Ministry of Natural Resources and Environmental Protection of the Republic of Belarus

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BELARUS: Derisking Renewable Energy Investment

Selecting Public Instruments to Promote Wind Energy Investment in Belarus

REPORT

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Acknowledgments: UNDP would like to express its gratitude to the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus for providing invaluable support and inputs for this report. The authors would also like to thank the wind energy investors, development specialists and experts in Belarus who participated in structured interviews for the modelling. Finally, the authors are grateful to all reviewers and contributors for their valuable comments and inputs. Any errors and oversights in this report are the sole responsibility of the authors.

This publication builds on a series of prior research papers. This includes the original *Derisking Renewable Energy Markets* (Waissbein et al., 2013) report, which sets out the methodology used in this publication.

This report should be referenced as: UNDP (2017). *Belarus: Derisking Renewable Energy Investment*. New York, NY: United Nations Development Programme.

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April 2017, Minsk and New York

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Section 4: Modelling of Wind Energy in Belarus

Annex A: Methodology and Data

Acronyms

BAU	Business-as-usual
CO_2e	Carbon Dioxide Equivalent
CDS	Credit Default Swap
CPP	Condensation Power Plants
DREI	Derisking Renewable Energy Investment
ECN	Energy Research Centre of the Netherlands
EBRD	European Bank for Reconstruction and Development
FiT	Feed-in Tariff
FTE	Full-time Employee
GDP	Gross Domestic Product
GEF	Global Environment Facility
HDI	Human Development Index
IEA	International Energy Agency
IFI	International Financial Institution
INDC	Intended Nationally Determined Contribution
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
kWh	Kilowatt-hour
LCOE	Levelized Cost of Electricity
MECE	Mutually Exclusive and Collectively Exhaustive
MW	Megawatt
MWhr	Megawatt-hour
NA	Not Applicable
NPP	Nuclear Power Plant
NREL	National Renewable Energy Laboratory (US)
OECD	Organisation for Economic Co-operation and Development
O&M	Operations and Maintenance
PPA	Power Purchase Agreement
PRI	Political Risk Insurance
SCGT	Single Cycle Combustion Turbine
TCE	Tonne of Coal Equivalent
TPES	Total Primary Energy Supply
TPP	Thermal Power Plant
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
WACC	Weighted Average Cost of Capital
WEO	World Energy Outlook

Foreword

One of main priorities of the Government of Belarus is to increase local carbon-neutral technologies in the energy mix to reduce dependency on energy imports. The Concept of Energy Security, one of the main energy policy documents in Belarus, plans to achieve a 9 % share of renewable energy in the country's energy mix by 2035.

Particularly the opportunity for wind energy in Belarus is strong. Many parts of the country have favorable wind speeds. Over the past decades, wind energy costs dropped significantly and often represent a cost competitive alternative to fossil fuels. Wind energy thus represents an opportunity for Belarus to lower energy imports while meeting its climate change mitigation contributions under the Paris Agreement.

The Government of Belarus and UNDP are currently implementing a five year Global Environment Facility (GEF) financed Project *"Removing Barriers to Wind Power Development in Belarus"*. The project advises Belarus in creating a conducive legislative environment for wind energy in order to overcome some of the existing risks and barriers of wind energy investment.

This report uses UNDP's *Derisking Renewable Energy Investment* methodology and analyses investment risks and barriers that currently impede lower-cost private sector investment in wind energy. It also proposes government interventions that create a conducive investment environment and thus address these risks and barriers. The aim of this report is to assist policy makers in Belarus to select and implement government interventions that catalyze private sector investment in wind energy at the lowest costs.

We hope that this report can contribute to help Belarus in achieving affordable, locally produced and clean wind energy benefiting the people, economy, and environment. The Ministry of Natural Resources and Environmental Protection of the Republic of Belarus and UNDP are prepared to work with our partners in the public and private sectors, and civil society, to achieve this objective.

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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 large-scale wind energy in the Republic of Belarus ("Belarus"). 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 wind energy investors and developers active in Belarus. This report was prepared in close coordination with the Ministry of Environment and Natural Resources.

Context and Opportunity for Wind Energy

The electricity sector in Belarus is currently heavily reliant on imported gas. In 2016, Belarus' total installed generation capacity was close to 9.9 GW. Gas-fired plants, which are often inefficient and dated, predominate, amounting to 8.8 GW. Belarus imports all (99 %) of its gas, which results in an accompanying exposure to price volatility. End-user tariffs are currently not fully cost-reflective, with industrial tariffs subsidizing residential tariffs. These tariffs have recently begun undergoing reform. Belarus has significant plans for additional capacity by 2020, including 961 MW in renewable energy (biomass, biogas, hydro, solar, wind), a 2.4 GW nuclear power plant and a large state programme for peat-based power. Overall electricity demand is projected to be flat in the near/mid-term.

To date, Belarus has received 68 MW of investment in wind energy. This investment, made up of 66 individual developers/licenses, is remarkably fragmented, a result of the current small quotas in the regulatory regime.

The opportunity for investment in wind energy in Belarus is strong. This report uses a 2030 target of an additional 500 MW in private sector investment in wind energy, building on the 2020 target found in the 'Government Program "Power Saving" for 2016 – 2020'. Belarus is well positioned for wind investment, with strong wind resources and a favourable ease-of-doing business environment. Increased investment in wind energy can contribute to improved energy security, a lowered dependence on energy imports, and can assist Belarus in meeting its climate change contributions under its INDC. Higher investment targets for wind energy could also open the door to potential export opportunities.

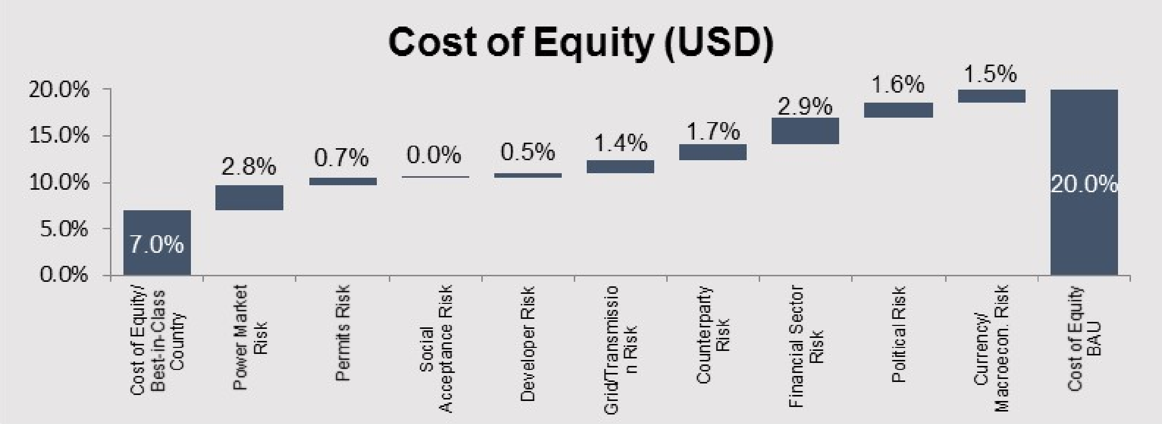
Financing Costs and Risk Environment

The modelling performs a detailed analysis of the financing costs and risk environment for wind energy in Belarus today.

- Financing costs (the cost of equity (USD) and the cost of debt (USD)) for wind energy projects are high in Belarus. This report finds that the cost of equity (USD) for large-scale wind energy in Belarus today is 20.0 %, compared with 7.0 % in Germany.
- These higher financing costs reflect a range of investment risks for wind energy in Belarus (Figure 1 below). Based on structured interviews with investors, two risks that predominantly contribute to higher financing costs in Belarus are:
  1) *power market risk*, related to the uncertain outlook for the power market, the fragmented quota system and the variable tariff for wind energy, and
  2) *financial sector risk*, related mainly to the impact of sanctions on limited financing (debt and equity) for wind energy as well as a lack of experience with financing wind energy projects. A range of additional investment risks were also identified as being impactful.

[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.

Figure 1: Impact of risk categories on the cost of equity for wind energy in Belarus, business as usual scenario



Source: Interviews with wind energy investors and developers; modelling; best-in-class country is assumed to be Germany; see Annex A for details of assumptions and methodology

Public Derisking Measures

The modelling examines the selection and cost-effectiveness of public derisking measures to meet an investment target of an additional 500 MW wind energy by 2030. 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.

The modelling identifies a targeted package of public derisking measures with an estimated cost of USD 193.0 million until 2030. The full instrument package is set out and itemised in Table 1.

If these derisking measures are implemented, this can result in the following benefits:

- Attracting USD 807.7 million of private sector investment in wind energy while saving an estimated USD 649.8 million of gas imports over the lifetime of the wind energy assets.
- Reducing wind energy generation costs due to derisking from USD cents 12.6 to USD cents 9.3 per kWh, almost at parity with current gas energy generation costs (USD cents 9.1 per kWh).
- Generating savings to the economy of USD 370.8 million when compared to commissioning 500 MW wind energy generation capacity under the current policy and investment environment.
- Lowering carbon emissions by 11.8 million tonnes of CO_2 over the next 20 years, thus contributing to climate change mitigation and environmental preservation.

Of note, investor feedback identified several priority derisking measures: transparent power sector planning; a national wind energy strategy; and reform of the bidding mechanism, targeting larger wind farms, using a fixed price tariff and introducing a standardized power purchase agreement. On a qualitative basis, investors communicated that these instruments will be key to unlocking investment at scale. These priority measures come at a relatively low cost of USD 1.1 million until 2030, and in turn have a relatively high impact on reducing associated risks.

Conclusion

Today's investment environment for wind energy in Belarus has 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 wind energy generation costs.

The modelling thus clearly demonstrates that investing in the identified package of public derisking measures creates significant economic savings in achieving a 2030 investment target of 500 MW in wind energy in Belarus. The modelling also confirms that, when analysed on an individual basis, each public derisking measure is cost-efficient for Belarus, compared to the alternative of higher generation costs.

As such, implementing these public derisking measures is indeed an opportunity for policymakers in Belarus. The end result can be affordable, locally produced and clean wind energy benefiting the people, economy, and environment in Belarus.

Executive Summary

Introduction

This report is part of the United Nations Development Programme's (UNDP) support to the Government of Belarus in the implementation of the five year Global Environment Facility (GEF) financed Full-Size Project *"Removing Barriers to Wind Power Development in Belarus"* which started implementation last year in 2015 and will last until 2020.

The *Removing Barriers to Wind Power Development in Belarus* project is promoting and supporting the development of a market for wind energy in Belarus. Overall, the project supports the removal of barriers to facilitate private sector driven investment in wind energy in Belarus.

The project aims to advise the Government of Belarus in creating a conducive legislative environment for wind energy, such as by the adoption of renewable energy legislation, in order to overcome some of the existing risks and barriers of wind energy investment in Belarus. In addition, having obtained 25 MW of wind energy quotas from the Government of Belarus, the aim of the project is to showcase financially viable and privately funded investment into wind energy.

The recent "Concept of Energy Security" represents one of the main energy policy documents in the Belarus, noting the government's plans to achieve a 9 % share of renewable energy in the country's energy mix by 2035. In the short term, the Government plans to increase current wind energy capacity to a total of 266.5 MW until 2020[2] as part as overall planned renewable electricity capacity of 961 MW by 2020[3]. In its Intended Nationally Determined Contribution (INDC), the Government has also pledged to reduce emissions by at least 28 % in 2030 compared to 1990 levels (UNFCCC, 2015).

Context and opportunity for wind energy in Belarus

The electricity sector in Belarus is currently heavily reliant on imported gas. In 2016, Belarus' total installed generation capacity was close to 9.9 GW. Gas-fired plants, which are often inefficient and dated, predominate, amounting to 8.8 GW. Belarus imports all (99 %) of its gas, which results in an accompanying exposure to price volatility. End-user tariffs are currently not fully cost-reflective, with industrial tariffs subsidizing residential tariffs. These tariffs have recently begun undergoing reform. Belarus has significant plans for additional capacity by 2020, including 961 MW in renewable energy (biomass, biogas, hydro, solar, wind), a 2.4 GW nuclear power plant and a large state programme for peat-based power. Overall electricity demand is projected to be flat in the near/mid-term.

To date, Belarus has received 68 MW of investment in wind energy. This investment, made up of 66 individual developers/licenses, is remarkably fragmented, a result of the current small quotas in the regulatory regime.

The opportunity for investment in wind energy in Belarus is strong. Belarus is well positioned for wind investment, with strong wind resources and a favourable ease-of-doing business environment. Increased investment in wind energy can contribute to improved energy security, a lowered dependence on energy imports, and can assist Belarus in meeting its climate change contributions under its INDC. Higher investment targets for wind energy could also open the door to potential export opportunities

The Derisking Energy Investment Methodology

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

A key focus of the DREI methodology is on financing costs for renewable energy. While technology costs for renewable energy have fallen dramatically in recent years[4], 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.

