usual* scenario, the modelling estimates that a premium price totalling USD 1.4 billion will be required over the next 20 years to achieve the 2021 target. However, if over the same period a total investment of USD 275.6 million is made in derisking measures, wind energy will become 23% cheaper and the price premium price reduces to USD 546.8 million, thereby saving USD 804.7 million in generation costs over the next 20 years.

- For solar PV, in the *business-as-usual* scenario, the modelling estimates that a premium price totalling USD 458.9 million will be required over the next 20 years to achieve the 2021 target. However, if over the same period a total investment of USD 54.1 million is made in derisking measures, solar PV will also become 23% cheaper and the price premium price reduces to 298.5 million, thereby saving USD 160.5 million in generation costs over the next 20 years.

The results demonstrate how investing in public derisking measures creates significant economic savings, both in meeting this report's 2021 (5 year) investment targets, as well as the official 2030 targets. The modelling clearly shows that investing in public derisking measures should in every case be more cost-effective for Kazakhstan, compared to an alternative of paying higher generation costs.

In recent years Kazakhstan has put in place a number of derisking measures to promote renewable energy. The opportunity for policymakers in Kazakhstan is to now pursue further derisking, both reforming the design of existing measures and implementing new measures, targeting unaddressed investment risks. By derisking the investment environment to meet this report's 2021 (5 year) targets, this can then kick-start the utility-scale investment flows necessary to achieve the official 2030 targets. The end result can be more reliable, affordable and clean power for Kazakh citizens.

1. Introduction

Introduction

1

The analysis set out in this report forms part of the United Nation Development Programme's (UNDP) support to the Republic of Kazakhstan in the implementation of the Global Environment Facility (GEF) financed project *"Derisking Renewable Energy Investment"*. The project is expected to start implementation in the second half of 2017 and run through early 2022, targeting both utility-scale and small-scale renewable energy investments. The project aims to promote private sector investment to achieve the country's 2030 and 2050 targets for renewable energy.

To date, Kazakhstan has adopted a number of important initiatives, including a FiT in 2014, to support development of renewable energy, thereby increasing investor interest in such projects. So far, the investment in utility-scale renewable energy has been limited: In wind energy, 71 MW of investment has been made, while in solar PV, this figure is at 57 MW.

This report focuses on the application of UNDP's "Derisking Renewable Energy Investment" methodology to utility-scale renewable energy investments in Kazakhstan. By systematically assessing the impact of investment risks alongside a menu of public derisking measures, the main objective of this study is to contribute to creating an enabled environment for wind and solar photovoltaic (PV) energy, two of the key technologies highlighted for achieving the government's long-term objectives.

In doing so, the study also aims to enhance UNDP's collaboration with other international development organizations (including EBRD, IFC, ADB, and USAID) that are currently on the ground, working towards catalysing utility-scale renewable energy investments in Kazakhstan through programmes aimed at policy and legislative support as well as directly investing in private renewable energy projects.

2. Overview of the Derisking Renewable Energy Investment Methodology

- 2.1 The impact of high financing costs on renewable energy
- 2.2 Identifying a public instrument mix to promote renewable energy
- 2.3 The methodology's four stage structure

Overview of the Derisking Renewable Energy Investment Methodology

2

METHODOLOGY

In 2013, UNDP issued the *Derisking Renewable Energy Investment* report (the "DREI report") (UNDP, 2013)[14]. The report introduced an innovative framework, with an accompanying methodology (the "DREI methodology") and financial tool in Microsoft Excel, to quantitatively compare different public instruments for promoting renewable energy investment. This section provides an overview of the following aspects of the DREI methodology:

- The framework's focus on financing costs for renewable energy
- The framework's approach to identifying a public instrument mix
- The methodology's 4-stage structure

For more detailed information on the DREI framework, please see the full DREI report.

2.1 THE IMPACT OF HIGH FINANCING COSTS ON RENEWABLE ENERGY

A key focus of the DREI framework is on financing costs for renewable energy. While technology costs for renewable energy have fallen dramatically in recent years[15], private sector renewable energy investors in developing countries still face high financing costs (both for equity and debt). These high financing costs reflect a range of technical, regulatory, financial and informational barriers and their associated investment risks. Investors in early-stage renewable energy markets, such as those of many developing countries, require a high rate of return to compensate for these risks.

Figure 7 below, from the DREI report, illustrates how these high financing costs can impact the competitiveness of renewable energy. The figure shows the results of UNDP modelling to compare the levelised cost of electricity (LCOE) of onshore wind energy and combined-cycle gas in a low and high financing cost environment. The analysis assumes cost of equity of 7% and cost of debt of 3% in the low financing cost environment, and a cost of equity of 16% and a cost of debt of 8% in the high financing cost environment. All modelling assumptions (investment costs, operational costs, capacity factors) are kept constant between the two environments – the only assumption that is varied is that relating to financing costs.

[14] Available for download at www.undp.org/DREI

[15] For example, in the case of solar photovoltaic, according to data from Bloomberg New Energy Finance, module costs experienced a 99 percent reduction between 1977 and 2013 (WEC, 2013).

In a country benefiting from low financing costs, wind power (at USD 6.2 cents per kWh) can be almost cost-competitive with gas (at USD 6.3 cents per kWh). However, in a country with higher financing costs, wind power generation (at USD 9.2 cents per kWh) becomes 49 percent more expensive than in a country with low financing costs. In contrast, gas (at USD 6.7 cents per kWh) becomes only 5 percent more expensive due to these same higher financing costs. As such, in the country with high financing costs, wind power is no longer competitive with gas.

The sensitivity of wind power – and many other forms of renewable energy (Schmidt, 2014) – to financing costs is due to the high upfront capital intensity of renewable energy. Renewable energy's upfront capital intensity is a function of its required initial investment in equipment, for example wind turbines and solar panels. Following this initial investment, renewable energy typically has very low operating costs and does not require any fuel costs. Fossil fuel based energy generation typically has the reverse profile, with low upfront costs and high operating costs and fuel costs[16]. The end result is that high financing cost environments penalize renewable energy when compared to fossil-fuel based power generation.

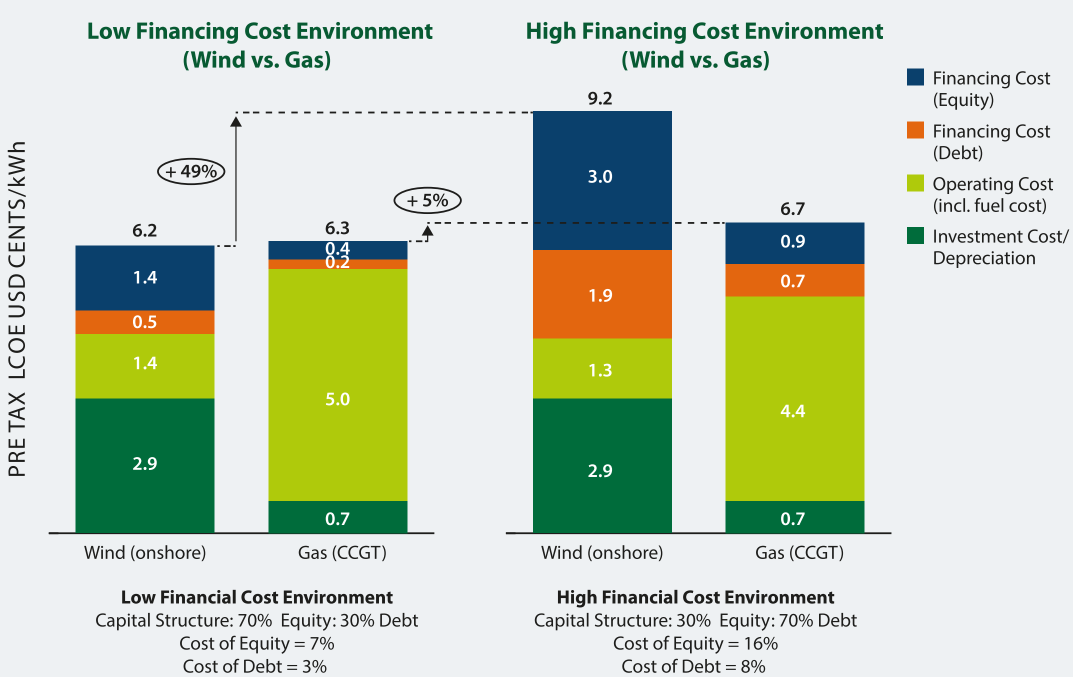
The theory of change underlying the DREI methodology is that one of the main challenges for scaling-up renewable energy technologies in countries with high financing costs is to lower the financing costs that affect renewables' competitiveness against fossil fuels. As these higher financing costs reflect barriers and associated risks in the investment environment, the key entry point for policy-makers promoting renewable energy is to address these risks and therefore lower overall life-cycle costs.

All assumptions besides the financing costs are kept constant between the low and high financing cost environments. Wind energy technology assumptions: investment cost: 1,520,000 USD/MW, O&M: 31,600 USD/MW/year, capacity factor: 30%, annual inflation: 2%; Gas (CCGT) assumptions: investment cost: 910,000 USD/MW, O&M: 35,100 USD/MW/year, full load hours: 5,000/year, fuel efficiency: 58%, annual Inflation: 2%; fuel costs are projected using IEA's New Policies Scenario, based on 2016 EU Import Prices for Natural Gas as the starting point. For more detail on data sources, please refer to Annex B.

Operating costs appear as a lower contribution to LCOE in developing countries due to discounting effects from higher financing costs.

[16] For example, based on the analysis shown in Figure 7, investment costs account for approximately 80% of the total lifetime technology costs for wind energy but only account for around 20% of such costs in the case of gas. See Annex B of the DREI report for assumptions.

Figure 7: Comparing wind energy and gas LCOEs in low and high financing cost environments



Source: Derisking Renewable Energy Investment (UNDP, 2013), subsequently updated as of 2017

2.2 IDENTIFYING A PUBLIC INSTRUMENT MIX TO PROMOTE RENEWABLE ENERGY

In seeking to create an enabled investment environment for renewable energy, policy-makers typically implement a package of public instruments. Identifying an appropriate combination of instruments can be highly challenging. Moreover, these public instruments can come at a cost – to industry, to consumers or to the tax-payer.

All assumptions besides the financing costs are kept constant between the low and high financing cost environments. Wind energy technology assumptions: investment cost: 1,520,000 USD/MW, O&M: 31,600 USD/MW/year, capacity factor: 30%, annual inflation: 2%; Gas (CCGT) assumptions: investment cost: 910,000 USD/MW, O&M: 35,100 USD/MW/year, full load hours: 5,000/year, fuel efficiency: 58%, annual Inflation: 2%; fuel costs are projected using IEA's New Policies Scenario, based on 2016 EU Import Prices for Natural Gas as the starting point. For more detail on data sources, please refer to Annex B. Operating costs appear as a lower contribution to LCOE in developing countries due to discounting effects from higher financing costs.

From a financial perspective, the overall aim for policy-makers in assembling a public instrument package is to achieve a risk-return profile for renewable energy that can cost-effectively attract private sector capital. Figure 8 below, from the DREI report, identifies the four key components of a public instrument package that can address this risk-return profile.

The cornerstone instrument is the centrepiece of any public instrument package. While there are tens, if not hundreds, of public instruments, only a select handful of instruments have shown themselves to be highly effective at transforming markets. For utility-scale renewable energy, the cornerstone instrument is typically a Feed-in Tariff (FiT) or a Power Purchase Agreement (PPA) tender process, either of which allows independent power producers (IPPs) to enter into long-term (e.g. 15-20 year) power purchase agreements with grid operators.

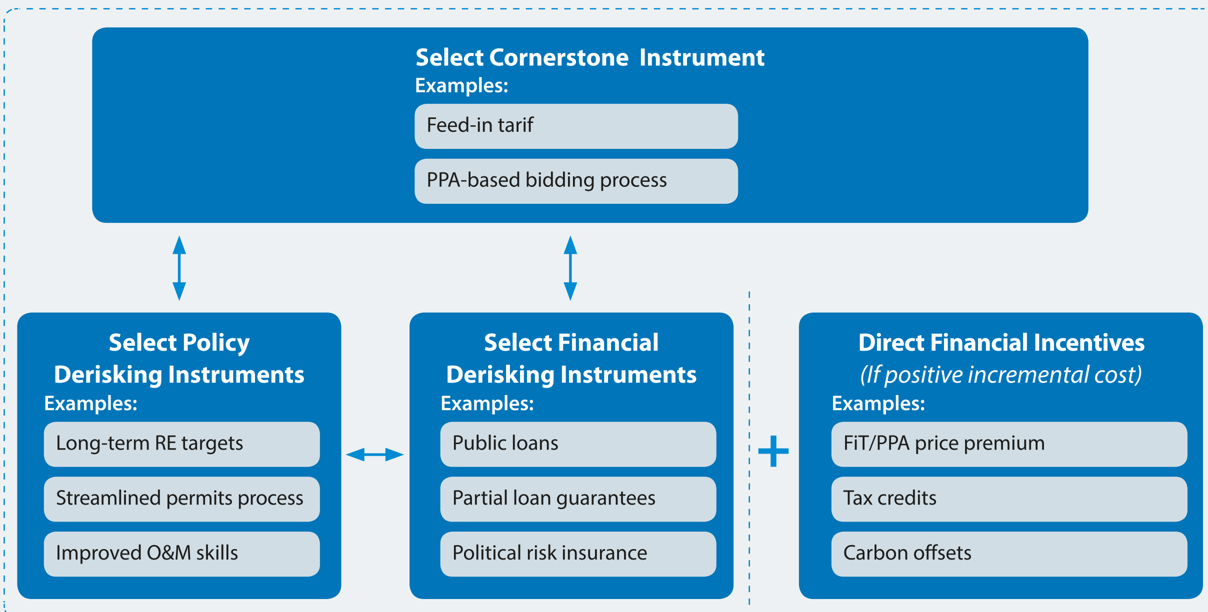
The **cornerstone instrument** can then be complemented by three core types of public instruments:

- **Instruments that reduce risk**, by addressing the underlying barriers that are the root causes of investment risks. These instruments utilise policy and programmatic interventions. An example might involve a lack of transparency or uncertainty regarding the technical requirements for renewable energy project developers to connect to the grid. The implementation of a transparent and well-formulated grid code can address this barrier, reducing risk. The DREI methodology terms this type of instrument **"policy derisking".**

- **Instruments that transfer risk**, shifting risk from the private sector to the public sector. These instruments do not seek to directly address the underlying barrier but, instead, function by transferring investment risks to public actors, such as development banks. These instruments can include public loans and guarantees, political risk insurance and public equity co-investments. For example, the credit-worthiness of a PPA may often be a concern to lenders. A development bank guarantee can provide banks with the security to lend to project developers. The DREI methodology terms this type of instrument **"financial derisking".**

- **Instruments that compensate for risk**, providing a financial incentive to investors in the renewable energy project. When risks cannot be reduced or transferred, residual risks and costs can be compensated for. These instruments can take many forms, including price premiums (either as part of a PPA or FiT), tax breaks, and proceeds from the sale of carbon credits. The DREI methodology calls these types of instruments **"direct financial incentives".**

Figure 8: Typical components of a public instrument package for utility-scale renewable energy



Source: Derisking Renewable Energy Investment (UNDP, 2013)

2.3 THE METHODOLOGY'S FOUR STAGE STRUCTURE

The DREI report sets out a detailed methodology, together with a financial tool in Microsoft Excel, to support policy decision-making by quantitatively comparing different public instrument portfolios and their impacts.

Selecting public instruments for renewable energy is highly dependent on national circumstances. Each country has its own particular renewable resources, objectives and constraints. Therefore, the methodology is designed to be applied flexibly and to be tailored to a specific renewable energy technology and national context. As illustrated in Figure 9, the methodology is organised into a framework with four stages, each of which is, in turn, divided into two steps.

- **Stage 1: Risk Environment** identifies the set of investment barriers and associated risks relevant to the renewable energy technology, and analyses how the existence of investment risks can increase financing costs.
- **Stage 2: Public Instruments** selects a mix of public derisking instruments to address the investor risks and quantifies how they, in turn, can reduce financing costs. This stage also determines the cost of the selected public derisking instruments.
- **Stage 3: Levelised Cost** determines the degree to which the reduced financing costs impact the renewable energy life-cycle cost (LCOE). This is then compared against the current baseline generation costs in the country.
- **Stage 4: Evaluation** assesses the selected public derisking instrument mix using four performance metrics, as well as through the use of sensitivity analyses. The four metrics are: (i) investment leverage ratio, (ii) savings leverage ratio, (iii) end-user affordability and (iv) carbon abatement.

The intent of the methodology is not to provide one predominant numerical result but is, instead, to facilitate a structured and transparent process whereby key inputs and assumptions are made explicit, so that they can contribute to and inform the design process.

Figure 9: Overview of the DREI methodology for selecting public instruments to promote renewable energy investment

	Step 1	Step 2
Stage 1: Risk Environment	• Determine a multi-stakeholder barrier and risk table for the renewable energy investment	• Quantify the impact of risk categories on increased inancing costs
Stage 2: Public Instruments	• Select one or more public derisking instrument(s) to mitigate the identiied risk categories	• Quantify the impact of the public derisking instrument(s) to reduce inancing costs • Quantify the public costs of the public derisking instrument(s)
Stage 3: Levelised Cost	• Calculate the levelised cost of electricity (LCOE) for the baseline energy generation mix in the particular country	• Quantify the LCOE for renewable energy investment in the (i) pre-derisking and (ii) post-derisking scenarios • Calculate the incremental cost (or savings) by comparing these scenarios vs. the baseline
Stage 4: Evaluation	• Analyse the selected public instrument(s) in terms of four key performance metrics	• Perform sensitivity analyses on key inputs and assumptions

Source: Derisking Renewable Energy Investment (UNDP, 2013)

3. Current Status of Wind Energy and Solar PV in Kazakhstan

Current Status of Wind Energy and Solar PV in Kazakhstan

3

Kazakhstan General Country Data[17]	
Population 2015:	17.5 m
Land Area:	2,724,902 sq. km
GDP 2015 (USD):	$184.4 billion
GDP/capita (USD) 2015:	$10,508
Sovereign rating 2016:	Negative outlook, Baa3 (Moody's), BBB- (S&P)
UNDP HDI 2015:	0.794 (56th of 188)
WB Ease of Doing Business (2017):	35th of 190

This section provides a brief overview of the current context, status and objectives for wind energy and solar PV in Kazakhstan.