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[2] *Government Program "Power Saving" for 2016 – 2020.*

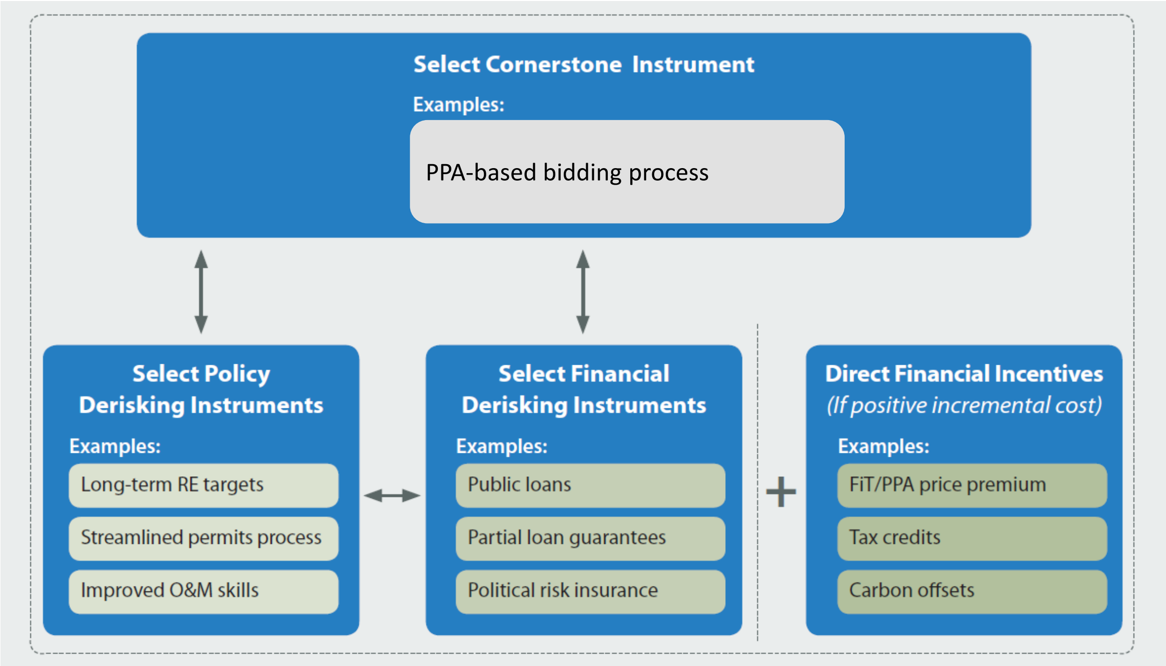
[3] Consisting of 153.2 MW biomass, 88.9 MW biogas, 109 MW hydro power, 343.5 MW solar PV and 266.5 MW wind energy.

[4] For example, for onshore wind energy, the installed cost went down by 7 % each time that the cumulative installed capacity has doubled between 1983 and 2014 (IRENA, 2016).

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[5].

In seeking to create an enabled environment for private sector renewable energy investment, policy-makers typically implement a package of public instruments[6]. 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.

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



Source: Waissbein et al., 2013.

The **cornerstone instrument** is the centerpiece of any public instrument package. For large-scale renewable energy, the cornerstone instrument is typically a tendering process 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 (as part of a PPA or a Feed-in Tariff (FiT)), tax breaks and proceeds from the sale of carbon credits. The DREI methodology calls these types of instruments "**direct financial incentives**".

[5] Interviews with project developers and investors identified higher financing costs for wind energy in Belarus in comparison to Germany, where the market for wind energy is mature and well established. For example, the cost of equity (USD) for wind energy investment is estimated at 20 % in Belarus today, in comparison to 7 % (EUR) in Germany.

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

Modelling Results

This report, using the DREI methodology, sets out modelling results showing how selected public instruments to attract private sector investment to achieve an additional 500 MW of installed wind energy generation capacity in Belarus by 2030.

Risk Environment

Data on the risk environment was obtained from a total of 10 structured interviews held with domestic and international project developers.

The results estimate that financing costs for wind energy in Belarus today are 20 % for the cost of equity (USD), and 12 % for the cost of debt (USD).· These are substantially higher than in the best-in-class country, Germany, which are estimated at 7.0 % cost of equity (EUR) and 3.0 % cost of debt (EUR). Given the longevity of energy assets in general as well as the capital intensity of renewable energy investments in particular, the impact of higher financing costs in Belarus on the competitiveness of wind energy is significant.

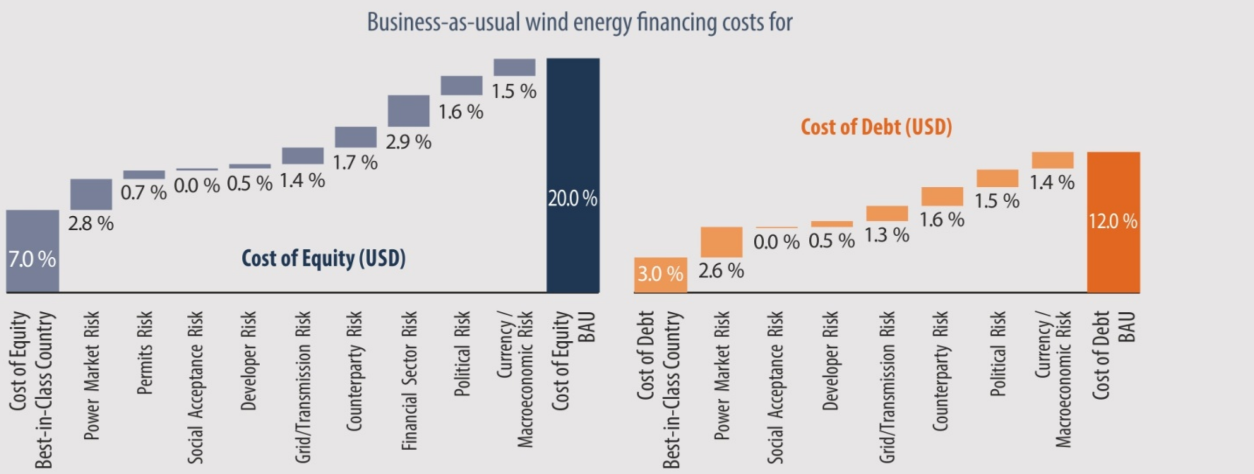
Figure 3 shows[7] that there are two risks that predominantly contributing to higher financing costs in Belarus:

1) *power market risk*, related to the uncertain outlook for the power market, the fragmented quota system and the variable tariff for wind energy, and
2) *financial sector risk*, related to the impact of sanctions on limited financing (debt and equity) for wind energy, as well as a lack of experience with financing wind energy projects.

A range of moderate investment risks that additionally contribute to higher financing costs in Belarus are

3) *counterparty risk* concerning the credit-worthiness of the electricity off-taker;
4) *political risk* concerning the country-specific governance and legal environment;
5) *currency and macroeconomic risk* arising from the depreciation of the Belarusian Ruble against harder currencies; and
6) *grid and transmission risk,* caused by limitations in grid management and transmission infrastructure particularly related to the commissioning of additional energy capacity in the short term.

Figure 3: Impact of risk categories on financing costs for wind energy in Belarus, business-as-usual scenario[7]



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

Public Instrument Selection

The modelling uses a hypothetical DREI investment target of 500 MW installed wind energy capacity by 2030, to showcase the high potential of increasing wind energy generation capacity in the Belarus.

It then models the implementation of a package of public instruments, containing both policy and financial derisking instruments, to promote investment to achieve these 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. The costs until 2030 for policy derisking instruments are estimated as being USD 3.8 million, and for financial derisking instruments USD 189.2 million.

[7] Due to the lack of experience and track record of the Belarusian financial sector with wind energy finance, financing cost waterfalls for both debt and equity were calculated by using a combined approach which is not differentiating between the answers from equity and from debt investors.

Table 1: The selection of public instruments to achieve additional 500 MW installed wind energy capacity

Risk Category	Policy Derisking Instruments	Financial Derisking Instruments
Power Market Risk	• Transparent energy sector planning • Long-term national wind energy strategy and targets • Well-designed and transparent procedures for quota and PPA tendering and fixed tariff • Standard PPA with well-designed, transparent key clauses across all regions	NA
Permits Risk	• Permit harmonization • Development of a registry of available wind sites • Contract enforcement and recourse mechanism	NA
Social Acceptance Risk	NA	NA
Developer Risk	• Capacity building for resource assessment • Feasibility studies; networking; training and qualifications; R&D; technology standards; • Exchange of market information (e.g., via trade fairs and the establishment of a wind energy association)	NA
Grid/Transmission Risk	• Strengthening Belenergo's operational performance, grid management etc. • Regular updates of the grid code	• Take-or-pay clause in PPA[8]
Counterparty Risk	• Strengthening Belenergo's and regional grid operators' management & operational performance for existing operations	• Government (sovereign) guarantee
Financial Sector Risk	• Promoting financial sector policy favorable to long-term green infrastructure investments, including project finance • Strengthening of investors' familiarity with financing renewable energy projects	• Concessional public loans
Political Risk	NA	• Political risk insurance
Currency/ Macroeconomic Risk	NA	• Partial-indexing of the PPA tariff

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

Of note, investor feedback identified several priority derisking instruments: transparent power sector planning; a national wind energy strategy; and reform of the bidding mechanism, targeting larger wind farms, using a fixed price tariff and introducing a standardized power purchase agreement. On a qualitative basis, it is felt that these instruments will be key to unlocking investment at scale. These measures come at a relatively low cost of USD 1.1 million until 2030.

Levelized Cost

The modelling is 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).

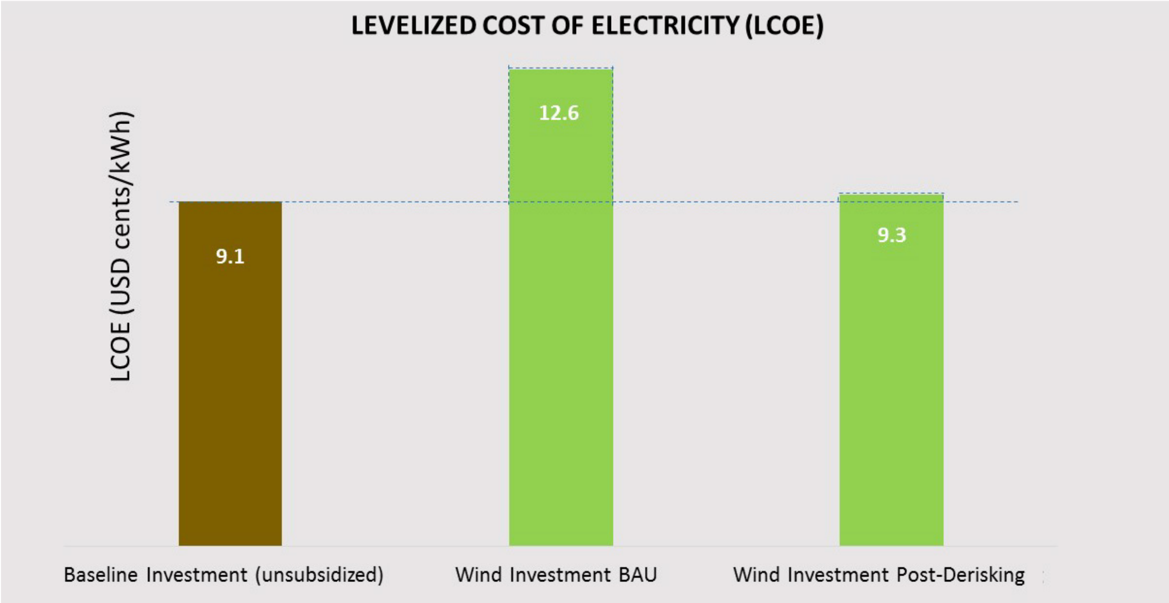
The results for generation costs, expressed as the Levelized Cost of Electricity (LCOE), are shown in Figure 4 below:

- In the *business-as-usual* (BAU) scenario, wind energy generation costs significantly exceed the unsubsidized gas power generation costs (baseline). Baseline generation costs[9] are estimated at USD cents 9.1 per kWh and wind energy generation costs in the BAU scenario at USD cents 12.6 per kWh, thus requiring a price premium (USD cents 3.5 per kWh) over the baseline energy technology.
- In the *post-derisking* scenario, the cost of wind energy falls to USD cents 9.3 per kWh. Following government interventions which derisk the investment environment, and with resulting lower financing costs, wind energy is nearly at parity with the unsubsidized baseline energy technology mix. In other words, implementing a comprehensive derisking package leads to almost equal wind energy generation costs of locally produced wind energy compared to imported gas.

[8] 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.

[9] The modeling uses a 100 % operating margin approach, with wind energy replacing electricity generation from existing single cycle gas turbines (SCGT). Given these are existing plants, the LCOE modeling assumed fully depreciated technology costs, and only modelled fuel and O&M costs.

Figure 4: LCOEs for the baseline and wind energy investment in Belarus



Source: Modelling; see Table 10 and Annex A for details of assumptions and methodology.

Evaluation of public instruments' effectiveness

The DREI methodology uses four performance metrics to analyze the impacts of the selected public instrument package to promote investment, with each metric taking a different perspective: the ability to catalyze 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).

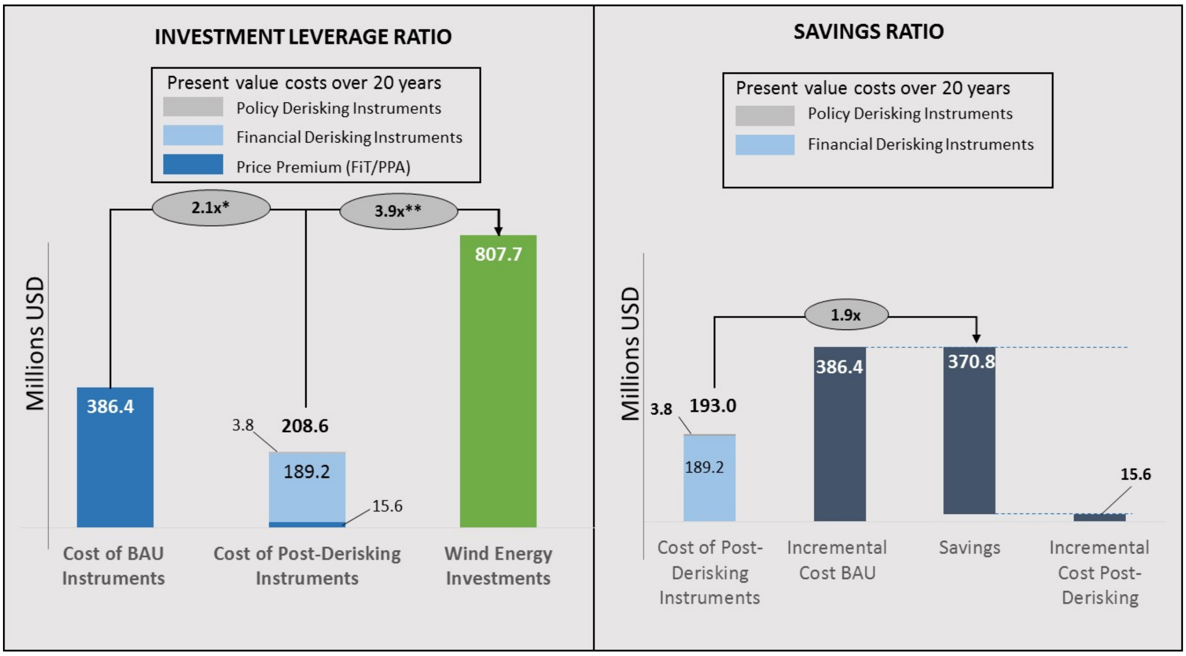
Figure 5 shows exemplarily the results for two out of the four performance metrics, namely the leverage and the carbon abatement ratio:

- The investment leverage ratio shows that derisking is an efficient use of public funding. Achieving 500 MW in installed wind capacity equates to USD 807.7 million in private sector investment. In the *business-as-usual* scenario, the model estimates that achieving this target will require a direct financial incentive in the form of a price premium over 20 years of USD 386.4 million. This results in a leverage ratio of 2.1 i.e. the investments catalyzed are around 2.1 times the amount spent on the public instruments. In the *post-derisking* scenario, the model estimates that this same investment target can be achieved with a package of derisking instruments valued at USD 193.0 million and a significantly reduced price premium over 20 years of USD 15.6 million. This raises the leverage ratio to 3.9, indicating a higher efficiency in terms of the costs of public instruments.
- The savings ratio shows that lower generation costs for wind energy in the *post-derisking scenario* mean that expenses for public derisking (USD 193.0 million) generate savings of USD 370.8 million.

In addition, the affordability ratio and the carbon abatement ratio show that that derisking reduces wind energy generation costs by 26.4 % and leads to a reduction of 46 % in abatement costs per 1 tonne CO_2e (refer to Section 4.2, Figure 14 in the main report).

Overall all performance from the modelling exercise on wind energy show improved cost-effectiveness from government measures to derisk the investment environment.

Figure 5: Performance metrics for the selected package of derisking instruments promoting 500 MW of wind energy investment in Belarus



Source: Modelling; see Table 10 and Annex A for details on assumptions and methodology.
* In the BAU scenario, the full 2030 investment target may not be met.
** The vast majority of costs of instruments in the post-derisking scenario come from financial derisking instruments (USD 189.2 million). Policy Derisking costs are estimated at USD 3.8 million only

Sensitivities

Sensitivity analyses can assist in gaining a better understanding of the robustness of the outputs and to be able to test different scenarios. Three broad types of sensitivity analysis have been performed on
(i) key input assumptions, such as investment cost, capacity factors and fuel costs,
(ii) on public instrument selection and their cost-effectiveness and
(iii) on the approach to costing financial derisking instruments.

The sensitivities on public instrument selection show a range of cost-effectiveness, with policy derisking instruments for power market risk being particularly cost-effective compared to all other instruments modelled. This means that instruments in the power market risk category (i. e. long-term national wind energy strategy and targets; transparent energy sector planning; well-designed and transparent procedures for quota and PPA tendering; and a standard PPA with a fixed tariff for wind energy) come at relatively low costs while having a relatively high impact on reducing the financing costs.

Sensitivity modelling also shows that whereas wind energy generation are independent from international energy prices and currency fluctuations, a gas price increase of 20 % higher than projected means that unsubsidized gas energy generation costs almost reach USD 10.5 cents per kWh. Wind energy saves an estimated USD 649.8 million[10] of gas imports over the lifetime of the wind energy assets.

Moreover, as the costing of financial derisking instruments is complex, different costing approaches can be taken. For example, one can assume a less conservative methodology (compared to the base case in this report) and 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. In this case, cost of financial derisking instruments drop to USD 27.6 million (compared to USD 189.2 million in the base case). In this scenario, the savings ratio increases to 11.8x compared to 1.9x in the base case scenario). Moreover, the investment leverage ratio increases to 17.2x compared to 2.1 in the base case scenario.

Detailed results for the sensitivities can be found in Section 4.2 and Annex A and B.

[10] Assuming avoided gas imports necessary to produce an equivalent of projected cumulative electricity from 500 MW of wind over the lifetime of investment; assuming USD 136 per 1 thousand m^3 for 2017 and using IEA's WEO gas growth price projections for the remaining years; discounting at 10 % estimated public cost of capital.

Conclusions

Today's investment environment for wind energy in Belarus has a number of investment risks that result in high financing costs. The results in this report confirm that financing costs for wind energy in Belarus are currently high, particularly in comparison to countries with more favorable investment environments. The cost of equity for wind energy in Belarus today is estimated at 20 % (USD), and the cost of debt at 12 % (USD). The modelling starts from nine different risk categories and evaluates to what extent they contribute to higher financing costs in Belarus. 2 of these – power market and financial sector risk are large contributors to high financing costs, increasing the cost of equity by more than 250 basis points (2.5 %) each.

The report then systematically identifies a comprehensive package of public derisking measures to target these risks and to achieve a 2030 target of an additional 500 MW in private sector investment in wind energy, building on the 2020 target found in 'Government Program "Power Saving" for 2016 – 2020'. The full instrument package is set out and itemised in Table 1 and comes with an estimated cost of USD 193.0 million until 2030.

A key conclusion from the modelling is that investing in derisking instruments is a cost-effective approach for achieving the 2030 wind energy investment target. The comprehensive package of public derisking measures that are modelled bring down the generation cost of wind energy from USD cents 12.6 per kWh to USD cents 9.3 cents per kWh which is almost at parity with the country's current costs for producing electricity using gas power plants (USD cents 9.1 per kWh).

If these derisking measures are implemented, this can result also in:

- Attracting USD 807.7 million of private sector investment in wind energy while saving an estimated USD 649.8 million of gas imports over the lifetime of the wind energy assets.
- Generating savings to the economy of USD 370.8 million when compared to commissioning 500 MW wind energy generation capacity under the current policy and investment environment.
- Lowering carbon emissions by 11.8 million tonnes of CO_2 over the next 20 years, thus contributing to climate change mitigation and environmental preservation.

The modelling thus clearly demonstrates that investing in the identified package of public derisking measures creates significant economic savings in achieving a 2030 investment target of 500 MW in wind energy in Belarus. The modelling also confirms that, when analysed on an individual basis, each public derisking measure is cost-efficient for Belarus, compared to the alternative of higher generation costs. Particularly instruments addressing power market risk, such as improving the current bidding mechanism and implementing a fixed price tariff for wind energy, will be key to unlocking investment at scale. These priority measures come at a relatively low cost of USD 1.1 million until 2030, and in turn have a relatively high impact on reducing associated risks. Thus, all derisking instruments that can be immediately implemented should, if possible, be prioritized.

As such, implementing these public derisking measures is indeed an opportunity for policymakers in Belarus. The end result can be affordable, locally produced and clean wind energy benefiting the people, economy, and environment in Belarus.

The results in this report should not be interpreted as a definitive quantitative analysis of wind energy in the Belarus but, rather, as one contribution to the larger policy decision-making process. It is hoped that the findings in this report can be compared, contrasted and combined with other analyses.

Introduction

1

This report is part of the United Nations Development Programme's (UNDP) support to the Government of Belarus in the implementation of the five year Global Environment Facility (GEF) financed Full-Size Project *"Removing Barriers to Wind Power Development in Belarus"* which started implementation last year in 2015 and will last until 2020.

The UNDP-GEF project is promoting the development of a market for wind energy in Belarus. Overall, the project supports the removal of barriers to facilitate private sector driven investment in wind energy in Belarus.

The project aims to advise the Government of Belarus in creating a conducive legislative environment for wind energy, such as by the adoption of renewable energy legislation, in order to overcome some of the existing risks and barriers of wind energy investment in Belarus. In addition, having obtained 25 MW of wind energy quotas from the Government of Belarus, the aim of the project is also to showcase financially viable and privately funded investment into wind energy.

One of the main priority of the Government of Belarus is to increase local energy generation, reduce import dependency and help to meet the country's Intended Nationally Determined Contribution (INDC) commitments in which the Government has pledged to reduce emissions by at least 28 % in 2030 compared to 1990 levels (UNFCCC, 2015).

The "Concept of Energy Security", which came into force in January 2016, is one of the main energy policy document in Belarus. The concepts plans to achieve a 9 % share of renewable energy in the country's energy mix by 2035. In the short term, the Government plans a total of 250 MW wind energy power capacity until 2020[11].

This report, using the Derisking Renewable Energy Investment (DREI) methodology developed by UNDP, systematically assesses investment risks and barriers currently holding back lower-cost private sector investment in wind energy in Belarus. It then proposes packages of targeted and most cost-effective public derisking instruments which reduce or transfer these risks to achieve a risk-return profile for wind energy that can attract private sector capital. This is important to meet to meet an additional 500 MW in private sector investment in wind energy, going beyond the 2020 target stated in the 'Government Program "Power Saving" for 2016 – 2020'.

The report therefore showcases how affordable, locally produced and clean wind energy can benefit the people, economy, and environment in the Belarus.

[11] *Government Program "Power Saving" for 2016 – 2020.*

Overview of the DREI Methodology

2

In 2013, UNDP issued the *Derisking Renewable Energy Investment* report (the "DREI report") (Waissbein *et al.*, 2013)[12]. The report introduced an innovative methodology (the "DREI methodology"), with an accompanying 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 methodology's focus on financing costs for renewable energy
- The methodology's approach to identifying a public instrument mix
- The methodology's 4-stage framework

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

2.1. The Impact of High Financing Costs on Renewable Energy

A key focus of the DREI methodology is on financing costs for renewable energy. While technology costs for renewable energy have fallen dramatically in recent years[13], 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 6 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 levelized cost of electricity (LCOE) of onshore wind energy and combined-cycle gas in a developed and developing country. The analysis assumes a low financing cost environment for the developed country (cost of equity (USD) of 7 %; cost of debt (USD) of 3 %), and a high financing cost environment for the developing country (cost of equity (USD) of 16 %; cost of debt (USD) of 9 %). All modelling assumptions (investment costs, operational costs, capacity factors) are kept constant between the developed and developing country – the only assumption that is varied is that relating to financing costs.

In the developed country benefiting from low financing costs, wind power (at USD cents 6.2 per kWh) is already t cost-competitive with gas (at USD cents 6.3 per kWh). However, in the developing country with higher financing costs, wind power generation (at USD cents 9.2 per kWh) becomes over 40 % percent more expensive than in a developed country. In contrast, gas (at USD cents 6.7 per kWh) becomes only 6 percent more expensive due to these same higher financing costs. As such, in the developing country, wind power is no longer competitive with gas in this high financing cost environment.

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[14]. The end result is that high financing cost environments penalize renewable energy when compared to fossil-fuel based power generation.