2021 Targets for Wind Energy and Solar PV

The opportunity for renewable energy in Kazakhstan is strong. Kazakhstan is well positioned for investment, with abundant wind resources, and a compelling case for solar PV in the south, around Almaty. Increased investment in renewable energy can contribute to Kazakhstan's long-term vision to establish itself as a regional leader in green economic development, to its goal to diversify electricity generation away from oil and coal, and to reducing greenhouse gas emissions in line with its Intended Nationally Determined Contribution (INDC) under the UNFCCC[18]. The overall opportunity for renewable energy is also fully aligned with Kazakhstan's green economic vision at Expo 2017.

The Government of Kazakhstan's long term objectives for renewable energy have been outlined in its *Concept for Transition to a Green Economy* (Republic of Kazakhstan, 2013). The country is aiming to achieve 5.5 GW of installed capacity in renewables in 2030, and 13 to 30 GW by 2050, depending on the level of energy demand and gas prices. Of this, wind and solar PV are targeted to contribute to 5 GW and 500 MW of installed capacity by 2030, respectively.

This report assumes 2021 (5 year) private sector investment targets of 1 GW in wind energy and 250 MW in solar PV. These targets can be viewed as the first, phased step to achieving the government's official 2030 targets. Complementing the report's 2021 targets, a summary of modelling results for the official 2030 targets can be found in Annex A.

Power Sector Context

Kazakhstan's power sector can be characterised by a dominant role for fossil fuels, coupled with an aging generation and transmission infrastructure.

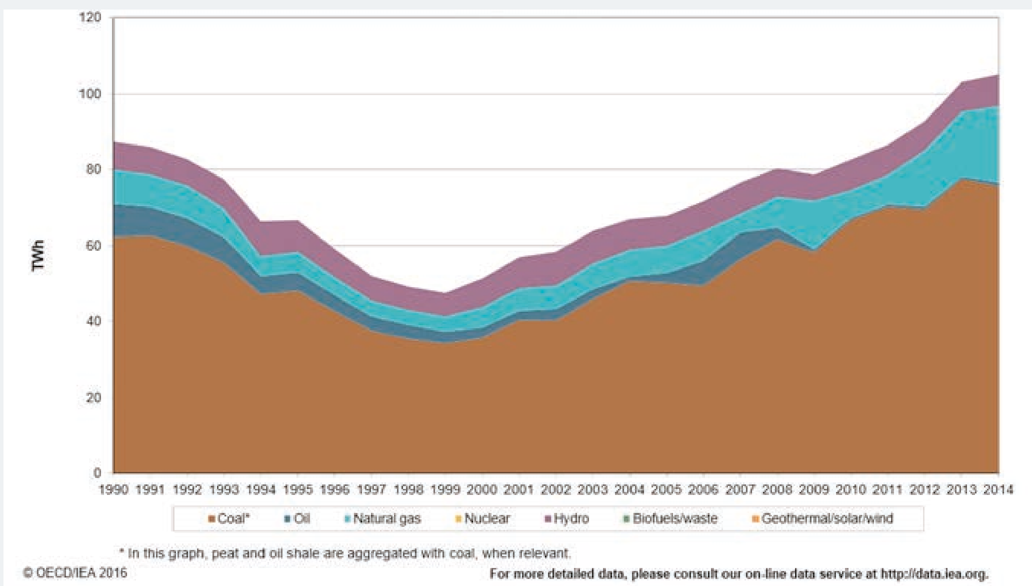
Kazakhstan's power sector currently reflects the country's endowment with an abundance of oil, natural gas, and coal reserves. Total installed capacity of the country's 118 power plants is 22.1 GW, while official available capacity is 18.8 GW (KEGOC, 2017). Nearly 75% of the plants are powered by locally sourced coal, followed by gas and oil. Renewable energy currently accounts for less than 1% of the electricity produced in Kazakhstan, which is predominantly hydro power (both large and small-scale).

[17] Sources: The World Bank – World Development Indicators Database, January 2017; The World Bank, Doing Business, April 2017; Moody's, Standard & Poor's; UNDP.

[18] With coal dominating its energy sector, Kazakhstan is also the largest emitter of greenhouse gases (GHGs) in Central Asia and it has one of the world's highest GHG emissions per capita. For its Intended Nationally Determined Contribution (INDC), Kazakhstan has pledged to reduce greenhouse gas emissions by 15%-25% by 2030.The higher "conditional target of 25% (by 31 December 2030) is subject to additional international investments, access to low carbon technologies, climate funds and use of the flexibility mechanism for countries with economies in transition (Kazakhstan National Inventory Report to UNFCCC, 2014).

Rapid economic growth in the past decade has led to increases in electricity demand, but the country faces the constraints of an aging generation and transmission infrastructure dating to the Soviet-era. As of 2013, network losses amounted to 12.9% of generation, and 57% of the power grid was deteriorated and in need of renewal[19]. Imbalances in the generation/transmission infrastructure in certain regions, particularly the south, can result in supply disruptions, and electricity imports from neighbouring countries to meet increases in demand during peak loads.

Figure 10: Electricity generation by fuel in Kazakhstan (1990 to 2014)



Source: OECD/IEA (2016)

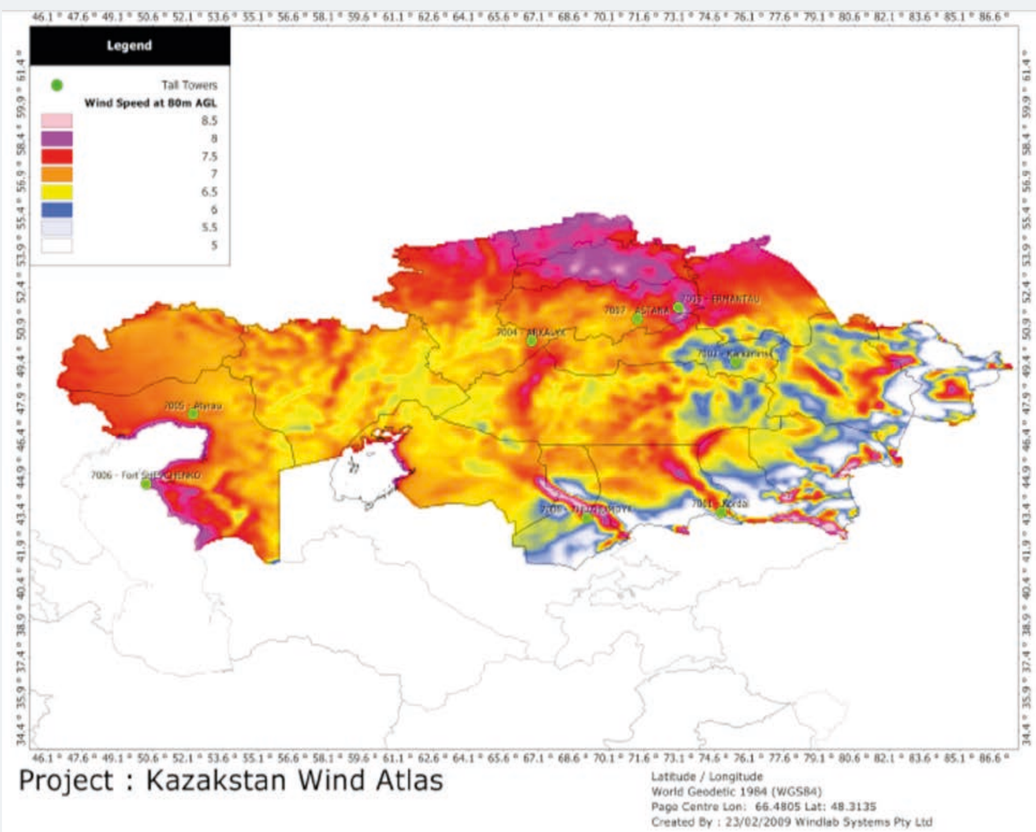
With coal dominating its energy sector, and an aging fleet of power plants, Kazakhstan has very low electricity generation costs. Retail end-user tariffs are also not cost-reflective, and commercial tariffs cross subsidise residential tariffs (Karatayev & Clarke, 2015). In addition, consumption subsidies for fossil fuels and the low cost of generation from fully-depreciated power plants result in tariffs that are among the lowest in the world. It is estimated total fossil fuel subsidies in 2014 were USD 5.3 billion, which represented about 2.5% of the country's GDP in that year (IEA, 2015).

[19] The Concept for Development of Power Sector in Kazakhstan until 2030 approved on 28th of June 2014 N724. This includes an action plan for power sector development up until 2030, with measures to modernize and reconstruct existing energy system and outlines the trends and targets for sector development

Renewable Energy Resources

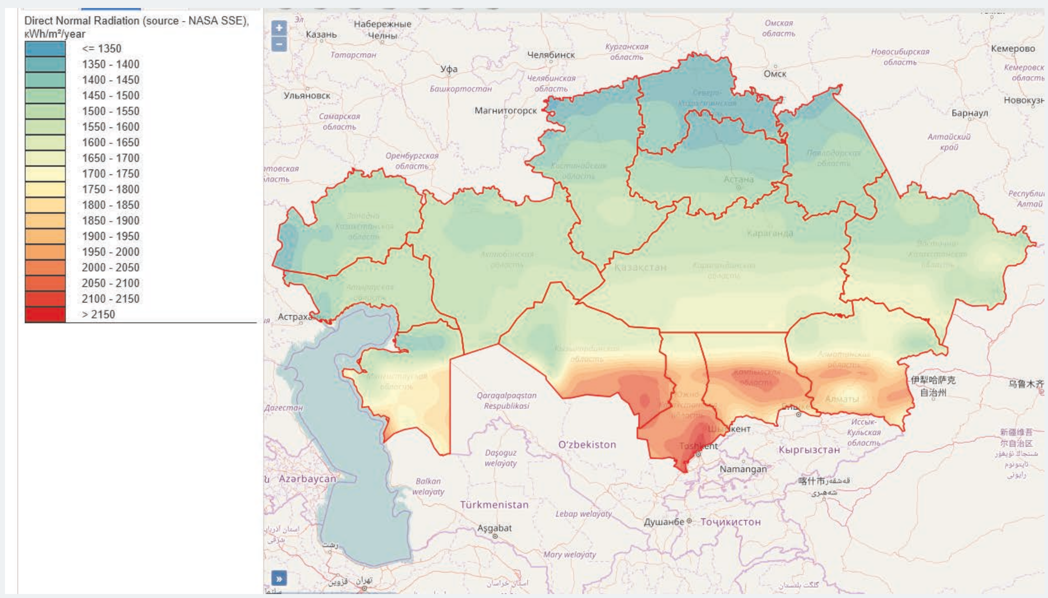
Kazakhstan has abundant wind energy resources. The UNDP project "Kazakhstan - Wind Power Market Development Initiative" identified many sites within the country with annual wind speeds of 6 m/s and above, with the strongest potential in the Caspian Sea, central and northern regions. The estimated economical potential for wind energy is about 760 GW (Karatayev and Clarke, 2016). The country also offers potential for solar PV investments, especially in the south with its higher levels of irradiation. Coupled with readily available transmission infrastructure, this makes the Almaty region particularly suitable. Kazakhstan also has the world's second largest reserves of silicon suitable for the production of solar cells. Figure 11 and Figure 12 show wind and solar resource maps for Kazakhstan, respectively.

Figure 11: Resource map for wind energy in Kazakhstan



Source: UNDP (2009)

Figure 12: Resource map for solar energy in Kazakhstan



Source: UNDP (2017)

For the 2017-2021 investment period, the modelling uses a capacity factor of 35% for wind energy, and 15% for solar PV.

Current Status of Wind and Solar PV Investment

There has been interest over time in utility-scale from a range of investors, with a variety of interests (both strategic and financial), including parastatal actors, oil and gas multinationals, and private sector international and domestic developers. Nonetheless, concrete investment in utility-scale wind and solar PV to date remains limited. In wind energy, 71 MW of wind farms have been commissioned: the 50 MW Ereymentau wind farm, developed by Samruk Green Energy; and the 21 MW Kordai wind farm, developed by Vista International. In solar PV, 57 MW has been commissioned and is operational, including: the 50 MW Burnoye-1 plant, a 2MW Samruk Green Energy Kapshagay plant, and a 2 MW Aksu-Energoplant. Samruk Green Energy is a subsidiary of Samruk Energy JSC, which provides 40% of electricity generation in Kazakhstan. Financing to date has been a combination of domestic sources and international financial institutions (EBRD, CTF). There is interest in utility-scale renewable energy from a number of domestic developers, both private sector and related to the sovereign wealth fund, and international developers.

Kazakhstan's power market was reformed in 1996, which has resulted in the privatization of 87% of the electricity generation market. The electricity system is operated by KEGOC (the Kazakhstan Electricity Grid Operating Company), which in turn is owned by the sovereign wealth fund Samruk Kazyna. In recent years, the government has developed a number of plans for the power sector, including: *The Concept for Development of the Power Sector In Kazakhstan to 2030*, approved in 2014, seeking to modernize the power system; and the *Concept for a Transition to a Green Economy*, approved in 2013.

To date, the centrepiece legislation for utility-scale renewable energy has been a feed-in-tariff (FiT) scheme, adopted in 2014, with tariffs specified for wind, solar PV, and solar PV with domestic modules. However, despite development plans submitted for 1,787 MW of wind energy and 713.5 MW of solar PV, the strong devaluation of the Tenge in August 2015 negatively affected the feasibility of these projects from moving forward. More recently, the government has indicated its intentions to use tendering or auctions for future capacity additions in renewable energy. In addition, there are potential incentives and tax exemptions for renewable energy created by the Law on Investments.

As the Republic of Kazakhstan continues to pursue its ambitions for renewable energy, a number of international organizations (including EBRD, USAID, IFC, ADB) have been working with the government through programmes aimed at policy and legislative support, as well as directly committing and providing financing for renewable energy investments. Box 1, below, summarizes this support.

Box 1: International support to utility-scale renewable energy in Kazakhstan

ADB in March 2017, recently approved a technical assistance project "Fostering the Development of Renewable Energy" to support the government in reaching its targets. This will include (i) training for KEGOC on system planning tools, (ii) improving KEGOC's system planning tools, and (iii) preparing a list of transmission improvement projects for integrating renewable energy into the Kazakhstan grid.

EBRD has been a long-term supporter of Kazakhstan in renewable energy through policy dialogues and project financing. EBRD has provided financing to the first wind and solar PV plants in Kazakhstan. In Dec 2016, EBRD announced further approval to finance an additional EUR 200 million/300 MW of capacity in the next five years. EBRD has various other related programmes, including support on financial sector reform for the green economy. EBRD is also working closely with IFC on various policy initiatives (see below).

The **European Union** is working with Kazakh government ministries on renewable energy via its CASEP initiative (Sustainable Energy programme for Central Asia), with a focus on policy development by sharing European good practice.

Germany, via the Federal Ministry for Economic Affairs and Energy (BMWi), has been supporting Kazakhstan via its 'Renewables made in Germany' programme, including a 2013 market analysis.

IFC's Clean Energy Infrastructure Programme in Central Asia and South Caucasus has been assisting IPP's on project structuring. IFC, in close collaboration with EBRD, has been providing support to the Ministry of Energy on various renewable energy policy initiatives, including: refinements to legislation; resolving grid integration issues; developing a well-functioning Financial Settlement Centre; and training for the system operator, KEGOC.

UNDP has provided early market support with the GEF-funded "Wind Power Market Development Initiative", which ran until 2011. This project contributed to establishing parts of the market architecture, including then 2015 and 2030 wind energy investment targets, the first iteration of a feed-in tariff mechanism, as well a wind resource map and initial support to KEGOC.

USAID is currently developing a programme on policy and legislation for utility-scale renewable energy, with initial support areas currently identified as load balancing and demand forecast for KEGOC, as well as development of an auction mechanism. The programme is currently envisaged to start in late 2017.

4. Modelling of Wind Energy and Solar PV in Kazakhstan

- 4.1 The Model's Approach
- 4.2 The Model's Results

Modelling of Wind Energy and Solar PV in Kazakhstan

4

This section describes the DREI modelling for promotion of private sector, utility-scale investment in wind energy and solar PV in Kazakhstan. First, a summary of the approach to the modelling is provided. It describes the two scenarios modelled, highlighting key modelling assumptions and setting out the underlying risk categories, as well as the associated barriers and public instruments. It then describes the modelling results, organized in terms of the DREI methodology's four stages.

As in any modelling exercise, the modelling uses a set of underlying data and assumptions that are presented in Annex B. Further in-depth data collection can strengthen the robustness of these results.

4.1 THE MODEL'S APPROACH

4.1.1 Modelling Two Core Scenarios in Kazakhstan

In order to study different public instrument packages, the modelling compares two core scenarios to achieve the envisioned 2021 investment targets for utility-scale wind energy and solar PV: a business-as-usual (BAU) scenario and a post-derisking scenario. Both scenarios take today's prevailing (2016[20]) risk environment in Kazakhstan as the starting point, while the study period for the financial modelling is set to be from 2017 to 2021 (5 years).

- ***Business-as-usual (BAU) scenario.***
    - This scenario assumes that the envisioned 2021 investment target is achieved under today's risk environment in Kazakhstan.
    - The business-as-usual scenario uses the current financing costs and terms (capital structure and loan tenor) that an investor encounters in Kazakhstan.
- ***Post-derisking scenario.***
    - This scenario assumes that the envisioned 2021 investment target is achieved under a derisked investment environment, in which a set of policy derisking and financial derisking instruments are deployed to address current investment risks and associated barriers.
    - As such, the post-derisking scenario uses adjusted financing costs and terms (capital structure and loan tenor) compared to the business-as-usual scenario, reflecting the impact of derisking instruments in reducing the financing costs and improving financing terms.

[20] Data collection has been performed in summer 2016.

4.1.2 Key Modelling Assumptions

The application of the DREI methodology entails a significant amount of data gathering and requires a number of assumptions to be made. In order to keep the scope of the modelling manageable, a set of simplified data and modelling assumptions have been used.

The following key issues associated with the modelling merit highlighting:

- **Baseline approach.**
  - Renewable energy investments are made in the context of an existing or evolving (with new installed capacity coming online) electricity generation mix. A combined baseline approach (50% build margin, 50% operating margin) is used to reflect that the electricity generated by wind and solar PV replaces electricity partly generated by the existing capacity and partly by capacity to be built[21]. In doing so, the analysis acknowledges the expected increase in energy demand in Kazakhstan, while recognizing that new investments in the power infrastructure are necessary to replace the old and outdated power plants dating to the Soviet-era.
    - o For the 50% *build margin* share of the baseline, a private sector perspective to investment is used. The modelling uses a mix of two technologies: (1) combined cycle gas turbine technology (CCGT) and (2) coal-fired thermal power plant as the marginal baseline technology.
    - o For the 50% *operating margin* share of the baseline, a number of assumptions and simplifications are made in order to keep the modelling exercise manageable. Coal-fired thermal plants generate nearly 70% of the electricity in Kazakhstan. As such, the technology represented in the operating margin is assumed to be 100% coal-fired thermal power plants.
  - Private-sector financing costs are used in the build margin and operating margin. This reflects an assumption that Kazakhstan is seeking to attract private sector investment irrespective of the energy technology. For the operating margin share, financial modelling considers that coal power plants are fully-depreciated and the costs are comprised of fuel costs and operations and maintenance costs, only.
  - The modelling assumes a combined baseline grid emission factor equating to 0.912 tonnes of CO_2e/MWh.
- **Variability.** An inherent characteristic of wind energy and solar PV is their variability and lack of dispatchability. Energy planners typically need to balance such renewable energy technologies with dispatchable capacity, and LCOE-based comparisons using variable energy sources can have limitations in not capturing this balancing cost, nor generation costs at peak demand. The modelling does not include balancing costs. The assumed targets for wind energy and solar PV for 2021 are expected to be absorbed into Kazakhstan's power grid with minimal cost or disruption.

[21] For the 2030 Targets (Annex A) a 25% BM: 75% OM baseline has been assumed for the larger targets of 5GW wind and 500 MW of solar PV as intermittency would be expected to more of an issue. By overweighing the operating margin baseline, this approach therefore penalizes the renewable energy technologies for their intermittency. Similar to the approach taken for 2021 targets, the breakdown for the operating margin is 100% existing coal plants while the build margin represents 50% new coal and 50% new combined cycle gas plants.

- **Transmission Lines.** In order to keep the modelling manageable, the modelling assumes that all the wind energy and solar PV sites to meet the envisioned 2021 investment target are within 10 km of the existing grid. Capital costs related to the upgrade and maintenance of the grid infrastructure in Kazakhstan are excluded from the analysis.
- **Unsubsidised baseline fuel costs.** The modelling exercise uses unsubsidised fuel prices for both natural gas and coal. This is in order to create an 'even-playing field' for the economic analysis and comparisons with renewable energy under the modelling exercise. An 'opportunity cost' approach is taken to estimating the unsubsidised cost of fuel – making an assumption that in the absence of subsidised domestic consumption, Kazakhstan could export at market prices. Fuel prices are projected using the International Energy Agency (IEA) World Economic Outlook projections (New Policies Scenario) for both natural gas and coal. It is important to note that issues of subsidisation of existing power generation in Kazakhstan via non-cost-reflective tariffs are outside the scope of this exercise and have not been captured in the modelling.
- **Installed costs for wind energy and solar PV.** Globally, the costs of renewable energy hardware have been falling consistently over time, and they are expected to continue to do so. This study assumes installed costs (i.e. the cost of hardware, such as wind turbines and solar panels) expected to prevail at the end of the year 2019, i.e. the year that reflects the mid-point of the modelling period 2017-2021. The 2019 cost estimates are derived from the latest projections elaborated by the International Renewable Energy Agency and published in June 2016 (IRENA, 2016). To complement this approach, the sensitivity analyses illustrate the impact on the results when assuming the present (2016) installed costs as provided by developers in Kazakhstan.

The full underlying data-sets and assumptions for the modelling are set out in Annex B.

4.1.3 Public Instrument Table

The following Table 2 sets out in full the stakeholders, barriers and risk categories for utility-scale wind energy and solar PV, and the matching public instruments to address these barriers and risks. This was derived from the generic public instrument table for utility-scale, renewable energy in the DREI report (UNDP, 2013). Based on stakeholder consultation and investors' feedback, a small number of changes have been made to the generic table; these changes are described in Annex B. Table 2 was then used as the basis for the DREI analysis in Kazakhstan, including the interviews with investors.

Table 2: The modelling exercise's public instrument table (Part I)

BARRIERS			
RISK CATEGORY	**DESCRIPTION**	**UNDERLYING BARRIERS**	**KEY STAKEHOLDER GROUP**
1. Power Market Risk	Risk arising from limitations and uncertainties in the power market, and/or sub-optimal regulations to address these limitations	• *Market outlook:* lack of or uncertainties regarding governmental renewable energy strategy and targets • *Market access and prices:* limitations related to energy market liberalization; uncertainty related to access, the competitive landscape and price outlook for renewable energy; limitations in design of bankable PPAs and tendering procedures • *Market distortions:* such as high fossil fuel subsidies	Public sector (policy makers, legislators, regulators)
2. Permits Risk	Risk arising from the public sector's inability to efficiently and transparently *administer* RE-related licensing and permits	• Labour-intensive, complex processes and long time-frames for obtaining licences and permits (generation, EIAs, land title) for renewable energy projects • High levels of corruption. No clear recourse mechanisms	Public sector (administrators)
3. Social Acceptance Risk	Risks arising from lack of awareness and resistance to renewable energy in communities and end-users	• Lack of awareness of renewable energy amongst consumers, end-users and local residents	End-users, general public
4. Developer Risk	Risks arising from use of the renewable energy resource and technology (resource assessment; construction and operational use; hardware purchase and manufacturing)	• *For resource assessment and supply:* inaccuracies in early-stage assessment of renewable energy resource; where applicable uncertainties related to future supply and cost of resource • *For planning, construction, operations and maintenance:* uncertainties related to securing land; sub-optimal plant design; lack of local firms offering construction, maintenance services; lack of skilled and experienced local staff; limitations in civil infrastructure (roads etc.) • *For the purchase and, if applicable, local manufacture of hardware:* purchaser's lack of information on quality, reliability and cost of hardware; lack of local industrial presence and experience with hardware, including skilled and experienced local workforce	Project developers, supply chain

MENU OF SELECTED PUBLIC INSTRUMENTS			
POLICY DERISKING INSTRUMENTS		FINANCIAL DERISKING INSTRUMENTS	
ACTIVITY	DESCRIPTION	ACTIVITY	DESCRIPTION
Establish transparent, long-term national strategy; clearer strategy for renewable energy targets	Establish transparent, long-term national wind energy strategy and targets; develop and regularly update transparent energy sector planning particularly with a view on excess electricity capacity from the new nuclear power plant		
Implement and run a well-designed, transparent IPP bidding process with bankable PPAs; Establish a renewable energy office in the regulator	Implement a clear and transparent process for IPPs by (i) establishing well-designed and transparent procedures for tenders and auctions; (ii) formulate bankable PPA with a well-designed, transparent policy framework		
Policy derisking instruments addressing this barrier, e.g., fossil subsidies reform/assessment of real cost of fossil electricity without fuel subsidies, are not included in this analysis following investor feedback.			
Streamline processes for obtaining permits	Establish a one-stop-shop for renewable energy permits; harmonisation of requirements; training of one-stop-shop staff in renewable energy		
Contract enforcement and resource mechanism	Enforce transparent practices, renewable energy related corruption control and fraud avoidance mechanisms; establish effective resource mechanism		
Awareness-raising campaigns targeting communities and end-users	Working with media, awareness campaigns, stakeholder dialogue and workshops with end-users, policymakers and local residents		
Policy derisking instruments addressing this barrier, e.g., capacity building for resource assessment, are not included in this Kazakhstan analysis following investor feedback.			
Networking; training and qualifications programmes	Strengthen and build upon the existing renewable energy industry association; training, apprenticeships and university programmes to build skills (planning, construction, O&M)		
Research and development; product adaptation; exchange of market information	Test centre for research and development into product adaptation, such as wind turbine adaptation to local conditions; awareness campaign and trade fairs		

Table 2: The modelling exercise's public instrument table (Part II)

BARRIERS			
RISK CATEGORY	**DESCRIPTION**	**UNDERLYING BARRIERS**	**KEY STAKEHOLDER GROUP**
5. Grid/Transmission Risk	Risks arising from limitations in grid management and transmission infrastructure in the particular country	• *Grid code and management:* limited experience or suboptimal operational track-record with intermittent sources (e.g., grid management and stability). Lack of standards for the integration of intermittent, renewable energy sources into the grid • *Transmission infrastructure:* inadequate or antiquated grid infrastructure, including lack of transmission lines from the renewable energy source to load centres; uncertainties for construction of new transmission infrastructure	KEGOC (as transmission company/grid operator)
6. Counterparty Risk	Risks arising from the utility's poor credit quality and an IPP's reliance on payments	• Limitations in the off-taker's credit quality, corporate governance, management and operational track-record or outlook	KEGOC/Financial Settlement Centre (as electricity purchaser)
7. Financial Sector Risk	Risks arising from general scarcity of investor capital (debt and equity) in the particular country, and investors' lack of information and track record on renewable energy	• *Capital scarcity:* Limited availability of local or international capital (equity/and or debt) for green infrastructure due to, for example: under-developed local financial sector; policy bias against investors in green energy • *Limited experience* with renewable energy: Lack of information, assessment skills and track-record for renewable energy projects amongst investor community; lack of network effects (investors, investment opportunities) found in established markets; lack of familiarity and skills with project finance structures	Investors (equity and debt)
8. Political Risk	Risks arising from country-specific governance and legal characteristics	• Uncertainty or impediments due to war, terrorism, and/or civil disturbance • Uncertainty due to high political instability; poor governance; poor rule of law and institutions • Uncertainty or impediments due to government policy (currency restrictions, corporate taxes)	National level
9. Currency/ Macro-economic Risk	Risks arising from the broader macroeconomic environment and market dynamics	• Uncertainty due to volatile local currency; unfavourable currency exchange rate movements • Uncertainty around inflation, interest rate outlook due to an unstable macroeconomic environment	National level

Source: authors, adapted from Derisking Renewable Energy Investment (UNDP, 2013)

MENU OF SELECTED PUBLIC INSTRUMENTS			
POLICY DERISKING INSTRUMENTS		FINANCIAL DERISKING INSTRUMENTS	
ACTIVITY	DESCRIPTION	ACTIVITY	DESCRIPTION
Strengthen transmission company's operational performance, grid management and formulation of grid code	Develop and upgrade a grid code for new renewable energy technologies including procedures to connect new RE infrastructure to the grid; sharing of international best practice in grid management i.e. with existing wind parks in other countries in the region	Include a "take-or-pay" clause in the standard PPA	"Take-or-pay" clause in PPA whereby renewable energy power plant operator is reimbursed for grid failure (black-out, brown-out) and/or curtailment (due to mismatches in grid management of supply/demand)
Policy support for national grid infrastructure development	Develop and regularly update a long-term national transmission/grid road-map to include intermittent renewable energy	*Financial derisking instruments addressing this barrier, e.g., public loans for grid infrastructure, are not included in this Kazakhstan analysis. Outside scope of analysis.*	
Reform the Financial Settlement Centre's structure	Reforming the Financial Settlement Centre's structure and capitalization; Establish international best practice in Settlement Centre's operations and corporate governance; implement sustainable cost recovery practices	Government (sovereign) guarantees or backing for PPA payments; public loans	Government letter of support for PPA payments to private wind energy developers; governmental/international buy-in to projects via public loans
Financial sector policy reforms	Promote inancial sector policy favourable towards long-term infrastructure finance	Financial products by development banks or the Central Bank, to assist project developers to gain access to capital/funding	Public loans for renewable energy developers provided by development banks and international finance institutions
Strengthen investors' (debt and equity) familiarity with and capacity regarding renewable energy projects	Industry-finance dialogues and conferences; workshops/training on project assessment and financial structuring (project finance); public-private partnership building		
		Financial derisking instruments addressing this barrier, e.g., political risk insurance (PRI), are not included in this Kazakhstan analysis following investor feedback.	
		Risk sharing mechanisms to address currency risk	Include current partial indexing of local currency tariffs in PPAs, so that foreign renewable energy investors and developers are partially reimbursed for local currency depreciation of tariff

4.2 THE MODEL'S RESULTS

4.2.1 Risk Environment (Stage 1)

Interviews

Data for Stage 1 (Risk Environment) of the modelling were gathered from interviews held with 12 domestic and international project developers and investors who are considering, or are actively involved in, utility-scale wind and solar PV investment opportunities in Kazakhstan. These investors reflect a variety of interests, both strategic and financial. Most of the interviews were held face-to-face in Astana and Almaty during a country mission in May-June 2016. A few interviews were held remotely over the phone during the same time period. Additional informational interviews were held with other stakeholders during a visit to Kazakhstan and included interviews with IFIs, donors, entrepreneurs, solar module manufacturer, and a range of policy makers, including the Ministry of Energy[22]. Finally, an interview was held with an investor in German utility-scale renewable energy for the best-in-class data.

Financing Cost Waterfalls

The analysis of the contribution of investment risks to higher financing costs in Kazakhstan is shown in the financing cost waterfalls in Figure 13. This analysis was performed jointly for wind energy and solar PV investors. Definitions of each of the risk categories can be found in Table 2.

A brief summary of the qualitative feedback that wind energy and solar PV developers and investors shared in their interviews is provided in Table 3.

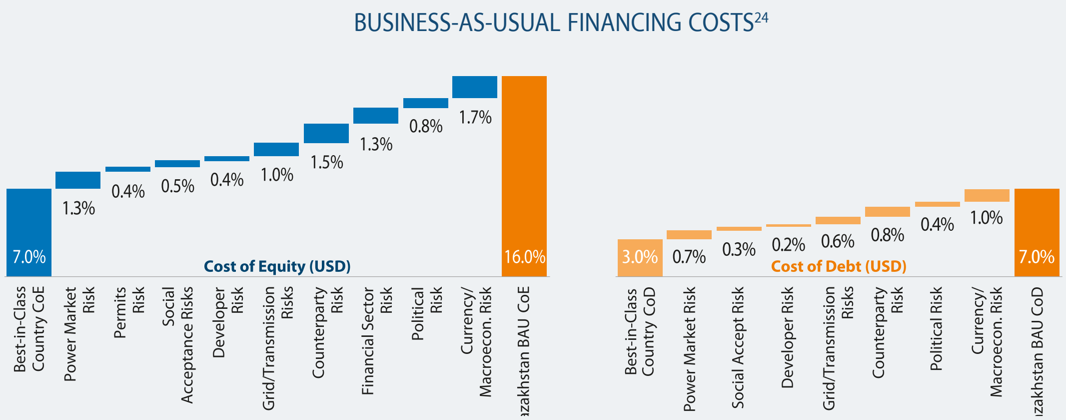
The results estimate the business-as-usual cost of financing in Kazakhstan today for wind energy and solar PV to be 16% (USD) for the cost of equity (CoE) and 7% (USD) for the cost of debt (CoD)[23]. These are substantially higher than in the best-in-class country, Germany, which is estimated at 7% for CoE and 3% for the CoD. Investors in utility-scale renewable energy projects in Kazakhstan are also hindered by less attractive capital structures (equity to debt ratios). Given the longevity of energy assets in general as well as the capital intensity of renewable energy investments in particular, the impact of Kazakhstan's higher financing costs on the competitiveness of wind energy and solar PV is significant.

[22] The interviews were focused on utility-scale renewables as this sector (as opposed to small-scale RE) dominates the renewable energy landscape in Kazakhstan. It is worth noting that there was a very perceptible variation in responses from experienced and less experienced investors (and developers). The interviewee sample was made up of approximately 40% of investors who had already made substantial investments in the Kazakh market or similar markets.

[23] CoE and CoD are USD-denominated.

Figure 13 shows that there are four major risks that that contribute significantly to higher financing costs in Kazakhstan: (i) *power market risk*, related to limitations in the feed-in tariff mechanism and a lack of a bankable PPA, (ii) *counterparty risk*, that concerns the credit-worthiness of the Financial Settlement Centre, the electricity off-taker, (iii) *financial sector risk*, relating to the scarcity of capital from international and domestic markets, and (iv) *currency and macroeconomic risk*, related to the fluctuations in the Kazakh Tenge vis-a-vis hard currencies in which financing is denominated. A number of other risk categories also contribute to higher financing costs. A brief summary of the qualitative feedback on these risks and barriers, shared by wind energy developers and investors in their interviews, is provided in Table 3.

Figure 13: Impact of risk categories on financing costs for wind energy and solar PV investments in Kazakhstan, business-as-usual scenario



Source: interviews with wind energy and solar PV investors and developers; modelling; best-in-class country is assumed to be Germany; see Annex B for details on assumptions and methodology.

[24] The financing cost waterfalls shown here are calculated by differentiating between the answers from equity and from debt investors, but not distinguishing further between investors with focus on wind energy and investors with focus on solar PV. It is recognized that the risk profiles of utility-scale wind energy and solar PV can differ. However, the results of the interviews with wind energy and solar PV investors made clear that these differences are minimal in the Kazakhstan context.