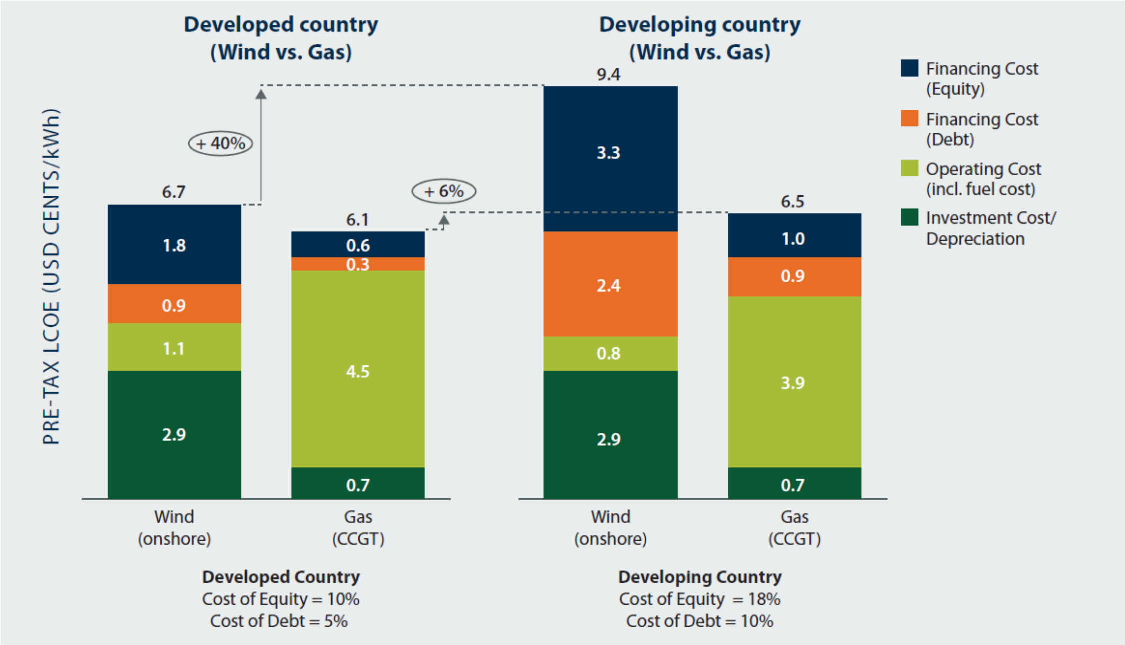
The theory of change underlying the DREI methodology is that one of the main challenges for scaling-up renewable energy technologies in developing countries is to lower the financing costs that affect renewables' competitiveness against fossil fuels. As these higher financing costs reflect barriers and 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.

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

[13] For example, for onshore wind energy, the installed cost went down by 7 % each time that the cumulative installed capacity has doubled between 1983 and 2014 (IRENA, 2016).

[14] For example, based on the analysis shown in Figure 5, investment costs account for approximately 80 % of the total lifetime technology costs for wind energy but only account for around 15 % of such costs in the case of gas. See Annex A of the DREI report for assumptions.

Figure 6: Comparing wind energy and gas LCOEs in developed and developing countries



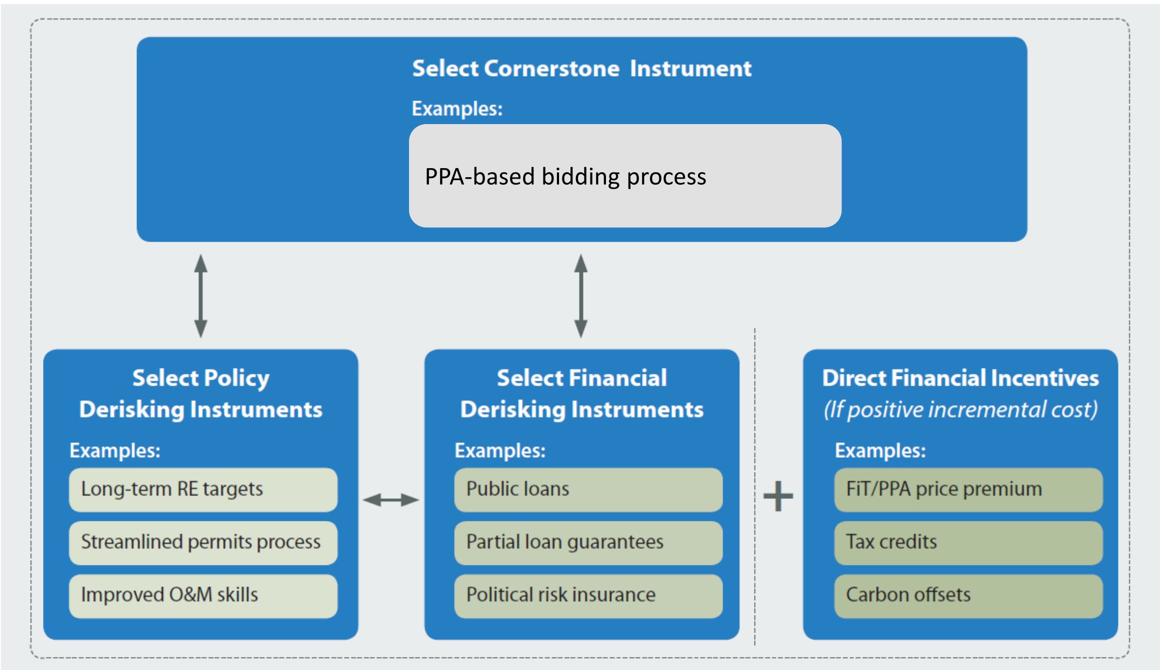
Source: (Waissbein et al., 2013). All assumptions (investment costs, operational costs, capacity factors) except for the financing costs are kept constant between the developed and developing country. See Annex A of the DREI Report for full assumptions. Operating costs appear as a lower contribution to LCOE in developing countries due to discounting effects from higher financing costs.

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.

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 7 below, from the DREI report, identifies the four key components of a public instrument package that can address this risk-return profile.

Figure 7: Typical components of a public instrument package for large-scale renewable energy



Source: Waissbein et al. (2013)

The **cornerstone instrument** is the centerpiece 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 large-scale renewable energy, the cornerstone instrument is typically 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 a feed-in tariff (FiT)), tax breaks, and proceeds from the sale of carbon credits. The DREI methodology calls these types of instruments "**direct financial incentives**".

2.3. The Methodology's Four Stage Framework

The DREI report sets out a detailed methodology 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.

Figure 8: 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 financing costs
Stage 2: Public Instruments	• Select one or more public derisking instrument(s) to mitigate the identified risk categories	• Quantify the impact of the public derisking instrument(s) to reduce financing 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 sensitivities on key inputs and assumptions

Source: Waissbein et al. (2013)

As illustrated in Figure 8, 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: Levelized 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.

Current Status of Wind Energy in Belarus

3

General Country Data in Belarus[15]	
Population 2015: 9.513 m	
Land Area: 202,910 sq. km	
GDP 2015 (current USD): $54.6 billion	
GDP/capita (current USD) 2015: $5,741	
Sovereign rating 2016: Substantial risks, Caa1 (stable) (Moody's), B-/B (S&P)	
UNDP HDI 2014: 0.151 (31st of 188)	**World Bank Ease of Doing Business (2017):** 37th out of 190

This section provides a brief overview of the current context, status and objectives for wind energy Belarus.

Targets for Wind Energy in Belarus

The potential for wind energy in Belarus is significant. Belarus has also a favorable regulatory environment for business, and holds a high rank on the World Bank's 'Ease of Doing Business' indicator (37). Being generated in-country, wind energy thus can lower the country's dependence on energy imports and contribute to a diversification of the energy generation mix while, at the same time, generating public and end-user savings, contributing to climate change mitigation and creating employment opportunities.

Due to its high dependence on gas imports, the main priority of the Government of Belarus is to increase local energy generation, reduce import dependency and realize gains in energy efficiency. Increasing carbon-neutral technologies in the current energy mix is also contributing to meet the country's Intended Nationally Determined Contribution (INDC) commitments.

On 01st January 2016, the new "Concept of Energy Security" came into force. This document represents one of the main energy policy documents in Belarus and outlines plans to increase the share of domestic energy sources in the Total Primary Energy Supply (TPES) from 14 % (2015) to 20 % by 2035.

Although this document contains no binding target for the share of renewable energy in the energy mix, it notes the government's plans to achieve a 9 % share of renewable energy in the country's energy mix by 2035.In the short term, the Government plans to increase current wind energy capacity to a total of 266.5 MW until 2020[16]. In total, the Government of Belarus plans a total renewable electricity capacity of 961 MW by 2020[17].

Building on the 2020 targets in the Government Program "Power Saving" for 2016 – 2020, and aligned to the long term target in the Concept of Energy Security, this study assumes a hypothetical DREI wind energy investment target of additional 500 MW wind energy realized by 2030 with private sector finance. Alongside other new technologies planned in the energy mix, this can also help the Government of Belarus to meet its plan to decrease of the share of gas in the production of heat and electricity down to 50 % by 2035 (compared to 90 % in 2015)[18].

Power Sector Context

In 2016, the total installed electricity generation capacity in Belarus was close to 9.9 GW. The power market of Belarus is vertically integrated, with the state owned utility Belenergo operating 95 % of the installed generation capacity. Belenergo is also the transmission grid operator, responsible for transmission, distribution and sale of electricity.

The country is heavily reliant on gas as shown in Figure 9. In 2014, 98 % of the country's electricity generation (34,042 GWh) came from gas power plants (OECD/IEA, 2016). In contrast, in 2016 renewable energy made up only 2.5 % of the overall installed electricity capacity in Belarus[19]. Almost 99 % of natural gas is imported from the Russian Federation.

[15] Sources: World Bank ; Moody's; Standard & Poor's; UNDP.

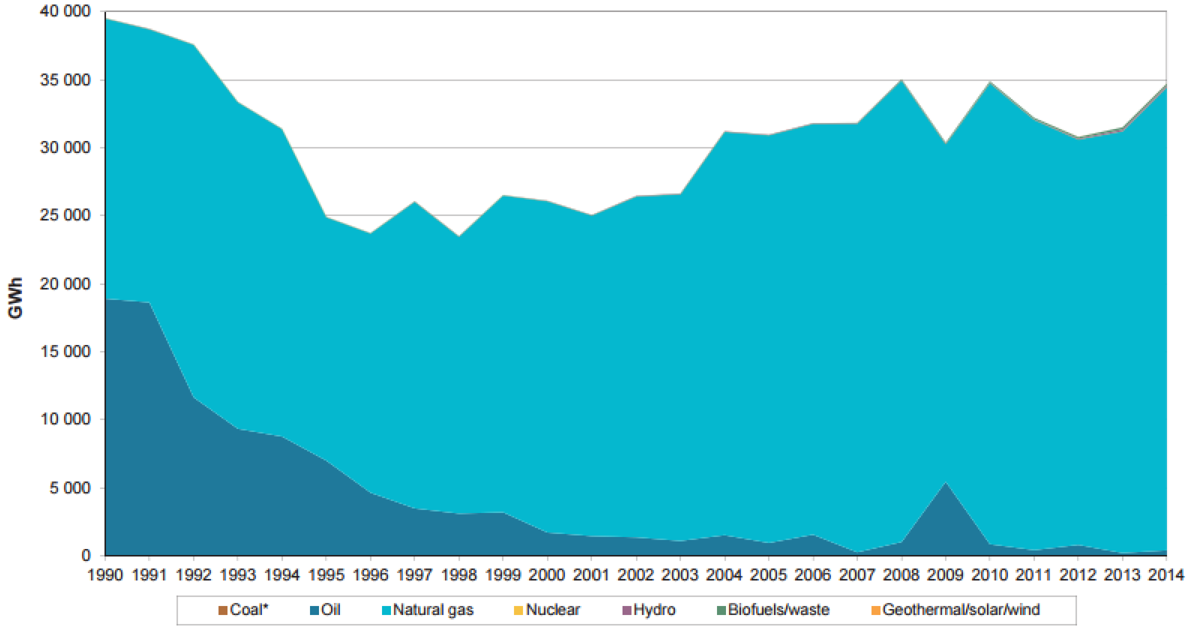
[16] *Government Program "Power Saving" for 2016 – 2020.*

[17] Consisting of 153.2 MW biomass, 88.9 MW biogas, 109 MW hydro power, 343.5 MW solar PV and 266.5 MW wind energy.

[18] *Concept of Energy Security.*

[19] In 2016, the total renewable energy capacity in Belarus consisted of 68.4 MW wind, 79.6 MW biomass, 26.5 MW biogas, 33.6 MW hydro and 50.5 MW solar.

Figure 9: Electricity generation by fuel in Belarus (1990 to 2014)



Source: OECD/IEA (2016)

In 2014, the country imported 20.1 billion cubic meters natural gas making it the 16th largest natural gas importer worldwide[20]. These gas imports create a significant current account deficit, and expose Belarus to volatile gas prices [21]. Due to structural changes in the economy and demand management programmes, Belarus achieved a decoupling of economic growth and energy demand since the mid-1990s. The country is also not characterized by a significantly increasing energy demand in the medium-term future. Still, additional electricity generation capacity is planned. A nuclear power plant (NPP) is currently constructed in Astravets district in the north-east of the country close to the border of Lithuania. The NPP will have 2.4 GW total installed capacity and is planned to be commissioned by 2020. In addition, in its *'State Program for Peat",* the Government of Belarus aims to utilize over 1.1 million tonnes of coal equivalent (TCE) peat for electricity generation by 2020.

End-user tariffs for electricity, heat, natural gas and liquefied petroleum gas are subsidized, with subsidies mainly applying to households being cross-subsidized by higher industry tariffs. However, the newly adopted (March 2016) *Comprehensive Development Plan for the Electricity Sector to 2025* seeks to fully phase out cross-subsidization of electricity end-user tariffs by introducing transparently determined and cost-reflective production, transmission, and distribution tariffs. Whereas end-user gas tariffs are subsidized, gas power plant operators pay a higher price per 1 thousand m^3 of natural gas compared to the price the Government pays when importing gas from the Russian Federation[22].