Table 3: Qualitative investor feedback on risk categories for wind energy and solar PV investment in Kazakhstan

RISK CATEGORY	INVESTOR FEEDBACK
Power market risk	This risk category has a high impact on financing costs. Investors shared their concerns about uncertainty in the outlook and targets for renewable energy and changes in the supporting mechanisms. The Government has been reconsidering the targets, and has recently shared its intention to introduce a new mechanism to replace the feed-in tariff, likely a bidding process. Many developers' activities are suspended as the level of uncertainty is high. Investors agreed that the Government has a tendency to change course frequently, reconsidering previously adopted measures and resulting in a lack of long-term vision. The interviewees also noted that there is already a strategy in place, which seems to be reasonable, but execution is lacking. Investors commented that the feed-in tariff mechanism is currently compromised by low tariff levels, which are no longer financially viable following the devaluation of the Kazakh Tenge. Investors also expressed concern regarding the bankability of the power purchase agreements, which are not drafted to international standards. In terms of regulatory oversight, investors commented that there is a national regulator in place; however, it does not have a clear mandate on renewable energy.
Permits risk	This risk category has a medium impact on financing costs. Many investors shared the view that the permitting process is complex and that many companies still do not fully understand it. However, the permitting system is still in its early days. Permits risks may increase if the bidding process is introduced, in which case there may be time constraints for securing the permits. Investors identified land allocation as a specific permitting issue.
Social acceptance risk	This risk category has a low impact on financing costs. This was rated as a risk with low probability, however, if such a situation occurs the impact to the project will be substantial. Some investors noted that according to their experience local people were not interested in their projects. However, the situation may change if additional renewable energy is associated with retail tariff reform or increases.
Developer Risk	This risk category has a medium impact on financing costs. Most investors assessed this risk as low probability and believed it is a developer's responsibility to mitigate the barriers. The approaches to reducing this risk are very common and well known. Having reliable partners and technology and insurance companies involved are very important. Investors commented that hardware is readily available, but that transport is a real challenge for wind energy hardware and creates significant additional costs in Kazakhstan. Another noted that the existing state expertise provides reasonable feasibility studies, however they don't fulfil the requirements of financial institutions.
Grid integration risk	This risk category has a medium impact on financing costs. Investors pointed out that a grid study is available from KEGOC and that the existing law is clear in terms of the grid connection procedures. Some investors commented that adding intermittent energy sources to the traditionally fossil-based power system is challenging for KEGOC and there's uncertainty about how KEGOC will manage this. There was general agreement among most of the developers that having take-or-pay clause provisions in the PPA is one way to mitigate these risks. Regarding connection issues, there was an opinion that connection to the national grid is not a problem while connection at the regional level is problematic.
Counterparty risk	This risk category has a high impact on financing costs. Investors recognized that the credit worthiness of the Financial Settlement Centre is a concern. There is little available information on its credit worthiness or its relationship to other potentially creditworthy government entities. Investors commented that they have very few legal means to protect themselves in case of non-payment. Investors also cautioned against an ad hoc approach to government guarantees for individual projects, preferring a systemic solution.
Financial sector risk	This risk category has a high impact on financing costs. Investors agreed that there is a lack of available long-term debt in local currency. An underlying cause is the practice of savers to keep saving in USD, despite government efforts to de-dollarize the economy. Additionally, investors noted that local banks are not familiar with project finance.
Political risk	This risk category has a moderate impact on financing costs. Kazakhstan is ranked 35 in the WB's Doing Business index (out of 190 countries) and investors mostly believe that there is low probability of interference with the operations and finances of the renewable energy plant due to socio-political instability and expropriation of assets.
Currency/ macroeconomic risk	This risk category has a high impact on financing costs. Existing tariffs are in local currency (Kazakh Tenge) with a partial indexation should the Tenge devalue more than 25% during any given year. This mechanism is viewed as sub-optimal, as significant risk exposure remains. Most current debt financing is expected to be denominated in hard currency, creating a significant currency risk exposure. Investors stated that this exposure is almost unmanageable - a devaluation of more than 10% can make a project financially unviable within 5 years.

Source: interviews with investors (equity investors/developers and debt investors).

4.2.2 Public instruments (Stage 2)

Selection and costing of public instruments

Having identified the key investment risks, a package of public instruments can then be assembled to address them. The modelling adopts a systematic approach to identifying policy instruments: if the financing cost waterfalls (Figure 13) identify an incremental financing cost for a particular risk category, then a matching public instrument is deployed as part of the public instrument package. Table 2 lists the public instruments in full detail, while Table 4 below provides a summary.

Table 4: The selection of public instruments to achieve the envisioned investment targets for wind energy and solar PV

RISK CATEGORY	POLICY DERISKING INSTRUMENTS	FINANCIAL DERISKING INSTRUMENTS
Power Market Risk	• Update transparent, long-term national renewable energy strategy • Establish and run IPP bidding process, with bankable PPA • Establish a renewable energy office in the regulator	NA
Permits Risk	• Streamlined process for RE permits (dedicated one-stop shop) • Contract enforcement and recourse mechanisms	NA
Social Acceptance Risk	• Awareness-raising campaigns	NA
Developer Risk	• Technology R&D • Support for industry associations	NA
Grid/Transmission Risk	• Strengthen KEGOC's grid management capacity • Transparent, up-to-date grid code • Policy support for long-term national transmission/grid road-map	• Take-or-pay clause in PPA[25]
Counterparty Risk	• Reform and maintain creditworthy Financial Settlement Centre structure	• Government guarantee for PPA payments • Public loans to IPPs
Financial Sector Risk	• Fostering financial sector reform towards green infrastructure investment • Strengthening financial sector's familiarity with renewable energy and project finance	• Public loans to IPPs
Political Risk	NA	NA
Currency/ Macroeconomic Risk	NA	• Partial indexing of PPA tariff to hard currencies[26]

Source: modelling. See Annex B for a full description of these instruments. "NA" indicates «Not Applicable».

[25] A *take-or-pay* clause is a clause found in a Power Purchase Agreement (PPA) that essentially allocates risk between parties in the scenario where transmission line failures or curtailment (required by the grid operator) result in the IPP being unable to deliver electricity generated by its renewable energy plant.

[26] *Partial indexing* involves tariffs in local-currency denominated PPAs being partially indexed to foreign hard currencies, such as USD or EUR. In this way, IPPS are partially protected against currency fluctuations. If a PPA tender process is used, IPPs can be asked to specify the minimum degree of partial indexing they require, thereby minimizing the cost of this instrument.

The public costs of each selected public instrument are also modelled:

- For wind energy (2021 target: 1 GW), the total public instrument cost (2017-2021) is estimated as being USD 6.3 million in policy derisking instruments and USD 269.3 million[27] in financial derisking instruments.
- For solar PV (2021 target: 250 MW), the total public instrument cost (2017-2021) is estimated as being USD 0.9 million in policy derisking instruments and USD 53.2 million[28] in financial derisking instruments.

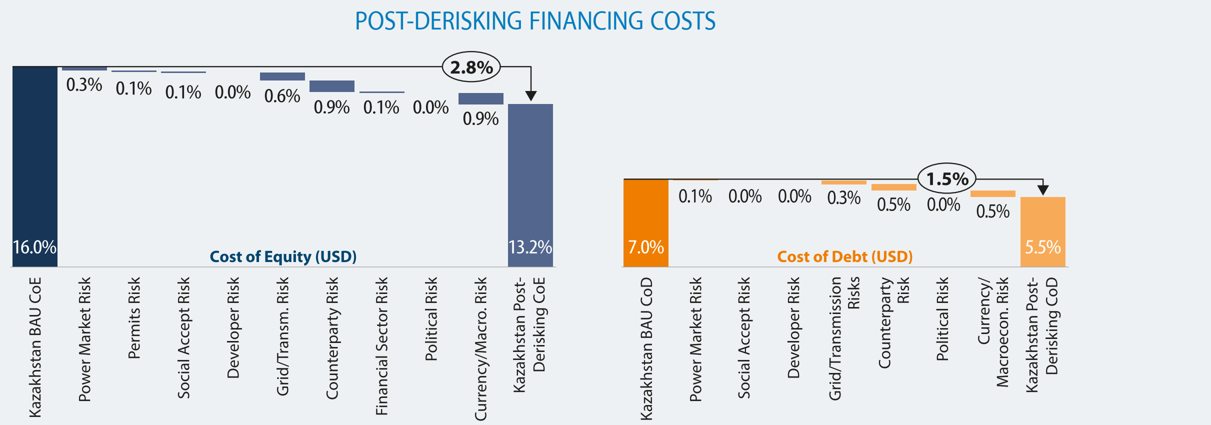
The full breakdown of each selected public instrument and its cost is provided in Table 16 (wind energy) and Table 17 (solar PV). Details of the assumptions and the methodology used to generate the cost estimates are available in Annex B.

Impact of public instruments on financing costs

The impact of the public instruments on reducing financing cost for wind energy and solar PV in Kazakhstan are shown in Figure 14. Based on the modelling analysis, the selected package of derisking instruments is anticipated to reduce the average cost of equity until 2021 by 2.8% points, down to 13.2%, and the cost of debt by 1.5% points down to 5.5%.

A brief summary of the qualitative investor feedback on the public instruments discussed in the interviews and on their effectiveness in reducing financing cost in Kazakhstan is provided in Table 5. While the approach taken in the DREI analysis assumes full and effective implementation of each selected instrument package, investors were very sceptical about the government's ability to implement these instruments as effectively.

Figure 14: Impact of public derisking instruments on reducing financing costs for wind energy and solar PV investments in Kazakhstan



Source: interviews with wind energy and solar PV investors and developers; modelling; see Annex B for details of assumptions and methodology. Note: the impacts shown are average impacts over the 2017-2021 modelling period, assuming linear timing effects.

[27] Different methodological approaches (e.g. face value, reserve, cost, no-cost) may be taken to costing financial derisking instruments. Here, a cost approach has been taken for the take or pay clause in PPA, 'government guarantee for PPA', and 'currency indexation', totaling USD 116.5 m; a reserve approach has been taken for 'public loans', totaling USD 152.8 m.

[28] Like in the case of wind energy (see previous footnote), for solar PV, too, a cost approach has been taken for the 'take or pay clause in PPA', 'government guarantee for PPA', and 'currency indexation', totaling USD 22.7 m; a reserve approach has been taken for 'public loans', totaling USD 30.4 m.

Table 5: **Investor feedback on the effectiveness of public instruments to address each risk category in Kazakhstan**

RISK CATEGORY	PUBLIC INSTRUMENTS PROPOSED	INVESTOR FEEDBACK
Power market risk	*Policy derisking instrument(s):* Update transparent, long-term national renewable energy strategy; establish and run IPP bidding process, with a bankable PPA; establish a renewable energy office in the regulator	Investors were cautious regarding a new long term strategy for renewables, but stated that a clear short and medium term outlook and target would be effective. Investors would welcome clarity and a well-designed support mechanism, and – if this is implemented and enforced – rated this as highly effective. This could take the form of a reformed feed-in tariff, with adjusted, financially viable tariffs, or a new bidding process. Investors stated that the support mechanism should be accompanied by a bankable PPA, drafted to international legal standards, giving banks the necessary comfort to provide financing.
Permits risk	*Policy derisking instrument(s):* Streamline processes for permitting, establish contract enforcement and recourse mechanism	Investors rated a one-stop-shop as moderately effective, but expressed concerns on the design to ensure it expressly reduces bureaucracy and the potential for corruption, as opposed to worsening these areas. Most of the developers rated a recourse mechanism as a moderately effective de-risking tool.
Social acceptance risk	*Policy derisking instruments:* Awareness raising campaigns, community-based pilots	Most of the investors agreed that an awareness programme at the national level would be an effective tool. On the other hand, investors thought an instrument to promote community-based models would not be effective, and that developers already seek to involve locals in investment project.
Developer Risk	*Policy derisking instruments:* technology R&D, industry association support	The views on the effectiveness of the proposed policy derisking instruments were mixed. This in part depended on contrasting views on how the market should evolve, either attracting large, established developers (no need for support) vs smaller, start-up developers (support is needed). Specific instruments were identified as having high effectiveness, specifically: R&D for hardware, to address the harsh conditions in parts of Kazakhstan; and support to industry associations, which are currently underfunded and struggling.
Grid integration risk	*Policy derisking instruments:* Strengthen KEGOC's grid management capacity, transparent, up-to-date grid code, policy support for long-term national transmission/ grid road-map Financial derisking instrument: Include take-or-pay clause in the standard PPA	Investors rated the effectiveness of the proposed policy derisking instruments as high. It was recognized that many of these activities are currently ongoing, with support by IFC, EBRD and ADB, and while progress has been made there is still work to do. Investors rated the effectiveness of the take-or-pay clause as high, and as an essential requirement.
Counterparty risk	*Policy derisking instrument:* Reform and maintain creditworthy Financial Settlement Centre structure Financial derisking instrument: Sovereign guarantees for PPA payment; public loans	Investors rated the effectiveness of a reformed Financial Settlement Centre, with transparent and high credit worthiness, as high. Investors also rated the proposed financial derisking instruments as high. It was recognized that, if implemented, there is duplication between these instruments.
Financial sector risk	*Policy derisking instruments:* Financial sector policy reform towards green infrastructure investment, strengthen investors' familiarity with and capacity for renewable energy *Financial derisking instruments:* Financial products to gain access to capital/funding, e.g. public loans	Investors rated the policy derisking instruments with moderate effectiveness. The value of domestic financial sector reform to increase available local-currency capital is tempered by investor's short-term outlook and the recognition that reform will take time. Investors rated the effectiveness of training for the domestic financial sector as low, preferring a learning by doing approach. Investors rated the financial derisking instrument, in particular public loans, as having high effectiveness. Such public loans can also indirectly address other risk categories, for example, counterparty risk, that are currently holding back investment. Investors pointed out that concessional public loans can also result in low tariffs, to be passed on to end-users.
Political risk	*Financial derisking instruments:* Political Risk Insurance (PRI)	Investors rated political risk insurance (PRI) as having moderate effectiveness. Investors had limited familiarity with PRI. While recognizing its value, certain investors were also cautious with regard to its fees.
Currency/ macroeconomic risk	*Financial derisking instrument:* Risk sharing mechanism to address currency risk	Investors viewed a risk sharing mechanism to address currency risk as highly effective and an essential requirement. Investors conveyed high levels of concern regarding recent Kazakh Tenge volatility. Risk sharing mechanisms, such as a USD-denominated tariff, or a more robust partial indexing of the tariff (beyond the current mechanism), are considered as instruments which can manage these risks.

Source: interviews with investors (equity investors/developers and debt investors). Short description of the public instruments can be looked up in Table 2.

4.2.3. Levelised Cost (Stage 3)

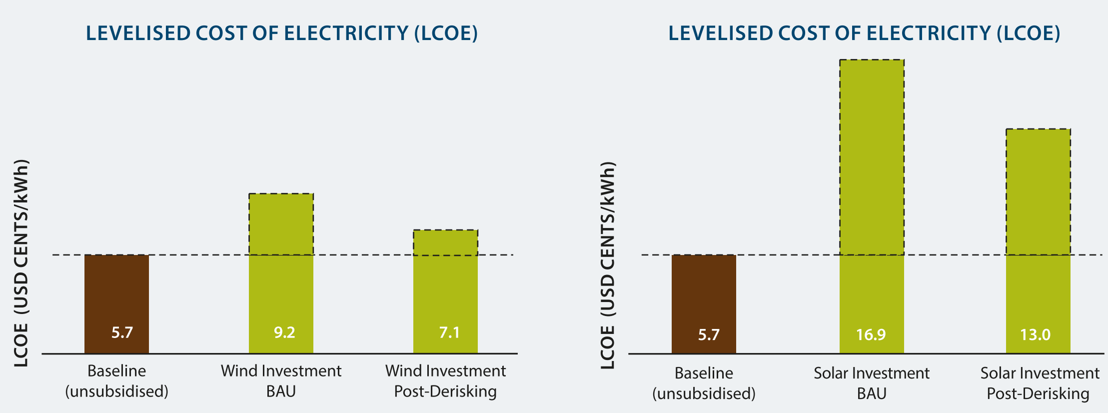
The modelling outputs in terms of LCOEs for wind energy and solar PV are shown in Figure 15.

In the *business-as-usual scenario*, wind energy and solar PV are more expensive than the baseline. The baseline technology mix considers a 50:50 combined margin approach, representing 50% operating margin (existing coal plants) and 50% build margin, (new supercritical coal and combined cycle gas turbine (CCGT) gas plants). This approach results in baseline generation costs of USD 5.7 cents per kWh, assuming unsubsidised fuel costs (see Annex B).

Wind energy is shown to be more expensive than the baseline cost in both the *business-as-usual* and the *post-derisking scenarios*. Nonetheless, the public instrument package reduces the LCOE for wind energy from USD 9.2 cents per kWh (*business-as-usual scenario*) to USD 7.1 cents per kWh (*post-derisking scenario*), reducing the price premium required from USD 3.5 cents per kWh to USD 1.4 cents per kWh.

The findings are similar for Solar PV, where derisking reduces the LCOE from USD 16.9 cents per kWh to USD 13.0 cents per kWh. The price premium required for solar PV can be reduced from USD 11.2 cents per kWh to USD 7.3 cents per kWh.

Figure 15: LCOEs for the baseline, wind energy (left) and solar PV (right) investment in Kazakhstan



Source: modelling; see Table 16 (wind) and Table 17 (solar PV), as well as Annex B for details of assumptions and methodology.

4.2.4 Evaluation (Stage 4)

Performance Metrics

The model's performance metrics, evaluating the impact of derisking on the envisioned 2021 targets for wind and solar PV investment in Kazakhstan, are shown in Figure 16 and Figure 17.

Each of the four performance metrics takes a different perspective in assessing the performance of the derisking instrument package.

- The **investment leverage ratio** shows the efficiency of public instruments in attracting investment, comparing the total cost of public instruments with the resulting private-sector investment.
- The **savings ratio** takes a social perspective, comparing the cost of derisking instruments deployed versus the economic savings that accrue to society from deploying the instruments.
- The **affordability** metric takes an electricity consumer perspective, comparing the generation cost of wind energy or solar PV in the post-derisking scenario with the original BAU scenario.
- The **carbon abatement** metric takes a climate change mitigation perspective, considering the carbon abatement potential and comparing the carbon abatement costs (the cost per tonne of CO_2 abated). This can be a useful metric for comparing carbon prices.

Taken as a whole, the performance metrics for wind and solar PV demonstrate how the deployment of public derisking instruments can significantly increase the competitiveness and affordability of both wind energy and solar PV in Kazakhstan.

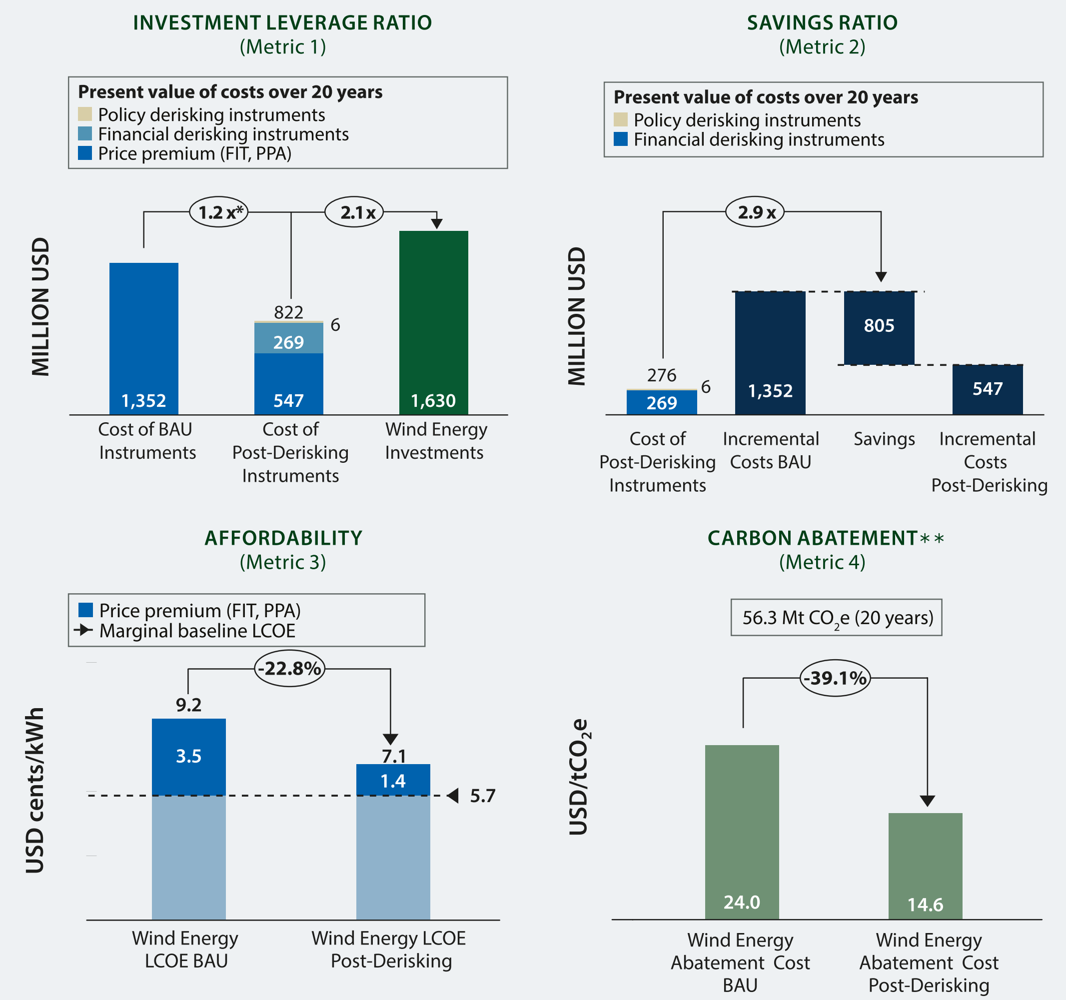
For instance, for both wind energy and solar PV, the savings leverage ratio shows that derisking is an efficient use of public funding.