Cost-reflective tariffs are also important to allow for sufficient investment in refurbishing the partially outdated and antiquated electricity transmission and distribution network[23]. Particularly with a view on the planned additional nuclear electricity generating capacity, the Government of Belarus aims to further improve the reliability of power supply in the regions and the stability of the power system.

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[20] CIA (2016)

[21] Between 2006 and 2010, the gas import price of Belarus significantly increased by 4.2 times from USD 46.68 per 1,000 m^3 of gas to USD 195.67 per 1,000 m^3 (both Q4) (Business Forecast, 2014). Although the price for gas has decreased over the recent years from USD 168 US per 1,000 m^3 in 2014 to USD 136 per 1,000 m^3 in 2016, international gas prices are volatile and expected to grow in the medium and long term (IEA, 2016).

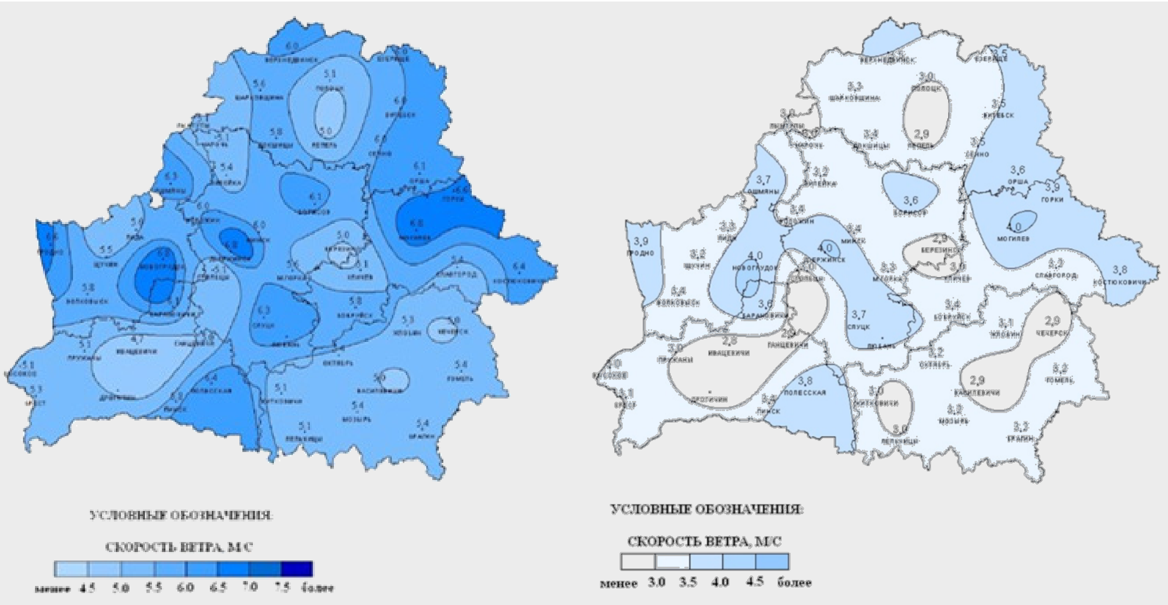
[22] For example, in 2016, Belarusian gas companies paid on average ca. USD 160 per 1,000 m^3 which is higher than the price paid by the Government of Belarus for gas imports (USD 136 per 1,000 m^3). The difference finances a special fund, managed by the Presidential office, providing financial support to specific projects and industries of strategic importance for the county.

[23] The degree of the electrical network ranges from 47.2 % on 750 kv transmission lines to 75 % on 35kV transmission lines. Electricity transmission and distribution losses amount to 9.01 % (Belenergo, 2016).

Renewable Energy Resources

Many parts of the country have favorable wind speeds with an average annual wind speed ranging between 3–4 meters per second at 10–12 m height above surface levels (Energy Charter, 2013). Figure 10 shows that the potential is particularly high in the north-east, the center and parts of the south-west of the country. The economically feasible potential is estimated at 1.6 GW installed wind energy capacity[24].

Figure 10: Background average wind speed in Belarus at 100 meters (left) and 10-12 meters (right) above surface



Source: (Hydromet Wind Atlas of Belarus)

The modelling uses a capacity factor of 30 % for wind energy. This capacity factor is a projection from Belarusian wind energy developers assuming favorable wind sites and new, high quality wind turbines.

Current Status of Wind Energy Investment in Belarus

To date, a total of ca. USD 40-45 million[25] has been invested in 68.4 MW installed wind energy capacity. This investment was directed to 66 imported and used wind turbines, indicating a high fragmentation of the market.

In 2016 the Government of Belarus amended the 2010 law "On renewable energy sources" by Presidential Decree №209 "On the use of renewable energy sources". The decree introduced a competitive auction mechanism to tender wind capacities to interested investors and independent power producers (IPPs)[26]. From December 2015 until the end of 2016 several bidding rounds took place during which a total of 59 MW of wind energy was tendered[27]. Not taking into account quotas that have been granted to international technical assistance projects (including the 25 MW that has been assigned to the UNDP-GEF project *Removing Barriers to Wind Power Development in Belarus*), the average capacity of one quota is ca. 3.5 MW. This again indicates the high degree of fragmentation in the market as no utility scale wind park quotas have been given out to date[28].

There is significant interest from the private sector in wind energy. For example, during the latest auction in October 2016, a total of 447.5 MW wind energy bids were submitted, which is 37 times more than the 12 MW wind energy capacity which was available during this tender. This interest was also confirmed during the interviews with investors and developers in Belarus.

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[24] *Strategy of the Republic of Belarus of the Energy Potential*

[25] Estimate from Belarusian wind energy experts.

[26] See Box 1 in Chapter 4.2 for a detailed description of the design and the drawback of the current quota system and wind energy tariff.

[27] The quotas were given out in several tenders and require quota holders to commission wind energy power plants in a specified year. 10 MW (4 quotas) is to be commissioned in 2016; 8.7 MW (2 quotas) by 2017; 28.4 MW (2 quotas – includes the 25 MW that has been assigned to the UNDP-GEF project *Removing Barriers to Wind Power Development in Belarus*) by 2018 and 12 MW (3 quotas) by 2019. These auctions included a range of other renewable energy technologies as well, such as solar PV and biomass. A total of 215 MW renewable energy generation has been tendered during the auctions, of which wind energy made up 27 % of the tendered capacity (59 MW).

[28] In addition, before Decree No 209 entered into force, the Government has signed investment agreements of additional 157.1 MW wind energy capacity. These investment agreements, applicable to wind energy projects that were concluded before 18 May 2015, may sell electricity from renewable energy sources using a fixed coefficient of 1.3.

4 Modelling of Wind Energy in Belarus

This section describes the DREI modelling for the promotion of private sector, large-scale investment in wind energy in Belarus. First, a summary of the approach to the modelling is provided. It describes the two scenarios modeled, 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 simplified set of underlying data and assumptions that are presented in Annex A. Further in-depth data collection and more comprehensive assumptions can strengthen the robustness of these results.

4.1. The Model's Approach

Modelling Two Core Scenarios in Belarus

In order to study different public instrument packages, the modelling compares two core scenarios to achieve the DREI models 500 MW wind energy investment target[29]: a *business-as-usual (BAU) scenario* and a *post-derisking scenario*. Both scenarios take today's (2017) current risk environment in Belarus as the starting point, while the study period for the financial modelling is set to be from 2017 to 2030 (14 years).

- ***Business-as-usual (BAU) scenario.***
  - This scenario assumes that the DREI model's 500 MW investment target is achieved under today's risk environment in Belarus.
  - The BAU scenario uses the current financing costs and terms (capital structure and loan tenor) that an investor encounters in Belarus today.
- ***Post-derisking scenario.***
  - This scenario assumes that the DREI models' 500 MW 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 BAU scenario, reflecting the impact of derisking instruments in reducing financing costs and improving financing terms.

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.

Four key issues associated with the modelling merit highlighting:

- **Baseline approach**
  - Wind energy investments are made in the context of an existing electricity generation mix that is mainly comprised by natural gas. As Belarus is not characterized by a significantly increasing energy demand forecast, and in the context of adding additional nuclear power capacity to the energy mix over the next years, new wind installations will likely need to replace existing generation capacity. As the existing gas power plant fleet has the highest marginal generation costs in the country's current electricity mix, gas would be the first technology to be phased out if additional capacity comes online. The modelling therefore takes a 100 % *operating margin* approach to estimate baseline costs, assuming new wind energy plants are partially replacing electricity generation from existing single cycle combustion turbines (SCGT).However, it is important

[29] This study therefore assumes a 'hypothetical' DREI investment target of 500 MW wind energy, which will be commissioned in addition to the wind energy capacity that has already be given out in forms of quotas or investment agreements in the past.

to note that new wind energy is assumed to partially replace existing gas generation and existing gas power plants are not decommissioned Therefore, this study assumed fully depreciated gas power plants and gas generation costs are comprised by O&M and fuel costs only.

- Since the current gas power plant fleet is operated by state owned enterprises, financing costs of SCGT gas power plants are assumed to equal the public cost of capital in Belarus (See Annex A for details). Financial modelling also considers the fuel type of the existing power plants.
- The fuel costs are obtained from Belarusian gas experts and reflect current gas prices in the Belarus. Throughout the modelling period, IEA World Energy Outlook (WEO) were used to estimate future gas prices[30].
- The baseline grid emission factor is assumed at 0.45 tonnes of CO_2e/MWh[31].

- **Variability.** An inherent characteristic of wind energy is its variability and lack of dispatch ability. Energy planners typically need to balance intermittent renewable energy technologies with dispatch able capacity, and LCOE-based comparisons using variable energy sources can have limitations in not capturing this balancing cost, nor generation costs at peak demand. In this study, the modelling does include balancing costs as it is assumed that 500 MW wind energy capacity is replacing existing gas electricity generation to the extent of the projected wind energy capacity factor (30 %). The model therefore compares a scenario in which existing gas power plants run at 100 % of time (baseline technology) with two scenarios in which existing gas power plants run only 70 % of the time and are complemented by wind energy (BAU and post-derisking) for the remaining 30 % of time. The latter means that existing gas power plants are not decommissioned but are needed to balance new wind energy plants when those are not producing electricity. The model accounts for these balancing costs by comparing wind energy generation costs that include installment costs and O&M costs only with the costs for electricity from gas that is replaced by electricity from wind. This means, gas energy generation costs are only a function of O&M and fuel costs. Investment costs of gas power plants are not included as they are assumed to be fully depreciated. This essentially also means that wind energy generation costs already reflect a balancing penalty.
- **Transmission Lines.** In order to keep it manageable, the modelling assumes that all the wind energy sites that are part of the 500 MW DREI wind energy investment target are within 10 km of the existing grid. Capital costs related to the upgrade and maintenance of the grid infrastructure in Belarus are excluded from the analysis.
- **Installed costs and O&M costs for wind energy.** The assumptions for the installed costs (i. e. the cost of hardware, such as wind turbines) and for operations and maintenance (O&M) costs have particular potential for improving the overall competitiveness of wind energy in Belarus. Globally, the costs of renewable energy hardware have been falling consistently over time, and they are expected to continue to do so. The same is true for O&M costs, which is partly due to technology improvements and better forecasting, and partly also due to the increasing competition for O&M contracts as the number of service providers keeps growing. This study assumes installed costs for onshore wind energy expected to prevail in the year 2023, i. e. the year that reflects the mid-point of the modelling period 2017–2030. The 2023 cost estimates are derived from the latest projections elaborated by the International Renewable Energy Agency (IRENA) and published in June 2016 (IRENA, 2016)[32]. The sensitivity analysis that is part of this DREI study will elucidate the impact on the results when assuming today's (2017) installed costs.

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

[30] Source: IEA (2016)

[31] EBRD (2009)

[32] To follow a conservative approach to costs, this report does not adjust wind energy O&M costs with cost decrease projections by the mid-point of the modelling period 2017–2030, as current O&M costs in Belarus are, according to existing wind power park developers, lower than observed in other countries or similar DREI assessments. See Annex A, Table 15 for O&M and other wind energy related modelling assumptions.

Public Instrument Table

Table 2: The Risks, Barriers and 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 energy market, and/or sub-optimal regulations to address these limitations and promote renewable energy markets	– *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 standard PPAs and/or in PPA tendering procedures since PPA is granted after plant commissioning – *Market distortions:* such as high fossil fuel subsidies	Ministry of Economy, Department of Energy Efficient of the State Committee on Standardization, Ministry of Energy, Ministry of Natural Resources and Environment Protection
2. Permits Risk	Risk arising from the public sector's inability to efficiently and transparently administer renewable energy- 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.	Regional Executive Committees, District Executive Committees, Belenergo, Ministry of Transport and Communications, Ministry of Communications and Informatization, Ministry of Defense, National Academy of Sciences of Belarus, Ministry of Natural Resources and Environment Protection
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 – Social and political resistance related to NIMBY concerns, special interest groups	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

Source: authors; adapted from Waissbein et al. (2013).