- For wind energy, in the *business-as-usual* scenario, the modelling estimates that a price premium (incremental cost) totalling USD 1.4 billion will be required over the next 20 years to achieve the report's 2021 (5 year) target. In the *post-derisking* scenario, the incremental cost falls to USD 546.8 million, saving the economy USD 804.7 million over the 20-year lifetime of the investments. Given that public derisking instruments costing USD 275.6 million are required to achieve this, this equates to a savings ratio of 2.9x, demonstrating that the benefits of lower price premiums outweigh the cost of derisking.
- For solar PV, in the *business-as-usual* scenario, the modelling estimates that a price premium (incremental cost) totalling USD 458.9 million will be required over the next 20 years to achieve the report's 2021 (5 year) target. In the *post-derisking scenario,* the incremental cost falls to USD 298.5 million, saving the economy USD 160.5 million over the 20-year lifetime of the investments. Given that public derisking instruments costing USD 54.1 million are required to achieve this, this equates to a savings ratio of 3.0x, demonstrating that the benefits of lower price premiums outweigh the cost of derisking.

Also the other performance metrics shown in Figure 16 and Figure 17 reveal the benefits of upfront derisking:

- The investment leverage improves from 1.2x to 2.1x for wind energy and from 0.7x to 0.9x for solar PV, respectively.
- Electricity from utility-scale wind farms and solar PV plants becomes 23% cheaper.
- Carbon abatement costs are reduced by 39% and 23% for wind energy and solar PV, respectively.

Figure 16: Performance metrics for the selected package of derisking instruments in promoting 1 GW of wind energy investment in Kazakhstan

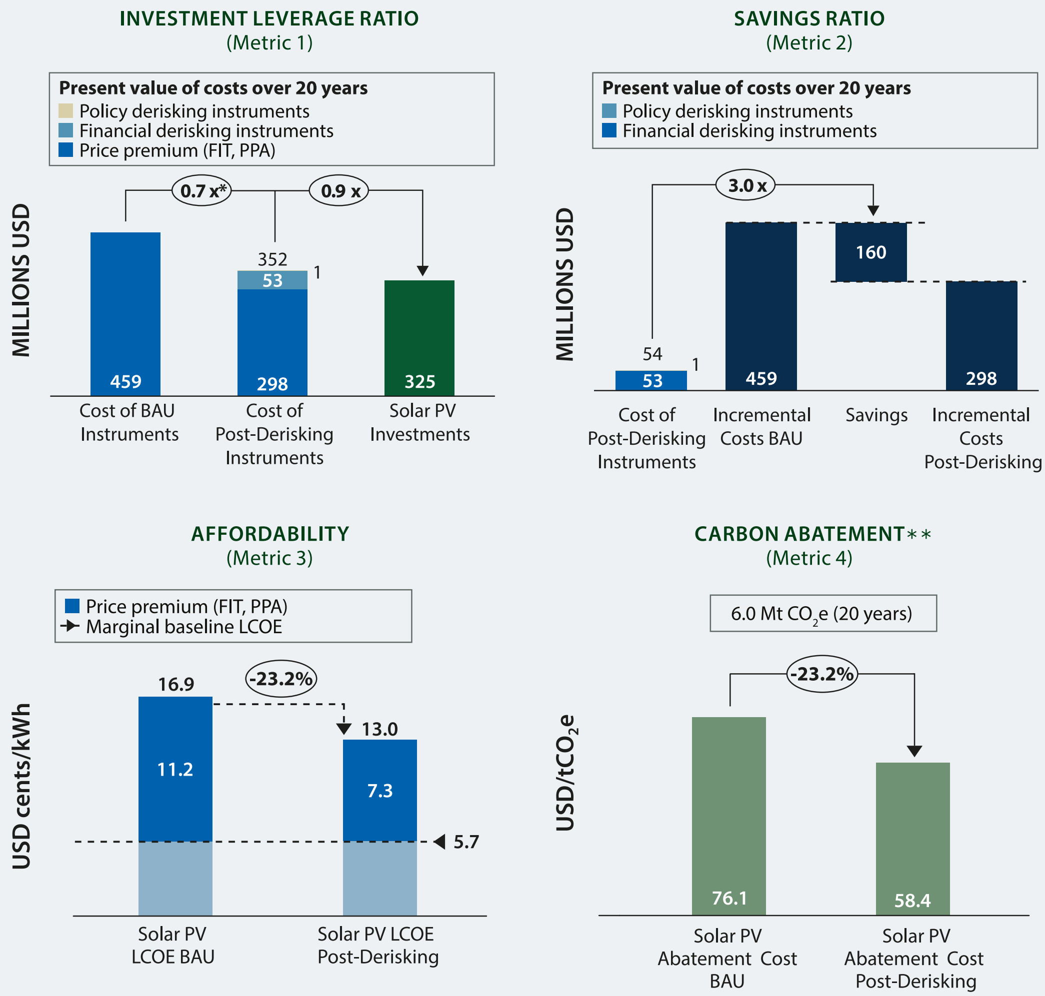


Source: modelling; see Table 17 and Annex B for details on assumptions and methodology.

*In the BAU scenario, the full 2021 investment target may not be met.

** The Carbon Abatement metric can be broken down into the costs of policy derisking instruments, financial derisking instruments and the price premium. While in the BAU scenario, the total of USD 24.0 per tCO_2e is due to the price premium, in the post-derisking scenario, this breakdown for the total of USD 14.6 per tCO_2e is USD 0.1, USD 4.8 and USD 9.7, respectively.

Figure 17: Performance metrics for the selected package of derisking instruments in promoting 250 MW of solar PV investment in Kazakhstan



Source: modelling; see Table 18 and Annex B for details on assumptions and methodology.

*In the BAU scenario, the full 2021 investment target may not be met.

** The Carbon Abatement metric can be broken down into the costs of policy derisking instruments, financial derisking instruments and the price premium. While in the BAU scenario, the total of USD 76.1 per tCO_2e is due to the price premium, in the post-derisking scenario, this breakdown for the total of USD 58.4 per tCO_2e is USD 0.2, USD 8.8 and USD 49.5, respectively.

Sensitivities

A set of sensitivity analyses has been performed for both wind energy and solar PV. The objective of performing the sensitivity analyses is to gain a better understanding of the robustness of the outputs and to be able to test different scenarios.

Five types of sensitivity analysis have been performed:

- Avoided fossil fuel subsidies
- Baseline selection
- Key input assumptions
- Public instrument selection and cost-effectiveness
- Approach to costing financial derisking instruments

1. Sensitivity analysis on avoided fossil fuel subsidies

Kazakhstan's low electricity generation costs and low retail tariffs can partly be explained by consumption subsidies for fossil-fuels. According to the IEA, in 2014, Kazakhstan's subsidies to coal and natural gas were USD 1.7 billion and USD 0.5 billion, respectively (IEA, 2015). The analysis in this section estimates the amount of avoided subsidies if 1 GW of wind and 250 MW solar PV were to replace the baseline technologies of coal and natural gas. The avoided fossil fuel subsidies are calculated as the difference of cost of fuel at subsidised and unsubsidised prices. The results for this analysis are summarized in Table 6 and Table 7.

Table 6: Wind energy: summary of avoided subsidies for 1 GW of wind replacing baseline technologies of coal and natural gas

TYPE OF TECHNOLOGY	ELECTRICITY GENERATION (MWH)	SUBSIDY PER MWH (USD/MWH)*	AVOIDED SUBSIDIES PER YEAR	PV OF AVOIDED SUBSIDIES OVER 20 YEARS
Wind	3,066,000	0	0	0
Baseline Technologies:**				
Natural Gas	766,500	1.49	$1,970,287	$24,554,134
Coal	2,299,500	3.77	$22,956,138	$286,084,219
Total	**3,066,000**		**$24,926,425**	**$310,638,353**

Source: sensitivity modelling; see Table 25 in Annex B for details of assumptions and methodology.

Table 7: Solar PV: summary of avoided subsidies for 250 MW of solar PV replacing baseline technologies of coal and natural gas

TYPE OF TECHNOLOGY	ELECTRICITY GENERATION (MWH)	SUBSIDY PER MWH (USD/MWH)*	AVOIDED SUBSIDIES PER YEAR	PV OF AVOIDED SUBSIDIES OVER 20 YEARS
Solar PV	328,500	0	0	0
Baseline Technologies:**				
Natural Gas	82,125	1.49	$211,102	$2,630,800
Coal	246,375	3.77	$2,459,586	$30,651,881
Total	**328,500**		**2,670,688**	**$33,282,681**

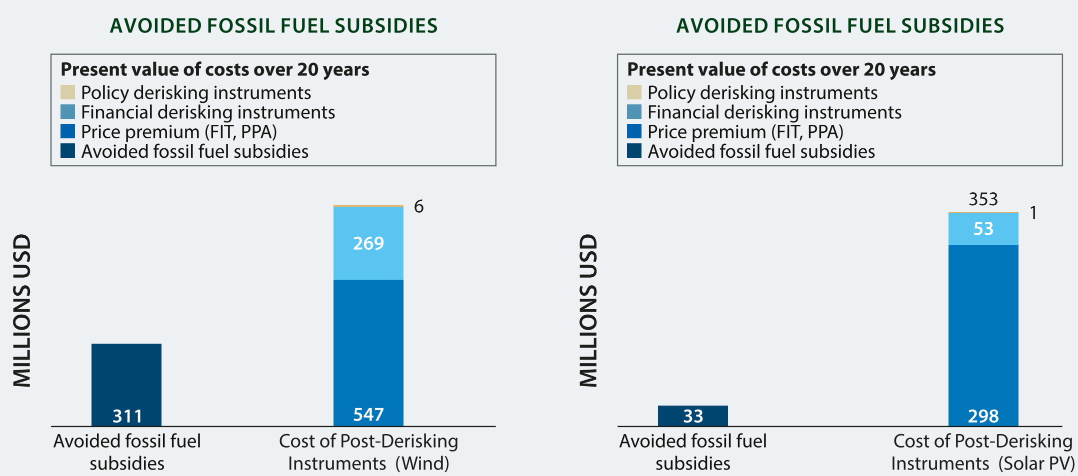
Source: sensitivity modelling; see Table 24 in Annex B for details of assumptions and methodology.

*Subsidy per MWh of fuel is calculated based on IEA's 2014 subsidy estimates for coal and natural gas in Kazakhstan as well as the

**Baseline assumption of 50% BM: 50% OM for the DREI analysis holds for this avoided fossil fuel subsidy analysis, with the following breakdown: 25% new natural gas, 25% new coal, and 50% old coal. Analysis assumes that 2014 subsidy levels remain constant and the present value of subsidies is calculated at the public cost of capital of 5%.

Figure 18 below compares the cost of public derisking instruments for wind and solar PV with the present value of avoided subsidies for fossil fuels over 20 years. In the case of wind energy, a significant installed capacity of 1 GW coupled with an abundance of wind resources means that the avoided subsidies of USD 310.6 million have a meaningful effect, covering more than the cost of policy and financial derisking instruments (USD 275.6 million).

Figure 18: Avoided fossil fuel subsidies in comparison to policy and financial derisking costs



Source: modelling; see Table 16 (wind) and Table 17 (solar PV), as well as Annex B for details of assumptions and methodology.

2. Sensitivity analyses on baseline selection

The baseline selection is an important decision that has considerable implications on results of the DREI analysis. Section 4.1.2 provides a detailed explanation of the baseline assumptions for the base case. This is especially the case when an operating margin is selected, whereby the electricity generation plants are fully-depreciated, with only operations and maintenance and fuel costs are accounted for. Tables 8 and 9 below illustrate the impact of varying the baseline selection from operating margin to build margin on FiT/price premium payments.

Table 8: Wind: impact of baseline selection on premium payments

TYPE OF SENSITIVITY	BASELINE TECHNOLOGIES	BASELINE LCOE (USD/kWh)	POST-DERISKING WIND LCOE (USD/kWh)	PRESENT VALUE OF PRICE PREMIUM/FiT PAYMENTS OVER 20 YEARS (USD MILLIONS)
Base case: 50% Operating Margin 50% Build Margin	50% Existing Coal 25% New Coal 25% New Natural Gas	5.7	7.1	$546.8
100% Operating Margin	100% Existing Coal	4.4	7.1	$1,039.2
100% Build Margin	50% New Coal 50% New Natural Gas	7.0	7.1	$54.5
100% Build Margin	100% New Coal	8.1	7.1	$0

Table 9: Solar PV: impact of baseline selection on premium payments

TYPE OF SENSITIVITY	BASELINE TECHNOLOGIES	BASELINE LCOE (USD/kWh)	POST-DERISKING SOLAR PV LCOE (USD/kWh)	PV OF PRICE PREMIUM/FiT PAYMENTS OVER 20 YEARS (USD MILLIONS)
Base case: 50% Operating Margin 50% Build Margin	50% Old Coal 25% New Coal 25% New Natural Gas	5.7	13.0	$298.5
100% Operating Margin	100% Old Coal	4.4	13.0	$351.2
100% Build Margin	50% New Coal 50% New Natural Gas	7.0	13.0	$245.7
100% Build Margin	100% New Coal	8.1	13.0	$198.7

If a build margin baseline of 50% new coal and 50% new natural gas plants is selected, the present value of premium payments for 20 years for wind energy is reduced from USD 546.8 million (combined margin) to USD 54.5 million. If a build margin with 100% new coal plants is selected, wind energy's LCOE becomes lower cost than the baseline, removing the need for premium payments.

3. Sensitivity analyses varying key input assumptions

These have been performed for the following input assumptions: (i) investment costs, (ii) capacity factor, (iii) fuel costs, and (iv) financing cost (CoE and CoD). The sensitivity analyses give an indication of the degree to which each input parameter affects the outputs. In each case, all other assumptions have been kept constant[29]. The results for this type of sensitivity are summarized in Table 10 and Table 11.

For instance, an increase in the capacity factor from 35% (base case) to 40% (sensitivity analysis) reduces the post-derisking LCOE for wind energy in the base case scenario from USD 7.1 cents per kWh to USD 6.2 cents per kWh.

Table 10: Wind energy: summary of LCOE outputs for sensitivity analysis on key input assumptions [USD cents/kWh]

TYPE OF SENSITIVITY	DESCRIPTION OF SENSITIVITY	BASELINE LCOE	WIND BAU LCOE	WIND POST-DERISKING LCOE
Base Case		**5.7**	**9.2**	**7.1**
Wind Investment Costs	Higher investment costs; uses 2016 investment costs (2,000,000 USD/MW), as provided by some developers (Base case is 2019 estimate: 1,630,000 USD/MW)	-	11.1	8.5
Wind Capacity Factor	Higher capacity factor. Sensitivity uses 40% (Base case is 35%)	-	8.1	6.2
Fuel Costs	20% higher fuel cost projections 20% lower fuel cost projections	6.3 5.1	-	-
Financing Costs	1% point higher financing costs (CoE=17.0%, CoD=8%)	-	9.7	7.3
	1% point lower financing costs (CoE=15.0%, CoD=6%) (Base case is CoE=16.0%, CoD=7 %)	-	8.8	7.0

Source: sensitivity modelling; see Table 17 and Annex B for details of assumptions and methodology.

[29] Note that keeping all other assumptions constant is a simplifying approach. For example, if higher capacity factors for wind energy are the result of larger turbines (as opposed to improved wind energy sites), a different approach may be to also increase investment costs.

Table 11: Solar PV: summary of LCOE outputs for sensitivity analysis on key input assumptions [USD cents/kWh]

TYPE OF SENSITIVITY	DESCRIPTION OF SENSITIVITY	BASELINE LCOE	SOLAR PV BAU LCOE	SOLAR PV POST-DERISKING LCOE
Base Case		**5.7**	**16.9**	**13.0**
Solar PV Investment Costs	Lower investment costs; uses 2016 investment costs (900,000 USD/MW), as provided by some developers (Base case is 2019 estimate: 1,299,000 USD/MW)	-	12.3	9.6
Solar PV Capacity Factor	Higher capacity factor Sensitivity uses 17% (Base case is 15%)	5.7	14.9	11.5
Fuel Costs	20% higher gas cost projections 20% lower gas cost projections	6.3 5.1	-	-
Financing Costs	1% point higher financing costs (CoE=17.0%, CoD=8%)	-	17.8	13.3
	1% point lower financing costs (CoE=15.0%, CoD=6%)	-	16.1	12.7
	(Base case is CoE=16.0%, CoD=7%)			

Source: sensitivity modelling; see Table 18 and Annex B for details of assumptions and methodology

4. Sensitivity analyses on public instrument selection and cost-effectiveness

Two types of sensitivities have been performed on public derisking instruments: (i) on selecting different sub-sets of instruments, and (ii) on the cost-effectiveness of individual instruments. Detailed descriptions for each instrument are found in Table 2. For these sensitivity analyses, the key relationship to analyse is between the cost of the instruments versus their impact on lowering generation costs, and hence the economic savings they create.

The following findings become evident from the results of these sensitivities. First, the sensitivities show that implementing public derisking measures are always cost effective, across all the scenarios. In other words, investment in the cost of derisking instruments is always more than paid back in terms of lower generation costs and economic savings. Second - with an important caveat, below - the findings show a range of the cost-effectiveness across instruments, with policy derisking instruments generally being more cost-effective than financial derisking instruments.

An important caveat is that the modelling cannot tell us whether a particular instrument is necessary; for example, while less cost-effective, financial derisking instruments, such as public loans, may be necessary at this stage of Kazakhstan's market development; likewise, power market risk activities, which encompass issues such as legislation and bidding processes, while less cost-effective than other policy derisking measures, may similarly be necessary. Therefore selecting and/or eliminating particular instruments based on cost-effectiveness alone may come with risks, and may reduce the chances of meeting Kazakhstan's investment targets.

(i) Sub-sets of instruments

While the base case scenario considers the complete set of instruments listed in Table 1, this type of sensitivity analysis examines the impact and cost-effecti veness of different sub-sets of public instruments: only policy derisking instruments; only financial derisking instruments; and, only instruments targeting those risk categories with the highest impact on financing cost. The key results for this type of sensitivity are summarized in Table 12 and Table 13 below.

Table 12: Wind energy: summary of key outputs for sensitivity analysis on sub-sets of derisking instruments

SCENARIO	DESCRIPTION OF SCENARIO	POST-DERISKING COST OF FINANCING		POST-DERISKING LCOE (USD cents/KWh)	COST OF INSTRUMENTS (USD million)	SAVINGS TO THE ECONOMY (USD million)
		EQUITY	DEBT			
Base case	Base case instruments	13.2%	5.5%	7.1	Policy: 6.3 Financial: 269.3 Total: 275.6	804.7
Policy derisking only	Policy derisking instruments only	15.3%	6.7%	8.5	Policy: 6.3 Financial: -	292.6
Financial derisking only	Financial derisking instruments only	13.8%	5.8%	7.3	Policy: - Financial: 271.7	748.6
High impact risk categories	Policy & financial derisking instruments addressing only high impact risk categories	13.9%	5.9%	7.3	Policy: 3.9 Financial: 246.7 Total: 250.7	739.4

Table 13: Solar PV: summary of key outputs for sensitivity analysis on sub-sets of derisking instruments

SCENARIO	DESCRIPTION OF SCENARIO	POST-DERISKING COST OF FINANCING		POST-DERISKING LCOE (USD cents/KWh)	COST OF INSTRUMENTS (USD million)	SAVINGS TO THE ECONOMY (USD million
		EQUITY	DEBT			
Base case	Base case instruments	13.2%	5.5%	13.0	Policy: 0.9 Financial: 53.2 Total: 54.1	160.5
Policy derisking only	Policy derisking instruments only	15.3%	6.7%	15.5	Policy: 0.9 Financial: -	58.3
Financial derisking only	Financial derisking instruments only	13.8%	5.8%	13.3	Policy: - Financial: 53.7	149.2
High impact risk categories	Policy & financial derisking instruments addressing only high impact risk categories	13.9%	5.9%	13.3	Policy: 0.4 Financial: 48.8 Total: 49.2	147.4

(ii) Cost-effectiveness of individual instruments

This type of sensitivity analysis examines the cost-effectiveness of individual instruments, in both the policy derisking instrument and financial derisking instrument categories. In order to have comparability between instruments, the metric used to analyse this sensitivity is the USD cost of each instrument required to lower the LCOE by USD 1/10th of a cent/kWh[30]. The lower the USD cost of this metric, the more cost-effective the instrument is. The sensitivities on public instrument selection show a range of cost-effectiveness, but that overall implementing public derisking instruments is always more cost effective than paying higher generation costs, across all scenarios. Table 14 below sets out the results of the sensitivities on individual instrument cost-effectiveness.

[30] This metric is sensitive to the particular investment target; therefore it can be misleading, particularly for instruments with variable cost components, to compare this metric across investment targets or technologies.

Table 14: Wind and solar PV: summary of results for sensitivity analysis on the cost-effectiveness of individual instruments

RISK CATEGORY	INSTRUMENT	WIND (1 GW) USD cost of instrument/ USD 1/10th of a cent of impact on post-derisking LCOE	SOLAR (250 MW) USD cost of instrument/ USD 1/10th of a cent of impact on post-derisking LCOE
POLICY DERISKING INSTRUMENTS			
Power Market Risk	Various	$1,807,941	$100,733
Permits Risk	Various	$1,655,110	$92,144
Social Accept. Risk	Various	$463,289	$25,813
Developer Risk	Various	$4,749,680	$1,130,286
Grid/Transmission Risk	Various	$1,918,563	$106,897
Counterparty Risk	Various	$507,306	$28,266
Financial Sector Risk	Various	$910,790	$50,706
FINANCIAL DERISKING INSTRUMENTS			
Grid/Transmission Risk	Take or Pay Clause	$20,664,308	$2,162,382
Counterparty Risk	Government Guarantee	$82,063,796	$8,587,431
Counterparty & Financial Sector Risk	Public Loans	$18,315,106	$1,961,134
Currency/Macroeconomic Risk	Partial Indexing	$8,512,745	$890,802

5. Sensitivity analyses on approach to costing financial derisking instruments

The costing of financial derisking instruments is complex, where different approaches can be taken, each with their pros and cons. For example, a conservative costing methodology may cost public loans at their face value, where a USD 50 million loan is assumed to cost USD 50 million. A less conservative methodology may take a loss reserve approach, for example applying a cost of 25% of a USD 50 million loan. A more aggressive costing methodology may assign zero cost to public loans, assuming that the loans should be paid back in full, and that providers of public loans will price in any default risk and cost of capital in the loan's terms and fees.

This sensitivity analysis assumes the same financial derisking instruments in all scenarios, and then examines these alternative costing approaches, analysing a high-cost scenario and a low-cost scenario. The assumptions behind these approaches are provided in Annex B. The key cost figures resulting from the different costing approaches are summarized in Table 15 and Table 16 below. The results illustrate that the approach taken can have a meaningful impact on the ratios, with the low-cost approaches resulting in very attractive performance metrics.

Table 15: Wind energy: summary of public cost outputs for sensitivity analysis varying costing approach for financial derisking instruments

SCENARIO	DESCRIPTION OF SCENARIO	COST TO PUBLIC (USD million)				SAVINGS RATIO	CARBON ABATEMENT COST* (USD/tCO_2)
		Actual/ Opp cost	Loss reserves	Face Value	Total Cost		
Base case	Actual cost for take or pay and partial indexing product; opportunity cost for government guarantee; loss reserves for public loans	116.5	152.8	0	269.3	2.9 x	14.6 (-39.1%)
High-cost approach	Actual cost for take or pay and partial indexing product; face value for government guarantee and public loans	42.1	0	830.0	872.1	0.9 x	25.3 (+5.5%)
Low-cost approach	Actual cost for take or pay and partial indexing product; no cost for government guarantee and public loans	42.1	0	0	42.1	16.6x	10.6 (-56.0%)

* In parentheses: relative change compared to pre-derisking carbon abatement cost of 24.0 USD/tCO_2e.

Table 16: Solar PV: summary of public cost outputs for sensitivity analysis varying costing approach for financial derisking instruments

SCENARIO	DESCRIPTION OF SCENARIO	COST TO PUBLIC (USD million)				SAVINGS RATIO	CARBON ABATEMENT COST* (USD/tCO_2)
		Actual/ Opp cost	Loss reserves	Face Value	Total Cost		
Base case	Actual cost for take or pay and partial indexing product; opportunity cost for government guarantee; loss reserves for public loans	22.7	30.4	0	53.2	3.0 x	58.4 (-23.2%)
High-cost approach	Actual cost for take or pay and partial indexing product; face value for government guarantee and public loans	8.2	0	164.5	172.7	0.9 x	78.3 (+2.9%)
Low-cost approach	Actual cost for take or pay and partial indexing product; no cost for government guarantee and public loans	8.2	0	0	8.2	17.5x	51.0 (-33.0%)

* In parentheses: relative change compared to pre-derisking carbon abatement cost of 76.1 USD/tCO_2e.

4.2.5 Summary Data Tables

Table 17: Summary modelling assumptions for wind energy in Kazakhstan

WIND TARGET AND RESOURCES	
2021 Target (in MW)	1,000
Capacity Factor (%)	35%
Total Annual Energy Production for Target (in MWh)	3,066,000
MARGINAL BASELINE: COMBINED MARGIN	
Energy Mix	
Build Margin Natural Gas (CCGT, new plants): 25% Coal (new plants): 25%	
Operating Margin Coal (existing plants): 50%	
Grid Emission Factor (tCO$_2$e/MWh)	0.918
GENERAL COUNTRY INPUTS	
Effective Corporate Tax Rate (%)	20%
Public Cost of Capital (%)	5%

	BUSINESS-AS-USUAL SCENARIO		POST-DERISKING SCENARIO
FINANCING COSTS			
Capital Structure			
Debt/Equity Split	70%/30%		75%/25%
Cost of Debt			
Concessional public loan	N/A		5.0%
Commercial loans with public guarantees	N/A		N/A
Commercial loans without public guarantees	7.0%		5.5%
Loan Tenor			
Concessional public loan	N/A		20 years
Commercial loans with public guarantees	N/A		N/A
Commercial loans without public guarantees	8 years		10 years
Cost of Equity	16.0%		13.2%
Weighted Average Cost of Capital (WACC) (After-tax)	8.7%		6.5%
INVESTMENT			
Total Investment (USD million)	$1630.0		$1630.0
Debt (USD million)			
Concessional public loan	$0.0		$611.3
Commercial loans with public guarantees	$0.0		$0.0
Commercial loans without public guarantees	$1,141.00		$611.3
Equity (USD million)	$489		$407.5
COST OF PUBLIC INSTRUMENTS			
Policy Derisking Instruments (USD million, present value)			
Power Market Risk Instruments	N/A		$3.2
Permits Risk Instruments	N/A		$0.5
Social Acceptance Risk Instruments	N/A		$0.3
Developer Risk Instruments	N/A		$0.8
Grid/Transmission Risk Instruments	N/A		$0.9
Counterparty Risk Instruments	N/A		$0.3
Financing Risk Instruments	N/A		$0.4
Total	N/A		$6.3
Financial Derisking Instruments (USD million, present value)			
Grid/Transmission Risk Instruments	N/A		$24.8
Counterparty Risk Instruments	N/A		$74.4
Financing Risk Instruments	N/A		N/A
Public Loans	N/A		$152.8
Public Guarantees for Commercial Loans	N/A		N/A
Political Risk Insurance	N/A		N/A
Currency/Macro Risk Instruments	N/A		$17.4
Total	N/A		$269.3
Direct Financial Incentives (USD million)			
Present Value of 20 year PPA Premium	$1,351.5		$546.8

Table 18: Summary modelling assumptions for solar PV in Kazakhstan

SOLAR PV TARGET AND RESOURCES	
2030 Target (in MW)	250
Capacity Factor (%)	19.8%
Total Annual Energy Production for Target (in MWh)	521,132
MARGINAL BASELINE: COMBINED MARGIN	50% BM: 50% OM
Energy Mix	
Build Margin Natural Gas (CCGT, new plants): 25% Coal (new plants): 25%	
Operating Margin Coal (existing plants): 50%	
Grid Emission Factor (tCO_2e/MWh)	0.918
GENERAL COUNTRY INPUTS	
Efective Corporate Tax Rate (%)	20%
Public Cost of Capital (%)	5%

	BUSINESS-AS-USUAL SCENARIO		POST-DERISKING SCENARIO
FINANCING COSTS			
Capital Structure			
Debt/Equity Split	70%/30%		75%/25%
Cost of Debt			
Concessional public loan	N/A		5.0%
Commercial loans with public guarantees	N/A		N/A
Commercial loans without public guarantees	7.0%		5.5%
Loan Tenor			
Concessional public loan	N/A		20 years
Commercial loans with public guarantees	N/A		N/A
Commercial loans without public guarantees	8 years		10 years
Cost of Equity	16.0%		13.2%
Weighted Average Cost of Capital (WACC) (After-tax)	8.7%		6.5%
INVESTMENT			
Total Investment (USD million)	$324.8		$324.8
Debt (USD million)			
Concessional public loan	$0.0		$48.83
Commercial loans with public guarantees	$0.0		$0.0
Commercial loans without public guarantees	$227.3		$121.8
Equity (USD million)	$97.4		$81.2
COST OF PUBLIC INSTRUMENTS			
Policy Derisking Instruments (USD million, present value)			
Power Market Risk Instruments	N/A		$0.3
Permits Risk Instruments	N/A		$0.0
Social Acceptance Risk Instruments	N/A		$0.0
Developer Risk Instruments	N/A		$0.4
Grid/Transmission Risk Instruments	N/A		$0.1
Counterparty Risk Instruments	N/A		$0.0
Financing Risk Instruments	N/A		$0.0
Total	N/A		$0.9
Financial Derisking Instruments (USD million, present value)			
Grid/Transmission Risk Instruments	N/A		$4.8
Counterparty Risk Instruments	N/A		$14.5
Financing Risk Instruments	N/A		N/A
Public Loans	N/A		$30.4
Public Guarantees for Commercial Loans	N/A		N/A
Political Risk Insurance	N/A		N/A
Currency/Macro Risk Instruments	N/A		$3.4
Total	N/A		$53.2
Direct Financial Incentives (USD million)			
Present Value of 20 year PPA Premium	$458.9		$298.5

5. Conclusion and Next Steps

Conclusion and Next Steps

5

The results in this report should not be interpreted as a definitive quantitative analysis of wind energy and solar PV in Kazakhstan but, rather, as one contribution to the larger policy decision-making process.

The results confirm that financing costs for wind energy and solar PV in Kazakhstan are currently high, particularly in comparison to countries with more favourable investment environments. The cost of equity for wind energy and solar PV in Kazakhstan today is estimated at 16% (USD), and the cost of debt at 7% (USD). The modelling evaluates nine different risk categories regarding their contribution to these higher financing costs in Kazakhstan. Five of these risk categories contribute to more than 1% point (100 basis points) to high financing costs. These include power market risk, grid/transmission risk, counterparty risk, financial sector risk, and currency and macroeconomic risk.

The results identify a comprehensive package of public derisking measures to achieve the report's 2021 (5 year) investment objectives for wind and solar PV in the near-term. These targets can be viewed as the first, phased step to achieving the government's official 2030 targets of 5 GW in wind energy and 500 MW in solar energy, as set out in its *Green Economy Concept Note* (Republic of Kazakhstan, 2013). These public derisking measures, consisting of a collection of policy and financial instruments, systematically target the identified investment risk categories. Table 1 itemises each of the measures. The modelling also estimates the public cost of these measures until 2021.

A key conclusion from the modelling is that investing in derisking instruments is a cost-effective approach for achieving Kazakhstan's wind and solar PV investment objectives. The derisking measures that are modelled bring down the generation cost of wind energy from USD 9.2 cents per kWh to USD 7.1 cents per kWh, and solar PV energy from USD 16.9 cents per kWh to USD 13.0 cents per kWh.

- For wind energy, in the *business-as-usual* scenario, the modelling estimates that a premium price totalling USD 1.4 billion will be required over the next 20 years to achieve the 2021 target. However, if over the same period a total investment of USD 275.6 million is made in derisking measures, wind energy will become 23% cheaper and the price premium price reduces to USD 546.8 million, thereby saving USD 804.7 million in generation costs over the next 20 years.
- For solar PV, in the *business-as-usual* scenario, the modelling estimates that a premium price totalling USD 458.9 million will be required over the next 20 years to achieve the 2021 target. However, if over the same period a total investment of USD 54.1 million is made in derisking measures, solar PV will also become 23% cheaper and the price premium price reduces to 298.5 million, thereby saving USD 160.5 million in generation costs over the next 20 years.

The results demonstrate how investing in public derisking measures creates significant economic savings, both in meeting this report's 2021 (5 year) investment targets, as well as the official 2030 targets. The modelling clearly shows that investing in public derisking measures should in every case be more cost-effective for Kazakhstan, compared to an alternative of paying higher generation costs.

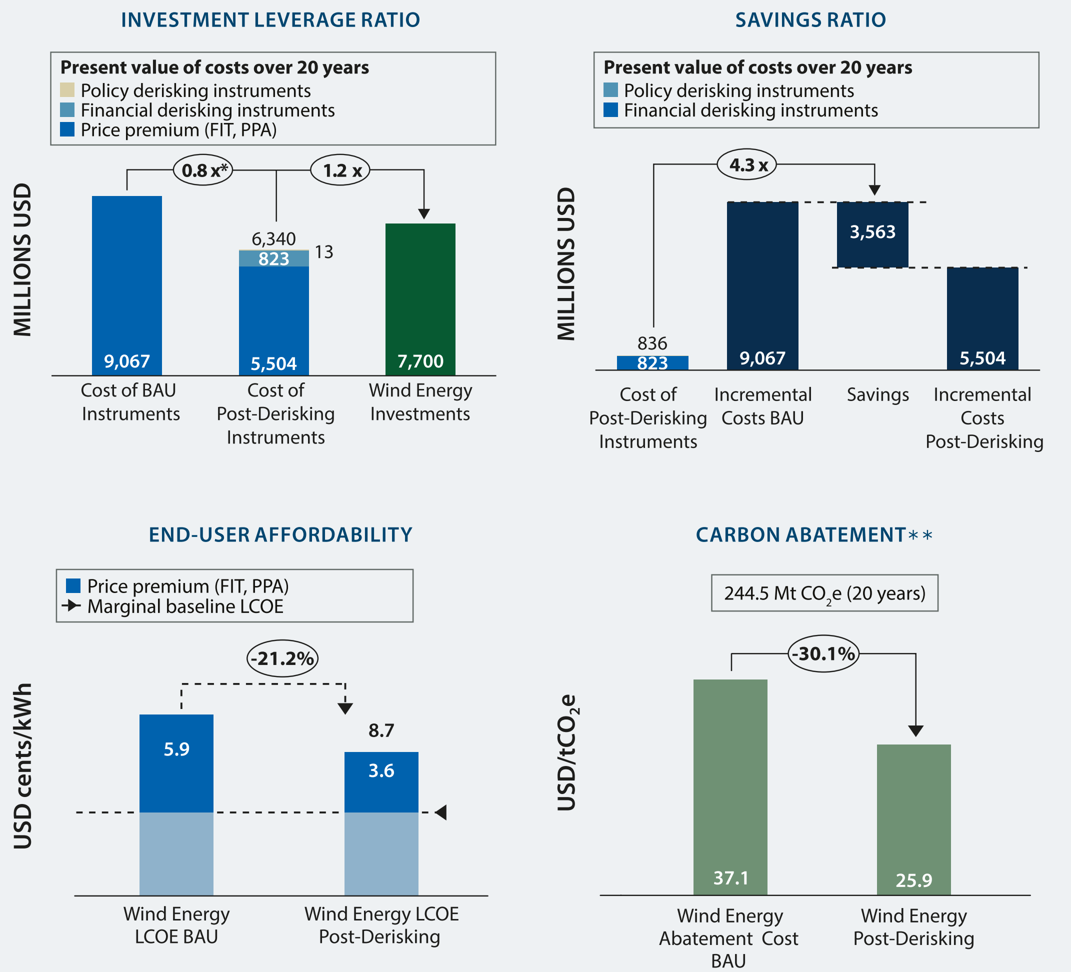
In recent years Kazakhstan has put in place a number of derisking measures to promote renewable energy. The opportunity for policymakers in Kazakhstan is to now pursue further derisking, both reforming the design of existing measures and implementing new measures, targeting unaddressed investment risks. By derisking the investment environment to meet this report's 2021 (5 year) targets, this can then kick-start the utility-scale investment flows necessary to achieve the official 2030 targets. The end result can be more reliable, affordable and clean power for Kazakh citizens.