MENU OF SELECTED PUBLIC INSTRUMENTS			
Policy Derisking Instruments		Financial Derisking Instruments	
Activity	Description	Activity	Description
Establish transparent, long-term national renewable energy strategy and 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.		
Establish a harmonized, well-regulated and unbundled energy market, with cornerstone instruments to address price and market-access risk for renewable energy projects	Legislative wind energy reform which includes (i) establishing well-designed and transparent procedures for quota and PPA tendering; (ii) a revised quota regulation which includes a fixed tariff (and not only fixed coefficient), and a standard PPA with a well-designed, transparent policy on key clauses in the PPA, optimally adopted by a new RE law; (iii) PPAs which are granted in the development stage prior to power plant commissioning		
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 Belarus analysis following investor and developer feedback.			
Introduction of permit harmonization and development of a register of available wind sites	Introduction of permit harmonization (regional vs. federal permits) and reduction of process steps; register of available wind sites that shows suitable (i. e. high wind speed) and available (i. e. allowed to use for wind energy generation) sites for wind power development.		
Contract enforcement and recourse mechanism	Enforce transparent practices, renewable energy related corruption control and fraud avoidance mechanisms; establish effective recourse mechanism.		
Policy derisking instruments addressing this barrier, e.g., awareness raising campaigns and pilot models for community involvement at project sites are not included in this Belarus analysis following investor and developer feedback.			
Capacity building for resource assessment	Establish a Wind Energy Support Unit for dissemination of top-level, national resource assessment findings, on-site resource assessment (depending on technology) and capacity building for resource assessment.		
Feasibility studies; networking; training and qualifications	Wind Private Finance Initiative to conduct feasibility studies; pre-development works; sites screening; industry conferences; establishment of a national wind energy association; grant funding for pre-feasibility studies; training, apprenticeships and university programmes to build skills (planning, construction, O&M).		
Derisking instruments addressing this barrier, e.g., trade fairs, financial products by development banks to assist local manufacturers, are not included in this Belarus analyses following the definition of the general investment assumptions.			

Table 2: The Risks, Barriers and 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 of Belenergo 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	Belenergo (as utility, 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 Belenergo's (as electricity purchaser) credit quality, corporate governance, management and operational track-record or outlook; unfavourable policies regarding Belenergo's cost-recovery arrangements	Belenergo (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 availablity 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 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/ Macroeconomic 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 Waissbein et al. (2013).

MENU OF SELECTED PUBLIC INSTRUMENTS			
Policy Derisking Instruments		**Financial Derisking Instruments**	
Activity	**Description**	**Activity**	**Description**
Strengthen Belenergo's operational performance, grid management and formulation of grid code	Develop and update 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 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 Belarus analysis. Outside scope of analysis.*	
Strengthen Belenergo's performance	Strengthening Belenergo's and regional grid operators management & operational performance for existing operations	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	Assess trade-offs between financial stability regulation and renewable energy objectives (e.g. liquidity treatment); promote financial sector policy favorable to long-term infrastructure, including project finance	Financial products by development banks 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		
		Risk sharing products by development banks to address political risk	Provision of political risk insurance (PRI) covering (i) expropriation, (ii) political violence, (iii) currency restrictions
		Risk sharing mechanisms to address currency risk	Inlcude current partial indexing (ca. 80 %) of local currency tariffs in PPAs, so that foreign renewable energy investors and developers are partially reimbursed for local currency depreciation of the tariff

4.2. The Model's Results

Risk Environment (Stage 1)

Interviews

Data for Stage 1 (Risk Environment) of the modelling were gathered from interviews held with 10 project developers and investors who are domestically and internationally active and who are considering, or are actively involved in, large-scale wind investment opportunities in Belarus. The interviews were held face-to-face during a country mission in August 2016. In addition, data was refined in 4 unstructured interviews with wind energy experts and 2 interviews with international finance institutions.

Financing Cost Waterfalls

The analysis of the contribution of investment risks to higher financing costs in Belarus is shown in the financing cost waterfalls in Figure 11. This analysis was performed jointly for wind energy investors. Definitions of each of the risk categories can be found in Table 2.

The results estimate the business-as-usual cost of financing in Belarus today for wind energy at 20 % for the cost of equity (USD) and 12 % for the cost of debt (USD). These are substantially higher than in the best-in-class country, Germany, which is estimated at 7.0 % for the cost of equity (EUR) and 3.0 % for the cost of debt (EUR). As is shown in later results, over the long lifetime of energy investments, the impact of higher financing costs on the competitiveness of renewable energy in Belarus is significant.

Figure 11 shows that there are two risks that predominantly contributing to higher financing costs in Belarus:

1) *power market risk*,
which relates to an uncertain outlook of the power market as a whole, accessing the power market through the quota system and the volatile nature of the tariff for wind energy, and

2) *financial sector risk*,
caused by the absence of appropriate financing (debt and equity) for wind energy in Belarus and a lack of experience and track record of the local financial sector with financing wind energy projects.

A range of moderate investment risks additionally contribute to higher financing costs including

3) *counterparty risk*,
4) *political risk,*
5) *currency and macroeconomic risk,* and
6) *grid and transmission risk.*

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.

Box 1: The current design of the tariff for wind energy in Belarus

In 2016 the Government amended the 2010 law "On renewable energy sources" by Presidential Decree №209 "On the use of renewable energy sources", which introduced a competitive auction mechanism to tender wind capacities to interested investors and IPPs. The quotas warrants renewable energy investors a tariff consisting of two components:

(i) a fixed coefficient for 10 years guaranteed determined based on the bids during a specific tender, which is

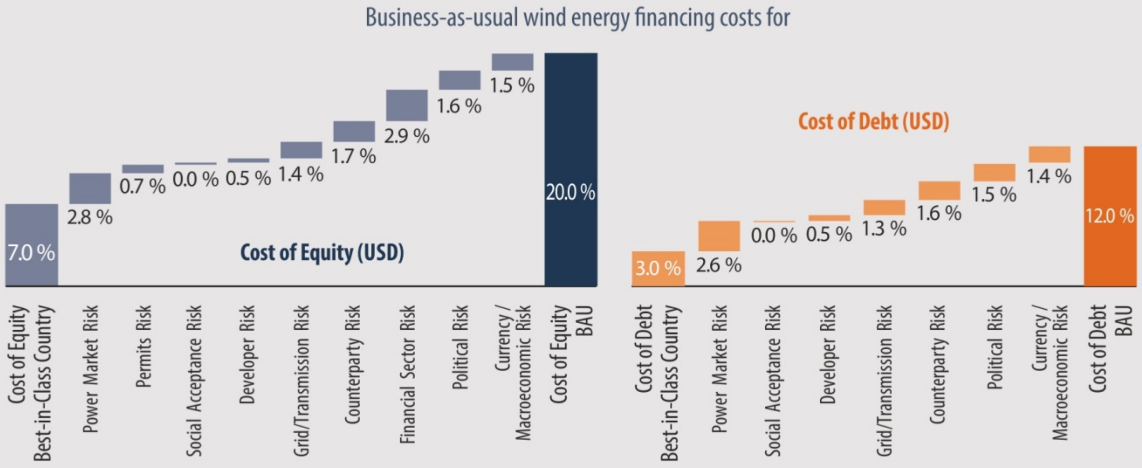
(ii) multiplied by the (varying) 'basic tariff', calculated as a function of the price for imported gas and oil.

Although parts of the resulting wind energy tariff are fixed, the variable component exposes investors to tariff fluctuations resulting in little planning security. The current design of the current wind energy tariff essentially means that it is a function of international gas price development, and as such penalized if international gas prices decrease (i. e. as this decreases the basic tariff). In addition, planned additional nuclear power generation capacities are likely to further influence the tariff setting negatively in the future, as increased nuclear capacity means less imported gas for electricity generation. The current tariff and quota design therefore penalizes electricity generation from renewable energy. As explained above, renewable energy investment (including wind energy) is characterized by a high upfront capital intensity with very low operating costs and zero fuel costs over their lifetime. As fossil fuel based energy generation typically has the reverse investment profile, wind energy is indeed more sensitive to changes in financing costs, but it has the advantage to lock-in fuel costs over its lifetime. In the current regulatory regime in Belarus, however, wind energy is penalized twice as

(i) it is relatively uncompetitive compared to fossil fuel generation due to its higher sensitivity to a high financing cost environment and
(ii) since the wind energy tariff is a function of future gas price and overall energy sector developments.

As risks related to tariff setting and policy regime were estimated as one of the main barriers to wind energy investment (see Figure 10), the authors of this report therefore analyze the introduction of a new wind energy policy regime. In this regime, a fixed wind energy tariff is introduce which is decoupled from other energy market developments and which, in turn, represents a hedge towards negative international fuel price developments in the future (see Box 2).

Figure 11: Impact of risk categories on financing costs for wind energy in Belarus, business-as-usual scenario[33]



Source: Interviews with wind energy investors and developers; modelling; best-in-class country is assumed to be Germany; see Annex A for details of assumptions and methodology[33].

Table 3: Qualitative investor feedback on risk categories for wind energy in Belarus[34]

Risk Category	Investor Feedback
Power Market Risk	This risk has a high impact on financing costs. Interviewees comment favorably on the government's commitment to increase wind energy generation in the coming years and recent efforts to create a conducive legislative framework which allows the private sector to invest in wind energy generation in Belarus, such as the recently introduced quota mechanism. However, the majority of interviewees also mention significant barriers and risks related to the current power market and wind energy policy environment: - Investors face uncertainties related to the outlook of wind energy and renewable energy sources in general. The planned commissioning of a nuclear power plant in the coming years creates additional significant uncertainties on the development of the power market. - Due to the partially volatile tariff structure in the wind energy quotas, interviewees expressed they face significant risks related to reductions of the 'basic tariff' in the coming years. Tariff fluctuations in the future make it difficult for private investors to assess future cash flows. - Interviewees explained that the coefficient, or in other words the fixed part of the tariff for wind energy, is determined in a presidential decree, which could be overruled by another presidential decree in the future. - Interviewees mentioned that standardized PPAs are nonexistent and that the current legislation allows signing a PPA with the off-taker only after commissioning the power plant. In addition, currently PPAs have to be negotiated bilaterally between developers and off-takers. - Some interviewees also mentioned a lack of transparency in the quota tendering process and the currently low capacity levels of quotas (i. e. on average 3.5 MW per quota) increase transaction costs for developers. - Finally, there are plans to liberalize the energy market in the future, splitting up generation, transmission and sale activities. The impact from this reform on private sector-operated renewable energy generation remains unclear.

[33] Due to the immaturity of the financial sector with wind energy finance in Belarus, financing cost waterfalls for both debt and equity were calculated by using a combined approach which is not differentiating between the answers from equity and from debt investors.

[34] As described in the original DREI report (Waissbein et al., 2013), the nine risk categories were designed in a way to meet the 'mutually exclusive and collective exhaustive' (MECE) criteria. This means, to correctly assign each risk's contribution to financing costs, these risk categories should show the lowest possible correlation among each while collectively representing all possible risks in the market. However, in practice, risk categories are often correlated, as barriers of one risk category may also have a negative impact on other risk categories. In the case for Belarus, correlations among the risk categories include:

(1) Power Market Risk with Developer Risk: The current design of the quota mechanism (average capacity per quota was 3.5 MW so far, refer to Chapter 3) holds back large scale investment in wind energy while also making it difficult to access hardware (wind turbines) from international, high quality manufacturers.

(2) Power Market Risk with Currency/Macroeconomic Risk: The current design of the tariff (linking the volatile 'basic tariff' to international gas and oil prices denominated in USD) means that the development of the wind energy tariff is also depended on the development of currency developments, i.e. the risk of depreciation of the Belarusian Ruble to the USD.