Annexes

Annexes

ANNEX A: SUMMARY OF 2030 RESULTS

Figure 19: Performance metrics for the selected package of derisking instruments in promoting 5 GW of wind investment in Kazakhstan

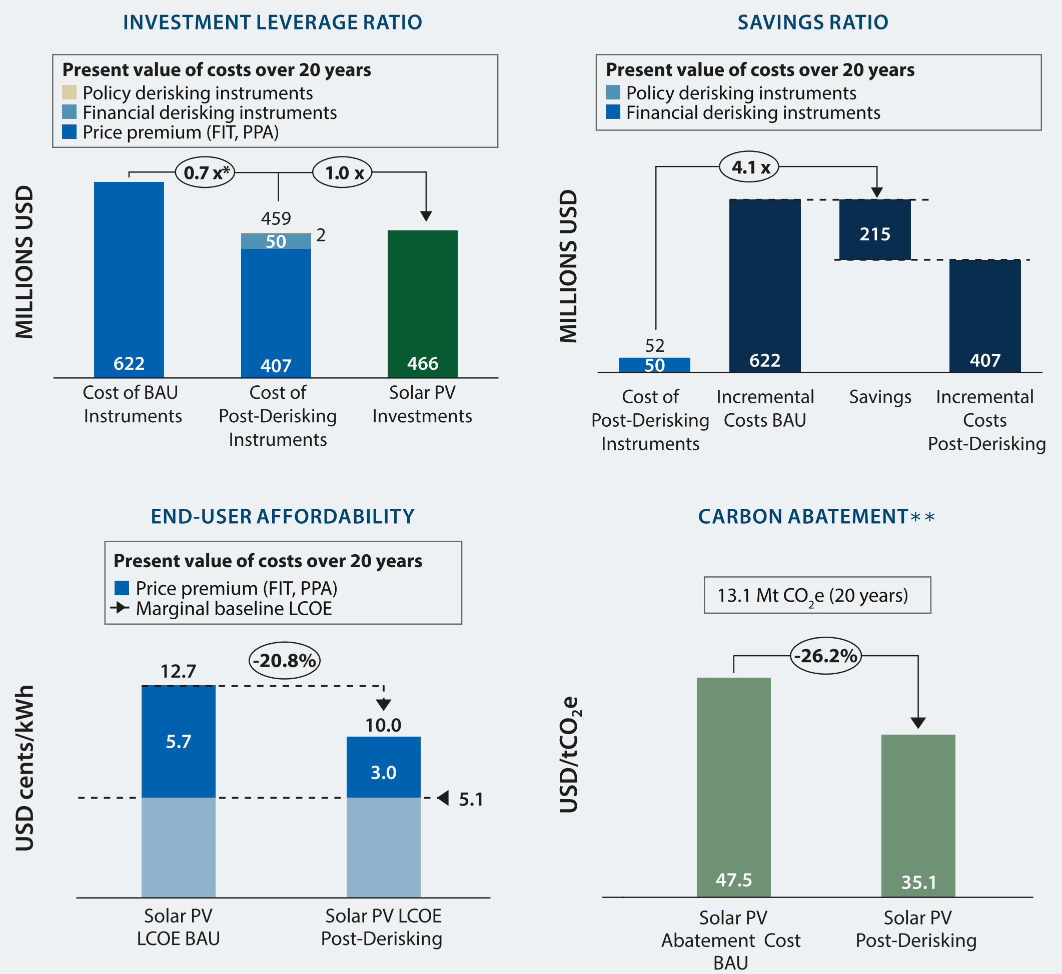


Source: modelling; see Annex B for details of assumptions and methodology.

*In the BAU scenario, the full 2030 investment target may not be met.

** The Carbon Abatement metric can be broken down into the costs of policy derisking instruments, financial derisking instruments and the price premium. While in the BAU scenario, the total of USD 37.1 per tCO_2e is due to the price premium, in the post-derisking scenario, this breakdown for the total of USD 25.9 per tCO_2e is USD 0.1, USD 3.4 and USD 22.5, respectively.

Figure 20: Performance for the selected package of derisking instruments in promoting 500 MW of solar PV investment in Kazakhstan



Source: modelling; see Annex B for details of assumptions and methodology.

*In the BAU scenario, the full 2030 investment target may not be met.

** The Carbon Abatement metric can be broken down into the costs of policy derisking instruments, financial derisking instruments and the price premium. While in the BAU scenario, the total of USD 47.5 per tCO_2e is due to the price premium, in the post-derisking scenario, this breakdown for the total of USD 35.1 per tCO_2e is USD 0.2, USD 3.9 and USD 31.1, respectively.

ANNEX B: METHODOLOGY AND DATA

This annex sets out the methodology, assumptions and data that have been used in performing the modelling described in this report.

The modelling closely follows the methodology set out in the UNDP Derisking Renewable Energy Investment Report (2013) ("DREI report (2013)"). This annex is organized in line with the four stages of the DREI report's framework: the Risk Environment Stage (Stage 1), the Public Instrument Stage (Stage 2), the Levelised Cost Stage (Stage 3) and the Evaluation Stage (Stage 4). Both wind energy and solar PV are addressed under each stage.

In addition, the modelling uses the financial tool (in Microsoft Excel) created for the DREI report framework. The financial tool is denominated in 2017 US dollars and covers a core period from January 1, 2017 (approximating the present time) to December 31, 2021[31]. Generation technologies have asset lifetimes which extend beyond 2021, and this is captured by the financial tool.

The DREI report and the financial tool are available for download at www.undp.org/DREI.

A.1 Risk Environment (Stage 1)

The data for the Risk Environment Stage come from three principal sources:

- 12 structured interviews with investors and developers in wind energy and solar PV in Kazakhstan.
- 2 structured interviews with RE investors in the best-in-class country, held by UNDP's DREI work team.
- Multiple informational interviews with and inquiries to the interviewees and other public and RE actors, including government officials, international development practitioners and domestic renewable energy actors.

In order to gather these data, the UNDP project team made a field mission to Astana in June 2016. Three structured interviews as well as a number of inquiries were conducted remotely.

Deriving a Multi-Stakeholder Barrier and Risk Table

The multi-stakeholder barrier and risk table for wind energy and solar PV is derived from the generic table for utility-scale, renewable energy introduced in the DREI report (2013; Section 2.1.1). It is composed of 9 risk categories and 21 underlying barriers. These risk categories, barriers and their definitions can be found in Table 2 in the body of this report.

[31] This period reflects the 2021 targets, guided by the vision set out in the Republic of Kazakhstan's "Concept for Transition to a Green Economy," adopted in May 2013.

Calculating the Impact of Risk Categories on Higher Financing Costs

The basis of the financing cost waterfalls produced by the modelling is structured, quantitative interviews undertaken with wind energy and solar PV investors and developers. The interviews were performed on a confidential basis, and all data across interviews were aggregated together. The interviews and processing of data followed the methodology described in Box 2 below, with investors scoring each risk category according to (i) the probability of occurrence of negative events and (ii) the level of financial impact of these events (should they occur), as well as also scoring (iii) the effectiveness of public instruments to address each risk category. Investors were also asked to provide estimates of their cost of equity, cost of debt, capital structure and loan tenors. Interviewees were provided beforehand with an information document setting out key definitions and questions, and the typical interview took between 45 and 60 minutes.

Box 2: Methodology for quantifying the impact of risk categories on higher financing costs

1. Interviews

Interviews were held with debt and equity investors active in wind energy and solar PV in Kazakhstan, as well as in the selected best-in-class country, Germany. The interviewees were asked to provide two types of data:

- Scores for the various risk categories identified in the barrier and risk framework. The two interview questions used to quantify the risk categories are set out in Figure 21.
- The current cost of financing for making an investment today, which represents the end-point of the waterfall (or the starting point in the case of the best-in-class country).

Figure 21: Interview questions to quantify the impact of risk categories on the cost of equity and debt

Q1: How would you rate the probability that the events underlying the particular risk category occur?

UNLIKELY **1** ○ **2** ○ **3** ○ **4** ○ **5** ○ VERY LIKELY

Q2: How would you rate the financial impact of the events underlying the particular risk category, should the events occur?

LOW IMPACT **1** ○ **2** ○ **3** ○ **4** ○ **5** ○ HIGH IMPACT

(Continued over the next page)

Box 2: Methodology for quantifying the impact of risk categories on higher financing costs

2. Processing the data gathered

The data gathered from interviews are then processed. The methodology involves identifying the total difference in the cost of equity or debt between the high financing environment (Kazakhstan) and the best-in-class developed country (Germany). This figure for the total difference reflects the total additional financing cost in the developing country.

The interview scores provided for each risk category address both components of risk: the probability of a negative event occurring above the probability of such an event occurring in a best-in-class country and the financial impact of the event if such an event occurs (see DREI Report (2013; Section 2.1.1)). These two ratings are then multiplied to obtain a total score per risk category. These total risk scores are then used to prorate and apportion the total difference in the cost of equity or debt.

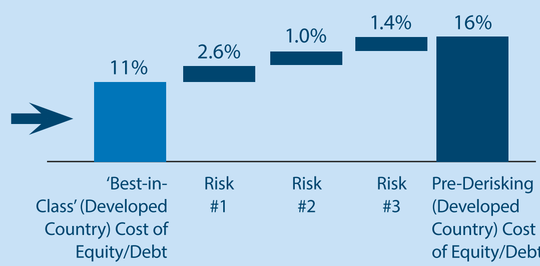
A very simplified example, demonstrating the basic approach, is demonstrated in Figure 22.

Figure 22: Illustrative simplified application of the methodology to determine the impact of risk categories on increasing financing costs

COST OF EQUITY	
Developing Country	16%
Best-in-class Developed Country	11%
Total Diference	**5%**

INVESTOR RISK SCORES FOR COST OF EQUITY	Incremental Score for Probability		Score for Impact		**Total Risk Score**
Risk Category # 1	4	X	4	=	16
Risk Category # 2	2	X	3	=	6
Risk Category # 3	3	X	3	=	9
				Total Across all Risks	**31**

PRO-RATING RISK SCORES ACROSS COST OF EQUITY	Pro-rated Risk Score		Total Diference for Cost of Equity		**Risk Category Cost of Equity**
Risk Category # 1	16/31	X	5%	=	2.6%
Risk Category # 2	6/31	X	5%	=	1.0%
Risk Category # 3	9/31	X	5%	=	1.4%
				Total Across all Risks	**5.0%**



In addition, the following key steps have been taken in calculating the financing cost waterfalls:

- In order to make interviews comparable, investors were asked to provide their scores while taking into account a list of eight key assumptions regarding wind energy or solar PV investment, as set out in Boxes 3 and 4 respectively. To maintain consistency, these assumptions were subsequently used to shape the inputs in the LCOE calculation for wind energy in Stage 3.

Box 3: The eight investment assumptions for wind energy in Kazakhstan

1. Provide scores based on the current investment environment in Kazakhstan today
2. Assume you have the opportunity to invest in a 50-100 MW on-shore wind farm
3. Assume 2-3 MW class turbines from a quality manufacturer with a proven track record (eliminating certain technology risks)
4. Assume a build-own-operate (BOO) business model
5. Assume a comprehensive O&M contract (eliminating certain technology risks)
6. Assume that transmission lines with free capacities and directly connected to the high-voltage grid of KEGOC are relatively close to the project site (within 10 km)
7. Assume an EPC sub-contractor, qualified for renewable energy, with high penalties for breach of contract (eliminating certain technology risks)
8. Assume a non-recourse, project finance structure

Box 4: The eight investment assumptions for solar PV in Kazakhstan

1. Provide scores based on the current investment environment in Kazakhstan today
2. Assume you have the opportunity to invest in a 1-10 MW solar PV plant (eliminating certain technology risks)
3. Assume a high quality c-Si PV panel manufacturer with proven track record
4. Assume a build-own-operate (BOO) business model
5. Assume a comprehensive O&M contract (eliminating certain technology risks)
6. Assume that transmission lines with free capacities and directly connected to the high-voltage grid of EDL are relatively close to the project site (within 10 km)
7. Assume an EPC sub-contractor, qualified for renewable energy, with high penalties for breach of contract (eliminating certain technology risks)
8. Assume a non-recourse, project finance structure

- Equity investors in renewable energy typically have greater exposure to development risks. The modelling uses the full set of 9 risk categories for equity investors. The 'permits risk' and 'financing risk' categories are removed for debt investors, assuming that banks will have prerequisites, such as having licenses, technical feasibility studies, and equity financing in place, before considering a funding request. As such, the modelling uses 7 risk categories for debt investors.

- The modelling selects Germany as the example of a best-in-class investment environment for wind energy and solar PV. Germany is generally considered by international investors to have a very well-designed and implemented policy and regulatory regime, with minimal risk for all nine of the investment risk categories. In this way, Germany serves as the baseline – the left-most column of the financing cost waterfall.

- The Risk Environment Stage (Stage 1) differentiates between the answers from equity and from debt investors, but it does not distinguish further between investors with focus on wind energy and investors with focus on solar PV.

Public Cost of Capital

The modelling takes a bottom-up approach to the calculation of the public cost of capital. In this case, the public cost of capital is denominated in USD. The bottom-up approach can then be summarized as follows:

Public Cost of Capital (USD) = Risk-free Rate (USD) + Country Risk Premium

The risk-free rate is taken as the 10-year US Treasury bond rate and the country risk premium is estimated based on either the country's sovereign credit rating or the credit default swap (CDS) spread over the US, depending on the availability of information. Both input parameters are based on publicly available information, with the US 10-year Treasury bond data available from the US Department of Treasury, and the country risk premium data available from academic sources.

For this analysis, as of November 2016, the 10-year US Treasury Bond rate is estimated at 2%, and the country risk premium was estimated at 2.5% (Damodaran, 2017), resulting in a 5% (rounded) public cost of capital for Kazakhstan.

As the DREI analysis is carried out through its various stages, this bottom-up approach to calculating the public cost of capital is also a reference for the assumed cost of equity and debt assumptions, and is cross-checked in the interviews with industry participants in-country.

A.2 Stage 2- Public Instruments

Public Instrument Table

The public instrument table for wind energy and solar PV is derived from the generic table in the DREI report (2013, Section 2.2.1). The table is set out in full in Table 2 and includes the following modification:

- Following investor feedback who did not consider fossil fuel subsidies a risk, the set of policy derisking instruments for fossil-fuel subsidy reform (part of *power market risk*) is excluded from the modelling.
- Financial derisking instruments addressing the 'hardware purchase and manufacturing' barrier under developer risk were excluded from the modelling, as this barrier affects mainly locally manufactured hardware, which are not considered in the general investment assumptions (Boxes 3 and 4).
- Financial derisking instruments addressing the 'transmission infrastructure' barrier under *grid & transmission risk*, e.g., financial products to support grid infrastructure, are excluded in order to keep the modelling exercise manageable.
- Investor feedback revealed that while *political risk* has a moderate impact on financing costs, limited experience with products such as *political risk insurance* (PRI) and the fees associated with them led to investors shying away from utilizing them in Kazakhstan. Accordingly, the financial derisking instruments for this category (political risk insurance) are not modelled.

Policy Derisking Instruments

The following is a summary of the key approaches taken:

- *Public Cost.* Estimates for the public cost of policy derisking instruments are calculated based on bottom-up modelling. This follows the approach for costing set out in the DREI report (2013, Section 2.2.2.). Each instrument has been modelled in terms of the costs of: (i) full-time employees (FTE) at mean yearly costs of USD 7,200 per FTE, and (ii) external consultancies/services at USD 200,000, USD 100,000, and USD 50,000 per large, medium, and small contract, respectively. An annual inflation of 2% is assumed for both FTE and consultancies/service contract costs. Typically, full-time employees are modelled for the operation of an instrument (e.g. the full-time employees required to staff an energy regulator), and external consultancies/services are modelled for activities such as the design and evaluation of the instrument, as well as certain services such as publicity/awareness campaigns. Policy derisking measures are modelled for up to the 5-year period from 2017 to 2021. Data have been obtained from local experts and the UNDP's in-house experience. See Tables 17 and 18 for the cost estimates of policy derisking instruments.

- *Effectiveness*. Estimates for the effectiveness of policy derisking instruments in reducing financing costs are based on the structured interviews with investors, and then further adjusted to reflect UNDP's in-house experience. The assumptions for the final effectiveness are shown in Table 19. As certain policy derisking instruments may take time to become maximally effective, a linear ("straight-line") approach to time effects is modelled over the target period – this is referred to as the discount for time effects in the table. The qualitative investor feedback on policy derisking instruments' effectiveness is provided in Table 5 of the report.