Risk Category	Investor Feedback
Permits Risk	This risk has a low impact on financing costs. Although there are number of stakeholders involved in granting permits, the majority of interviewees mentioned that obtaining necessary permits for wind energy is not a significant problem. Clearly defined steps for necessary wind energy permits and licenses are existing. However, interviewees mentioned a lack of knowledge on wind energy sites which are both available as a wind energy site, granted by a Local Executive Committee, and suitable for wind energy development, meaning that they have a considerably high wind energy potential. Since current regulations require concrete site specifications when applying for quotas, developers face high transaction costs for identifying legally available land which has sufficient wind potential while having the insecurity of an unsuccessful quota bid.
Social Acceptance Risk	This risk has no impact on financing costs. All interviewees mentioned that skepticism and resistance to wind energy such as from local communities is minimal given that affected communities are involved in the development of a wind park from the beginning. However, some interviewees mentioned that this might change in the future once the market reaches scales beyond 1 GW installed capacity.
Developer Risk	This risk has a low impact on financing costs. Interviewees gave mixed feedback on this risk category. Some expressed confidence about the availability of good companies and qualified personnel in Belarus. Others felt that there is a lack of local firms and skills related to the development (feasibility studies, wind measurements etc.) and the maintenance of parks, particularly once the sector reaches scale. To date, wind energy measurements have been conducted by international companies. Some investors also mentioned that the lack of local industrial presence makes it difficult to access wind turbines from international, high quality manufacturers. Low capacity levels of quotas (i. e. on average 3.5 MW per quota) make it relatively less attractive for world leading wind energy manufacturers to enter the market.
Grid/ Transmission Risk	This risk has a medium impact on financing costs. Overall, investors reported that at the moment, the grid is relatively stable and risks in this category are manageable. However, in the short and medium term, planned additional electricity generation capacity, such as from the nuclear power plant, create uncertainties related to stable grid and transmission infrastructure management. Although current legislation protects wind park developers from being cut of the electricity grid without reason, there is no financial reimbursement for curtailment of wind power parks if it should take place. Planned access generation capacities in the future might force regional and national transmission companies to curtail intermittent RE electricity due to generation overcapacity. Investors also mentioned that grid operator Belenergo has a limited track record with intermittent electricity sources and, in parts of the country, there is inadequate or antiquated grid infrastructure. Some interviewees also expressed problems with the local grid operator to agree on adequate terms of connecting wind energy plants to the grid, despite legislative obligations. Unforeseen obligations by local grid operators, such as to build an electricity sub-station, has increased installment costs significantly. In other cases, wind turbines were connected to the grid at significantly farther distances than necessary, leading to an increase in installment costs.
Counterparty Risk	This risk has a medium to high impact on financing costs. Interviewees concluded that, at the moment and in the short term, the risk of not receiving payments for electricity from wind is relatively small. The Ministry of Energy buys the entire electricity and defines the consumer tariffs based on aggregated expenses on wholesale electricity tariffs. However, investors mentioned that planned energy market liberalization efforts might increase this risk in the medium term and the commissioning of the nuclear power plant in the future could have a negative effect on Belenergo's ability to pay.
Financial Sector Risk	This risk has a high impact on financing costs. On the one hand, investors commented favorably on the lifting of sanctions and the increased availability of international public debt and equity. On the other hand, local capital for wind energy is relatively scarce and comes at high financing costs. Interviewees also mention that local banks have limited experience with renewable energy finance, project finance in general as well as with hedging foreign exchange exposure (i. e. Belarusian Ruble to EUR or USD). For example, a missing PPA in the development and design phase makes it very difficult to obtain debt financing in general. Interviewees mentioned that for local financing real estate has been used as collateral to obtain RE related debt financing. However, international financial institutions (IFIs) representatives expressed their readiness and willingness to provide international public debt and equity for wind energy projects in Belarus, given there are bankable PPAs.
Political Risk	This risk has a medium impact on financing costs. Interviewees commented favorably on the political stability and strong institutions with an effective rule of law but some interviewees expressed there is some residual risk.
Currency/Macro-economic Risk	This risk has a medium impact on financing costs. Investors comment favorably on current legislation, which indexes the basic tariff (fluctuation component of the wind energy tariff) to the USD (ca 80 %) due to its dependency on imported gas and oil prices traded in USD. Thus, currency risk is partially addressed if financing is in USD and not EUR. Interviewees mention that if the index would not be fixed, this risk is very high. In addition, since the index is determined in the legislation and not in a PPA, investors expressed concerns regarding revising the indexation in the future. In the past, partial indexing of the tariff has been decreased already and some interviewees fear that indexing could be revised or even eliminated in the medium term, due to for example, less dependency on oil and gas imports as a result of the nuclear power plant.

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

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 11) identify incremental financing costs for a particular risk category, then the matching public instrument (Table 2) is deployed as part of the public instrument package.

While Table 2 lists the public instruments in full detail, Table 4 below provides a brief summary on the identified public instrument package including their costs. Box 2 illustrates exemplarily in more detail how power market risk instruments are addressing specific barriers in this risk category.

Box 2: Policy derisking instruments reducing risk in the power market

Due to the currently prevailing barriers and risks in the power and wind energy market in Belarus explained in the section above, key instruments in the power market risk category suggest to introduce a new wind energy policy regime. These instruments include the establishment of transparent, long-term national wind energy strategy as well as transparent energy sector planning. Both are particularly important as market actors currently phase insecurities related to excess electricity capacity once the nuclear power plant is commissioned. In addition, these instruments include the establishment of a well-designed and transparent procedure for quota and PPA tendering which includes granting standard PPAs at the development stage prior to power plant commissioning. The PPA should be a standard document with key clauses applicable in all regions and it should guarantee a fixed tariff for 10-15 years, based on the outcome of the quota tendering and optimally adopted by a new renewable energy law. Costs related to these instruments come in the form of regular updates to long-term renewable energy targets, support to the completion of the reform of the current legislative environment for wind energy including as well as administrative costs related to operating PPA and quota tenders.

Table 4: The selection of public instruments to achieve additional 500 MW installed wind energy capacity

Risk Category	Policy Derisking		Financial Derisking Instruments	
	Instruments / Description	Costs, USD mln	Instruments / Description	Costs, USD mln
Power Market Risk	• Long-term national wind energy strategy and targets; • Transparent energy sector planning; • Well-designed and transparent procedures for quota and PPA tendering and fixed tariff; • Standard PPA with a well-designed, transparent policy on key clauses across all regions	1.06	NA	NA
Permits Risk	• Permit harmonization • Development of a register of available wind sites • Contract enforcement and recourse mechanism	0.635	NA	NA
Social Acceptance Risk	NA	NA	NA	NA
Developer Risk	• Capacity building for resource assessment; • Feasibility studies; networking; training and qualifications; Research and development; technology standards; exchange of market information (e.g., via trade fairs and the establishment of a wind energy association)	0.360	NA	NA
Grid/ Transmission Risk	• Strengthening Belenergo's operational performance, grid management etc. • Regular updates of grid code	0.585	Take-or-Pay Clause in PPA[35]	6.2
Counterparty Risk	• Strengthening Belenergo's and regional grid operators' management & operational performance for existing operations	0.700	Government (Sovereign) Guarantee	48.0
Financial Sector Risk	• Promoting financial sector policy favorable to long-term infrastructure, including project finance • Strengthening of investors' familiarity with financing renewable energy projects	0.510	Public loans for renewable energy developers provided by development banks and international finance institutions	113.6
Political Risk	NA	NA	Political risk insurance	9.1
Currency/Macro-economic Risk	NA	NA	Partial-indexing of the PPA tariff	12.3 [36]
	Total Costs, million USD	**3.8**		**189.2**

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

[35] 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.

[36] The "partial indexing mechanism" fixes the tariff in the PPA, paid in Belarusian Ruble, to 50 % of the current USD. Costs for this indexing mechanism are estimated at USD 12.3 million, representing the cost of a premium to hedge against anticipated depreciation rates in the future, based on a the inflation differential. The current legislative environment in Belarus already contains a partial indexation of the wind energy tariff at ca. 80 %, as the (varying) 'basic tariff' is a function of gas import prices, denominated in USD. Local currency depreciation also affects gas price import in the same way as international gas prices are denominated in USD.

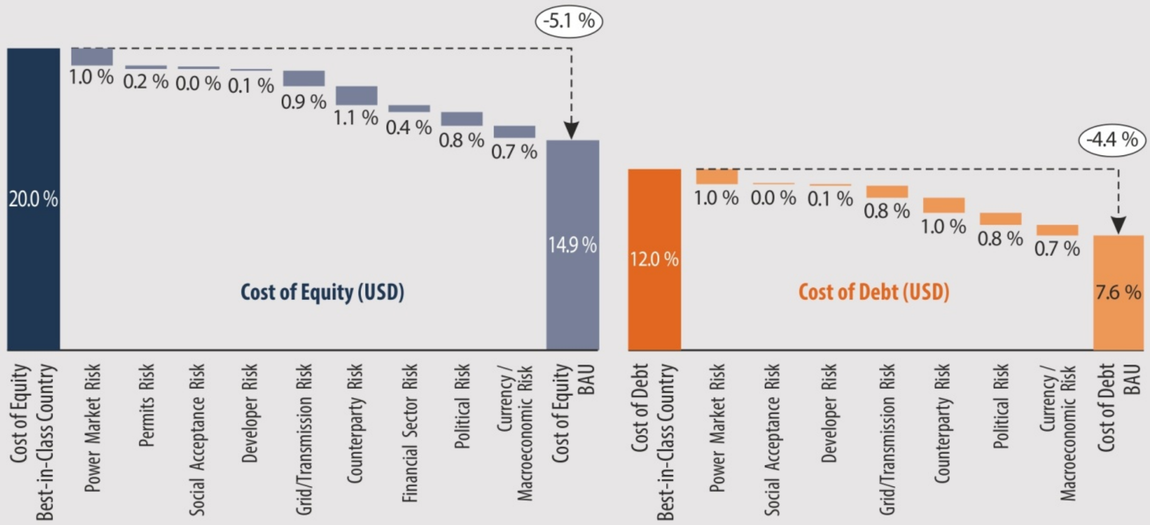
The public costs of each selected public instrument are also modeled. Implementing public derisking instruments to achieve 500 MW of additional wind energy capacity will cost USD 3.8 million in policy derisking instruments and USD 189.2 million[37] in financial derisking instruments.

The full breakdown of each selected public instrument and its cost is provided in Table 10. Details of the assumptions and the methodology used to generate the cost estimates are available in Annex A.

Impact of Public Instruments on Financing Costs

The impact of the public instruments on reducing financing cost for wind energy in Belarus are shown in Figure 12. Based on the modelling analysis, the selected package of derisking instruments is anticipated to reduce the average cost of equity (USD) until 2030 by 5.1 percentage points down to 14.9 %, and the cost of debt (USD) by 4.4 percentage points down to 7.6 %.

Figure 12: Impact of public derisking instruments on reducing financing costs for wind energy in Belarus



Source: Interviews with wind energy investors and developers; modelling; see Annex A for details of assumptions and methodology.
Note: the impacts shown are average impacts over the 2017-2030 modelling period, assuming linear timing effects.

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 Belarus is provided in Table 5.

[37] Different 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', the 'government guarantee for PPA', and for the 'partial indexing product' totaling USD 66.5 mln; a reserve approach has been taken for 'public loans' and 'political risk insurance', totaling USD 122.7 mln. See Section for sensitivity analyses in chapter 4.2 on costing. See Annex A for details.

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

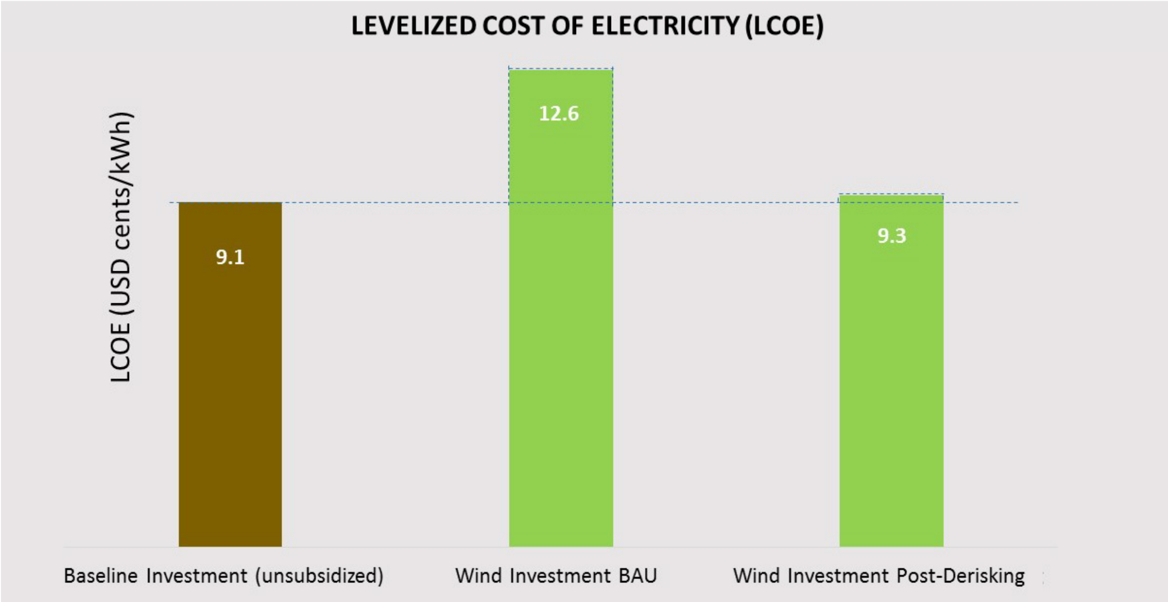
Risk Category	Public Instruments	Investor Feedback
Power market risk	Policy derisking instruments: (i) Long-term national wind energy strategy and targets; (ii) transparent energy sector planning; (iii) well-designed and transparent procedures for quota and PPA tendering and fixed tariffs; (iv) standard PPA with a well-designed, transparent policy on key clauses across all regions	Policy derisking instruments are highly effective. The instruments in this risk category are generally perceived highly effective by investors, particularly increasing transparency of energy planning and providing a fixed tariff for wind energy. Investors' high effectiveness rating assumes that development and implementation of power market reforms and regulations are implemented and enforced effectively.
Permits risk	Policy derisking instruments: (i) Permit harmonization (regional vs. federal permits) and reduction of process steps; (ii) Development of a register of available wind sites; (iii) Contract enforcement and recourse mechanism	Policy derisking instruments are effective. As particularly land titles are difficult to obtain, interviewees commented favorably on the development of a register containing available wind sites which makes suitable and available land areas accessible for potential investors.
Social acceptance risk	Policy derisking instruments: (i) awareness-raising campaigns; (ii) pilot models for community involvement at project sites	Interviewees have not rated the effectiveness of policy instruments as social acceptance risk has not been identified as a risk in Belarus. Therefore, these instruments were not included in the modelling.
Developer risk	Policy derisking instruments: (i) Capacity building for resource assessment; (ii) Feasibility studies; networking; training and qualifications; Research and development; technology standards; exchange of market information (e.g., via trade fairs and the establishment of a wind energy association)	Policy derisking instruments are effective. Interviewees commented favorably on organizing international wind industry fairs in Belarus, increasing awareness of international companies for this market. The majority of interviewees also rated capacity building for resource assessment and feasibility studies, pre-development works, and site-screening as effective instruments to address barriers under this risk category. Given the barriers related to accessing land mentioned above, interviewees also mentioned that the establishment of a specialized agency conducting wind measurements and site screening could be particularly effective. Finally, higher capacity levels in quotas (i. e. 20 MW and above) would facilitate the purchase of high quality wind manufactures as this makes the market more attractive for world leading wind energy manufacturers.
Grid/ Transmission risk	Policy derisking instruments: (i) Strengthen Belenergo's operational performance, grid management etc.; (ii) regularly update grid code Financial derisking instrument: (i) Include take-or-pay clause in the standard PPA	Policy derisking instruments are effective. Interviewees commented it would be helpful to support Belenergo to increase its experience with intermittent sources. Financial derisking instruments are very effective. Some of the interviewees mentioned that they had negotiated bilateral take-or-pay clauses with local grid operators. However, this causes huge insecurities and increased transaction costs. Particularly as wind park capacity levels increase, take-or-pay clauses in the PPAs are a highly effective instrument to address parts of the barriers under this risk.
Counterparty risk	Policy derisking instruments: (i) Strengthen Belenergo's performance Financial derisking instrument: (i) Government guarantees or backing for PPA payments	Policy derisking instruments are effective. Interviewees commented it would be helpful to establish international best practice in Belenergo's management, operations and corporate governance and to implement sustainable cost recovery policies. Financial derisking instruments are effective. Interviewees rated the introduction of government guarantees ensuring PPA payments as generally effective to address this risk.
Financial sector risk	Policy derisking instruments: (i) Financial sector policy favorable to long-term infrastructure; (ii) strengthen investors' familiarity with financing renewable energy projects Financial derisking instrument: (i) Public loans for renewable energy developers provided by development banks and international finance institutions	Policy derisking instruments have limited effectiveness. However interviewees commented that the promotion of financial sector policies and increasing local bank's capacity with project finance in general and renewable energy finance in particular would be of help to addressing this risk in the long term. Financial derisking instruments are highly effective. Due to scarcity of local equity and debt, all investors commented very favorably on the availability of public loans for wind energy.
Political risk	Financial derisking instrument: (i) Risk sharing products by development banks to address political risk	Financial derisking instruments are very effective. Particularly international investors and development bank representatives mentioned political risk insurances as very effective in transferring this risk.
Currency/ Macro-economic risk	Financial derisking instrument: (i) include current partial indexing (80 %) of local currency tariffs in PPA	Financial derisking instruments are highly effective. Although parts of the tariff (ca. 80 %) are already indexed in the current legislation, investors mentioned that including the indexing mechanism in the PPA would be effective. However, with a view on recent currency depreciations, residual risks remain.