Table 19: The modelling assumptions for policy derisking instruments' effectiveness

RISK CATEGORY	POLICY DERISKING INSTRUMENT	EFFECTIVENESS	DISCOUNT FOR TIME EFFECT (2017-2021)	DISCOUNT FOR TIME EFFECT (2017-2030)	SOURCE/COMMENT
Power Market Risk	Transparent, long-term national renewable energy strategy; Establishment of a transparent, clear IPP bidding process, with bankable PPA; Establishment of a renewable energy office in the regulator	75%	75%	50%	Source: authors. Interview responses: high effectiveness.
Permits Risk	Streamlined process for RE permits (dedicated one-stop shop); Contract enforcement and recourse mechanisms	50%	75%	50%	Source: authors. Interview responses: moderate effectiveness.
Social Acceptance Risk	Awareness raising campaigns	75%	75%	50%	Source: authors. Interview responses: high effectiveness.
Developer Risk	Technology R&D; support for industry associations	25%	75%	50%	Source: authors. Interview responses: low effectiveness.
Grid / Transmission Risk	Strengthen KEGOC's grid management capacity; Conduct transparent updates to the date grid code; Provide policy support for long-term national transmission/grid road-map	25%	75%	50%	Source: authors. Interview responses: low effectiveness.
Counterparty Risk	Reform and maintain creditworthy Financial Settlement Centre structure	25%	75%	25%	Source: authors. Interview responses: low effectiveness
Financial Sector Risk	Foster financial sector reform towards green infrastructure investment; Strength financial sector's familiarity with renewable energy and project finance	25%	75%	50%	Source: authors. Interview responses: low effectiveness.

Financial Derisking Instruments

The modelling assumptions for financial derisking instruments are informed by UNDP's in-house experience, including interviews with representatives from international financial institutions and interviews with project developers.

Empirically, the selection, pricing and costing of financial derisking instruments for a particular renewable energy investment are determined on a case-by-case basis, and reflect the particular risk-return characteristics of that investment. The modelling assumptions instead cover the aggregate investments for Kazakhstan's envisioned RE targets and represent a simplified, but plausible, formulation for the selection and pricing of financial derisking instruments. The following is a summary of the key assumptions used.

- *Cost*. Estimates of public cost of financial derisking instruments are set out in Table 20 below.

Table 20: The modelling assumptions on costing of financial derisking instruments

RISK CATEGORY	FINANCIAL DERISKING INSTRUMENT	DESCRIPTION OF MODELLING ASSUMPTIONS
Grid/ Transmission Risk	Take-or-Pay Clause in PPA[32]	• Assumes 1% of annual production is lost due to grid management (curtailment) or transmission failures (black-out/brown-out) • Assumes 100% of IPP's lost revenues due to grid management or transmission failures are reimbursed by take-or-pay clause
Counterparty Risk	Government (sovereign) Guarantee	• Assumes the Republic of Kazakhstan provides "Letter of Support" for each PPA entered into between KEGOC and the IPP • The public cost of this type of guarantee are modelled as opportunity cost to Republic of Kazakhstan from setting aside 12 months' worth of PPA payments at 3% cost of capital (public cost of capital of 5% minus 10y US Treasury bond rate of 2%)
Financial Sector Risk	Public Loan	• Assumes concessional (5% and 20-year tenor) USD loans from multilateral development banks to cover: o 50% of total debt needs in the 2017-2021 period. o 25% of the total debt needs in the 2017-2030 period. This reduction over the longer target period reflects the greater share of commercial lending as track record in renewable energy lending is built up. • Public cost: o Assumes the public cost is 25% (loss reserve) of the face value of the loan to the IPP (World Bank, 2011)
Currency/ Macroeconomic Risk	Partial Indexation	• Assumes illustrative mechanism whereby IPPs can request partial indexing of KZT-denominated of tariffs to USD • Assumes illustrative indexation of 50% of the tariff to the USD • Public cost: o Assumes the cost to the public cost is a function of the currency hedging premium, adjusted by the portion of the tariff that is (i) indexed to the USD and (ii) can be adjusted to reflect changes in inflation. o The hedging premium is calculated based on two key assumptions: ◊ Interest rate differential between the KZT-denominated Kazakh government bonds and the USD-denominated Kazakh government bonds.[33] ◊ Currency swap premium for KZT, assumed to be 50% of the interest rate differential for illustrative purposes (CPI, 2014)

Source: authors, unless otherwise stated.

[32] A "take or pay" clause is a clause found in the PPA that essentially allocates risk between parties in the scenario where transmission line failures or curtailment (required by the grid operator) result in the IPP being unable to deliver electricity generated by its renewable energy plant.

[33] The yield on the 2024 KZT-denominated government bonds is 9.5%, while the yield on the 2025 USD-denominated government bond is at 3.9%, resulting in an interest rate differential of 5.6%.

- *Effectiveness*. Estimates for the effectiveness of financial derisking instruments in reducing financing costs are based on the structured interviews with investors, and then further adjusted to reflect UNDP's in-house experience. The figures for effectiveness have full and immediate impact once the instrument is implemented (i.e. no timing discount). The assumptions for effectiveness are shown in Table 21. The qualitative investor feedback on financial derisking instruments' effectiveness is provided in Table 5 of the report.

Table 21: The modelling assumptions for financial derisking instruments' effectiveness

RISK CATEGORY	FINANCIAL DERISKING INSTRUMENT	EFFECTIVENESS[34]	DISCOUNT FOR TIMING EFFECT	SOURCE/COMMENT
Grid/Transmission Risk	Take-or-Pay Clause in PPA	50%	0%	Source: authors. Interview responses: moderate to high effectiveness
Counterparty Risk	Government (sovereign) Guarantee	25%	0%	Source: authors. Interview responses: moderate effectiveness.
	Public Loan	25%	0%	Source: authors. Interview feedback: public "buy-in", especially from international donors, reduces also counterparty risk
Financial Sector Risk	Public Loan	0% [Impact via concessional interest rates]	0%	Source: authors. Interview responses: high effectiveness.
Currency Indexation	Partial indexation of the PPA tariff	50%	0%	Source: authors. Interview responses: high effectiveness.

A.3 Stage 3 – Levelised Costs

Levelised Cost of Electricity (LCOE) Calculation

The DREI report's (2013) financial tool is used for the LCOE calculations. The financial tool is based on the equity-share based approach to LCOEs, which is also used by ECN and NREL (IEA, 2011; NREL, 2011). Box 5 sets out the LCOE formula used. In this approach, a capital structure (debt and equity) is determined for the investment, and the cost of equity is used to discount the energy cash-flows.

Box 5: The modelling LCOE formula

$$\frac{\%\,\text{Equity Capital} * \text{Total Investment} + \sum_{\tau=1}^{T} \dfrac{(\textit{O\&M Expense})_\tau + (\textit{Debt Financing Costs})_\tau - \textit{Tax Rate} * (\textit{Interest Expense}_\tau + \text{Depreciation}_\tau + \textit{O\&M Expense}_\tau)}{(1 + \textit{Cost of}\ \text{Equity})^\tau}}{\sum_{\tau=1}^{T} \dfrac{\textit{Electricity Production}_\tau * (1 - \textit{Tax Rate})}{(1 + \textit{Cost of}\ \text{Equity})^\tau}}$$

Where,
% Equity Capital = portion of the investment funded by equity investors
O&M Expense = operating & maintenance expenses
Debt Financing Costs = interest & principal payments on debt
Depreciation = depreciation on fixed assets
Cost of Equity = after-tax target equity IRR

[34] Grid/Transmission, Counterparty and Financial Sector Risk have multiple instruments (both policy and financial derisking instruments). The sum of the effectiveness percentages therefore cannot exceed 100%. For example the policy derisking instruments "Strengthen KEGOC's grid management capacity" and "regularly update the grid code" addressing Grid/Transmission risk have an effectiveness of 25%. (See Table 21 above). Therefore, the effectiveness of the take-or-pay clause cannot exceed 75%, which would reflect the highest effectiveness. However, within this take-or-pay clause mechanism residual risks remain. To reflect this, the take-or-pay clause has an effectiveness of 50%.

Tax-deductible, linear depreciation of 95% of fixed assets over the lifetime of investment is used. The standard corporate tax rate for Kazakhstan at 20% was used[35]. No tax credits, or other tax treatment, are assumed.

Baseline Energy Mix Levelised Costs and Emissions

The modelling makes a number of important methodological choices and assumptions regarding the baseline. The key steps in the approach taken are set out here:

- A combined baseline approach (50% build margin, 50% operating margin) is used to reflect that the electricity generated by wind and solar PV replaces electricity partly generated by the existing capacity and partly by capacity to be built[36]. In doing so, the analysis acknowledges the expected increase in energy demand, while recognizing that new investments in the power infrastructure are necessary to replace the old and outdated power plants dating to the Soviet-era.

- For the 50% build margin share of the baseline, a private sector perspective to investment is used and as such private sector financing costs are modelled. The modelling uses a mix of two technologies: (1) combined cycle gas turbine technology (CCGT) and (2) coal-fired thermal power plant as the marginal baseline technology. The modelling assumptions for CCGT and coal are shown below in Table 22 and Table 23, respectively.

- For the 50% operating margin share of the baseline, a number of assumptions and simplifications are made in order to keep the modelling exercise manageable. The modelling assumptions for are shown below in Table 24.

    - Coal-fired thermal plants generate nearly 70% of the electricity in Kazakhstan. As such, the technology represented in the operating margin is assumed to be 100% coal-fired thermal power plants.

    - Operating margin baseline assumes that coal power plants are fully depreciated and the costs are comprised of fuel costs and operations and maintenance costs, only.

- The modelling exercise uses unsubsidised fuel prices for both natural gas and coal. This is in order to create an 'even-playing field' for the economic analysis and comparisons with renewable energy under the modelling exercise. An 'opportunity cost' approach is taken to estimating the unsubsidised cost of fuel - making an assumption that in the absence of subsidised domestic consumption, Kazakhstan could export at market prices.

[35] Source: PWC, 2016

[36] For the 2030 Targets (Annex A) a 25% BM: 75% OM baseline has been assumed for the larger targets of 5GW wind and 500 MW of solar PV as intermittency would be expected to more of an issue. By overweighing the operating margin baseline, this approach therefore penalizes the renewable energy technologies for their intermittency. Similar to the approach taken for 2021 targets, the breakdown for the operating margin is 100% existing coal plants while the build margin represents 50% new coal and 50% combined cycle gas plants.

- o Natural gas: Kazakhstan exports natural gas to Central Asia, Russia and China. As a proxy, the model uses EU import prices in 2016, adjusted down by 5% for transportation costs.
- o Coal: Kazakhstan exports coal to Ukraine and Russia. As a proxy, the model uses the OECD import price in 2016, adjusted down by 10% for transportation costs. It is important to note that transport costs make up a greater percentage of coal prices vs those in gas prices.

- Fuel prices are projected using the International Energy Agency (IEA) World Economic Outlook projections (New Policies Scenario) for both natural gas and coal.[37] According to these projections, the 2017 starting values are 15.1 USD/MWh and 8.7 USD/MWh for natural gas and coal respectively.
- An analysis of avoided fossil fuel subsidies has been performed as part of the sensitivity analyses in section 4.2.4. The assumptions behind this analysis are listed in Table 25.

Table 22: The modelling assumptions for the build margin baseline energy technology (CCGT)

TECHNOLOGY ITEM	ASSUMPTION	SOURCE/COMMENTS
Initial investment cost (USD/MWel)	1,164,415	EC (2014)
Initial O&M cost excl. fuel (USD/MWel)	29,110	EC (2014)
O&M Inflation	2%	Authors
Lifespan (years)	25	Schmidt *et al*., 2012
System Efficiency	58%	EC (2014)
Capacity Factor	85%	EC (2014)
Emission Factor	0.448 tCO_2e/MWh	Bizerte CDM PDD (2012)[38]
FINANCING ITEM		
Capital structure	30% equity, 70% commercial loan	Authors
Cost of Equity	13.6%	Same as for RE, 15% discounted to account for market maturity for fossil thermal plants
Loan terms	6.0%, 13-year tenor	CoD: Same as for RE, 15% discounted to account for market maturity for fossil thermal plants; tenor: half the lifespan of asset
Depreciation allocation	Straight line, 100% depreciable	Authors

[37] IEA (2016)

[38] Bizerte wind farm CDM PDD (2012). Available at https://cdm.unfccc.int/Projects/DB/DNV-CUK1337768970.01/view

Table 23: The modelling assumptions for the build margin baseline energy technology (Coal-Fired Thermal Plants)

TECHNOLOGY ITEM	ASSUMPTION	SOURCE/COMMENTS
Initial investment cost (USD/MWel)	3,257,576	Publicly available data for construction of Balkash supercritical coal power plant
Initial O&M cost excl. fuel (USD/MWel)	54,796	EC (2014)
O&M Inflation	2%	Authors
Lifespan (years)	40	Schmidt *et al*., 2012
System Efficiency	45%	EC (2014)
Capacity Factor	85%	EC (2014)
Emission Factor	1.075 tCO_2e/MWh	Lahmeyer (2016)
FINANCING ITEM		
Capital structure	30% equity, 70% commercial loan	Authors
Cost of Equity	13.6%	Same as for RE, 15% discounted to account for market maturity for fossil thermal plants[39]
Loan terms	6.0%, 20-year tenor	k_d: Same as for RE, 15% discounted to account for market maturity for fossil thermal plants; tenor: half the lifespan of asset
Depreciation allocation	Straight line, 100% depreciable	Authors

Table 24: The modelling assumptions for the operating margin baseline energy technology (Coal-Fired Thermal Plants)

TECHNOLOGY ITEM	ASSUMPTION	SOURCE/COMMENTS
Initial investment cost (USD/MWel)	0	Authors assume fully-depreciated assets
Initial O&M cost excl. fuel (USD/MWel)	54,796	EC (2014)
O&M Inflation	2%	Authors
Lifespan (years)	40	Schmidt *et al*., 2012
System Efficiency	35%	Authors
Capacity Factor	65%	Authors
Emission Factor	1.075 tCO_2e/MWh	Lahmeyer (2016)
FINANCING ITEM		
Capital structure	NA	Authors
Cost of Equity	13.6%	Same as for RE, 15% discounted to account for market maturity for fossil thermal plants
Loan terms	NA	Authors assume all debt financing has been paid off
Depreciation allocation	NA	Authors assume fully depreciated assets

[39] For consistency and simplicity, authors have maintained the same financing costs for all baseline technologies. Nonetheless, arguably new coal plants could face premium financing costs given the risk of becoming stranded assets in the future.

Table 25: The modelling assumptions for the avoided fossil fuel subsidy analysis

COAL SUBSIDIES	VALUE/ASSUMPTION	SOURCES
Production (tonnes of coal equivalent)	62,569,000	IEA (2014)
Subsidies (USD)	1,700,000,000	IEA (2014)
Subsidy/Metric Tonne (USD/metric tonne)	27.2	
Conversion Factor to USD/MWh	7.2	Authors, based on academic research
Subsidy (USD/MWh)	3.8	Authors, based on IEA (2014)
NATURAL GAS SUBSIDIES		
Production (TJ)	1,207,626	IEA (2014)
Production (MBTU)	1,144,608,600	IEA (2014)
Subsidies (USD)	500,000,000	
Subsidy/Metric Tonne (USD/metric tonne)	0.4	
Conversion Factor to USD/MWh	0.293	Authors, based on academic research
Subsidy (USD/MWh)	1.5	Authors, based on IEA (2014)

Wind Energy – Technology specifications

The technical assumptions for the wind energy LCOE calculation are set out in Table 26 below.

Table 26: The modelling assumptions for wind energy technology specifications

TECHNOLOGY ITEM	ASSUMPTION	SOURCE/COMMENTS
Wind energy installed capacity	2021: 1,000 MW 2030: 5,000 MW	Authors; Government of Kazakhstan (Concept for Transition to a Green Economy"
Turbine size	2-3 MW class	Authors
Park size	50-100 MW	Authors
Core investment costs, including balance of plant costs (civil works, transformers, grid interconnection), mid-point investment cost	For 2021 target: 1,630,000 USD/MW For 2030 target: 1,540,000 USD/MW	IRENA, (2016) cost reduction curve, showing compound annual decline rate of -1.3% between 2015 and 2025, extrapolated to mid-point of the model period 2017-2021 and 2017-2030, or 2019 and 2023 respectively. IRENA cost assumptions have been adjusted by 10% to reflect the terrain of Kazakhstan and the higher than average transportation costs.
Annual O&M costs at start of operation Annual increase	31,269 USD/MW 2%	Authors, informed by IRENA (2016)
Lifetime	20 years	Authors
Wind energy capacity factor	2017-2021: 35% 2017-2030: 28%	UNDP (2011) UNDP /GEF Kazakhstan Wind Power Market Development Initiative 2017-2021 period capacity factor reflects that earlier commissioned projects will be at sites that have higher than average capacity factors.
Emission Factor	0 tCO_2e/MWh	Authors (only direct emissions from RE asset are considered)

Solar PV – Technology specifications

The technical assumptions for the solar PV LCOE calculation are set out in Table 27 below.

Table 27: The modelling assumptions for solar PV technology specifications

TECHNOLOGY ITEM	ASSUMPTION	SOURCE
Solar PV installed capacity	2017-2021: 250 MW 2017-2030: 500 MW	Authors; Government of Kazakhstan (Concept for Transition to a Green Economy"
Solar PV technology	C-Si	Authors
Park size	1-10 MW	Authors
Core investment costs, including balance of plant costs (civil works, transformers, grid interconnection) mid-point investment cost	For 2021 target: 1,299,000 USD/MW For 2030 target: 932,000 USD/MW	IRENA, (2016) cost reduction curve, showing compound annual decline rate of -8% between 2015 and 2025, extrapolated to mid-point of the model period 2017-2021 and 2017-2030, or 2019 and 2023 respectively. No incremental transportation cost adjustment has been made.
Annual O&M costs at start of operation Annual increase	24,600 USD/MW 2%	Authors
Lifetime	20 years	Authors
Solar PV capacity factor	15%	Authors, informed by local experts
Emission Factor	0 tCO_2e/MWh	Authors (only direct emissions from RE asset are considered)

Wind Energy and Solar PV – Terms of Finance

The financial assumptions used for both wind energy and solar PV LCOE modelling are set out in Table 28 below.

Table 28: The modelling assumptions for wind energy and solar PV terms of finance

	ASSUMPTION		
FINANCE ITEM	BAU	POST-DERISKING	SOURCE/COMMENTS
Capital structure	30% equity, 70% commercial loan	25% equity, 75% commercial loan	Authors
Cost of equity	16%	2021: 13.2% 2030: 12.5%	This study
Debt structure	100% commercial loan	2017 - 2021: 50% concessional public loan, 50% commercial loan 2017- 2030: 25% concessional public loan, 75% commercial loan	Authors
Loan terms	Commercial: 7%, 8-year tenor	2017- 2021: Concessional public: 5%, 20-year tenor, Commercial: 5.5%, 10-year tenor 2017-2030: Concessional public: 5%, 20-year tenor, Commercial: 5.2%, 10-year tenor	Commercial: investors, Concessional: authors
Depreciation allocation	Straight line, 95% depreciable		Authors (5% non-depreciable reflects land)

ANNEX C: REFERENCES

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