Source: Interviews with investors (equity investors/developers and debt investors). Short description of public instruments are given in Table 2.

Levelized Costs (Stage 3)

The modelling outputs in terms of LCOEs for wind energy are shown in Figure 13.

Figure 13: LCOEs for the baseline and wind energy investment in Belarus



Source: Modelling; see Table 10 and Annex A for details of assumptions and methodology.

The marginal (unsubsidized) baseline LCOE of existing SCGT gas power plants is estimated as being USD cents 9.1 per kWh. In other words, this is the per kWh tariff required to produce the same amount of electricity using existing gas power infrastructure as it could be produced, alternatively, by the additional wind power capacity (assuming a capacity factor of 30 %).

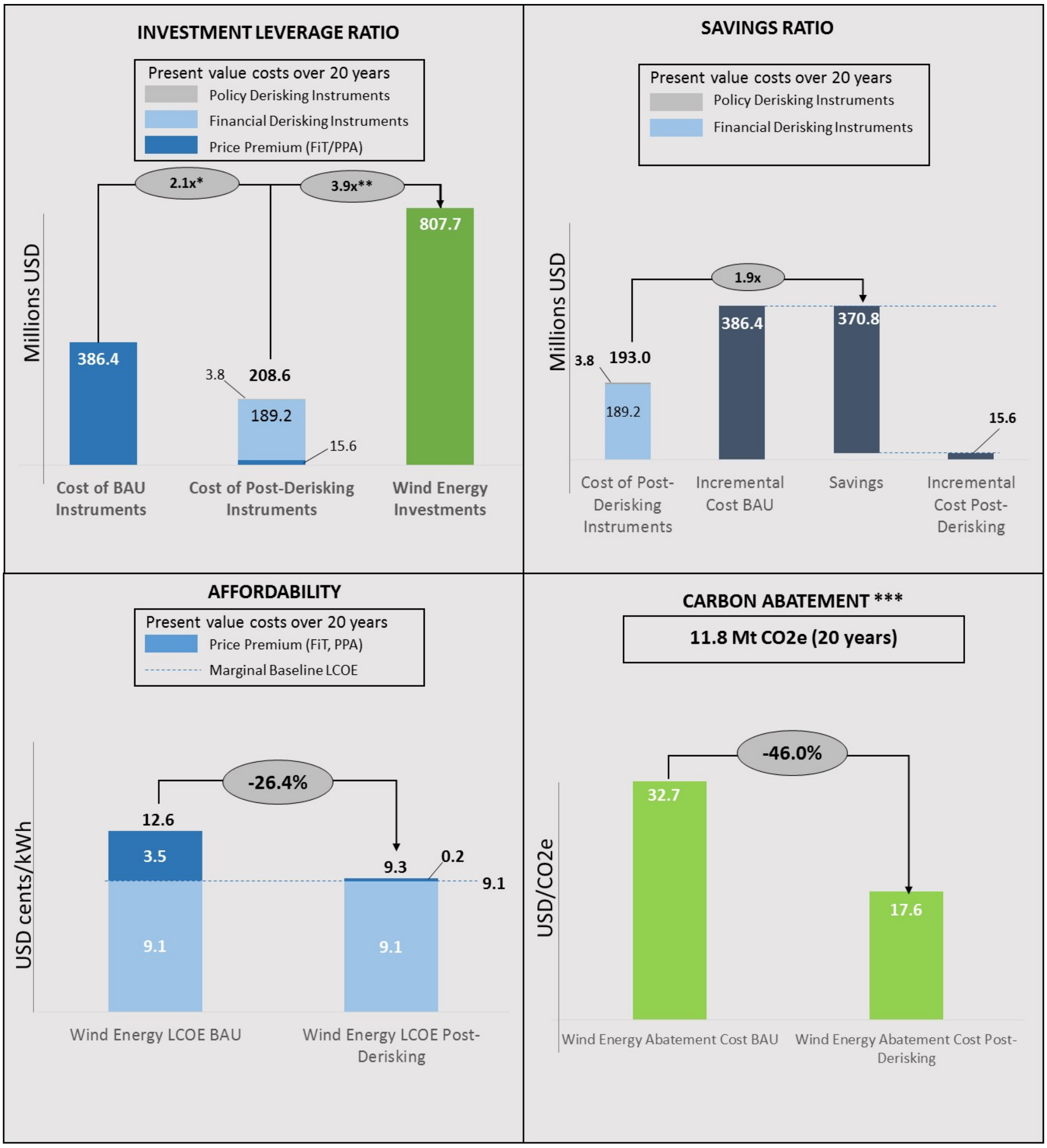
Whereas wind energy is shown to be more expensive than the unsubsidized baseline cost in the *business-as-usual* scenario, it is almost cost competitive in the *post-derisking scenario*. The public instrument package reduces the LCOE for wind energy from USD cents 12.6 per kWh (*business-as-usual* scenario) to USD cents 9.3 per kWh (*post-derisking* scenario). The price premium of USD cents 3.5 per kWh in the *business-as-usual* scenario is reduced to USD cents 0.02 per kW in the *post-derisking* scenario. This means that in a derisked environment, the kWh price from existing gas power infrastructure is only marginally lower than wind energy generation costs, although the latter requires upfront investment in new wind energy generation infrastructure whereas gas generation costs include only O&M and fuel costs.

Evaluation (Stage 4)

Performance Metrics

The model's performance metrics, evaluating the impact of derisking on realizing 500 MW of additional wind energy capacity in Belarus, are shown in Figure 14.

Figure 14: Performance metrics for the selected package of derisking instruments promoting 500 MW of wind energy investment in Belarus



Source: Modelling; see Table 10 and Annex A for details on assumptions and methodology.

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

** The vast majority of costs of instruments in the post-derisking scenario come from financial derisking instruments (USD 189.2 million).Policy Derisking costs are estimated at USD 3.8 million only

*** 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 32.7 per t CO_2e comes from the price premium, in the *post-derisking* scenario, USD 1.3 is attributed to the price premium, USD 16.0 to financial derisking costs, and USD 0.3 to policy derisking costs leading to a total of USD 17.6 per t CO_2e.

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 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_2e abated). This can be a useful metric for comparing carbon prices.

Taken as a whole, the performance metrics demonstrate how the deployment of public derisking instruments can significantly increase the competitiveness and affordability of wind energy in Belarus:

- The investment leverage ratio shows that derisking is an efficient use of public funding. Achieving 500 MW installed wind capacity equates to USD 807.7 million in private sector investment. In the *business-as-usual* scenario, the model estimates that achieving this target will require a direct financial incentive in the form of a price premium over 20 years of USD 386.4 million. This results in a leverage ratio of 2.1 i. e. the investments catalyzed are around 2.1 times the amount spent on the public instruments. In the *post-derisking* scenario, the model estimates that this same investment target can be achieved with a package of derisking instruments valued at USD 193.0 million and a significantly lower price premium of USD 15.6 million. This raises the leverage ratio to 3.9, indicating a higher efficiency in terms of the costs of public instruments.
- The affordability ratio shows that derisking is an effective and efficient tool to decrease wind energy generation costs significantly by 26.4 % to USD cents 9.3 per kWh which is almost at parity with carbon intensive (unsubsidized) gas power baseline generation costs.
- Over the lifetime, expenses for public derisking (USD 193.0 million) in the *post-derisking scenario* generate savings to the economy of USD 370.8 million.
- Finally, the carbon abatement ratio shows that derisked wind energy is not only cheaper but also results in a total reduction of 11.8 million tonnes of CO_2 over the lifetime of the wind plants. In the *business-as-usual* scenario, the abatement cost of the investment in wind energy are USD 32.7 per tonne of CO_2e. Or, in other words, the cost of public instruments equates to USD 32.7 for every tonne of CO_2e reduced by the investment in wind energy. In the *post-derisking* scenario, these cost falls to USD 17.6 per tonne of CO_2e. This means that total abatement costs per 1 tonne CO_2e are reduced by 46.0 %. This performance metric is also 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.

Sensitivities

An initial set of sensitivity analyses has been performed for wind energy and the baseline. 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.

Three broad types of sensitivity analysis have been performed:

- Varying key input assumptions
- Varying public instrument selection and cost-effectiveness
- Approach to costing financial derisking instruments

1. Sensitivity analyses varying key input assumptions

Sensitivity analyses have been performed for the following input assumptions: (i) investment costs, (ii) capacity factor, (iii) fuel costs, and (iv) financing cost (cost of equity and cost of debt). These sensitivity analyses give an indication of the degree to which each input parameter affects the outputs.

As an illustration, for wind energy, an increase in the capacity factor from 30 % (base case) to 33 % (sensitivity analysis) reduces the LCOE for wind energy in the BAU scenario from USD cents 11.4 per kWh to USD cents 8.4 per kWh in the post-derisking scenario. On the other hand, assuming a lower capacity factor of 27 % increases the post-derisking wind LCOE to USD cents 10.3 per kWh. However, the LCOE for the unsubsidized baseline also ranges between USD cents 7.8 and 10.5 per kWh if 20 % lower or higher gas prices are assumed.

Table 6: Wind energy: summary of LCOE outputs for sensitivity analysis on key input assumptions (USD cents per kWh)

TYPE OF SENSITIVITY	DESCRIPTION OF SENSITIVITY	BASELINE LCOE	WIND LCOE	
			BAU	POST-DERISKING
Base Case	**None**; complete menu of derisking instruments is selected.	**9.1**	**12.6**	**9.3**
Wind Investment and O&M Costs	Higher investment costs; uses 2016 investment costs as provided by Belarusian developers (Base case is 2023 – mid-point of study period 2017-2030 – investment cost estimate)	–	13.8	10.1
Wind Capacity Factor	Higher capacity factor. Sensitivity uses 33 % (Base case is 30 %)	–	11.4	8.4
Wind Capacity Factor	Lower capacity factor. Sensitivity uses 27 % (Base case is 30 %)		14.0	10.3
Fuel Costs	20 % higher fuel cost projections 20 % lower fuel cost projections	10.5 7.8	–	–
Financing Costs	1 % point higher financing costs (cost of equity (USD) =21.0 %, cost of debt (USD) =13 %)		13.1	9.5
	1 % point lower financing costs (cost of equity (USD)=19.0 %), cost of debt (USD) =11 %)		12.0	9.0

Source: sensitivity modelling; see Table 18, Annex A for details of assumptions and methodology.

2. Sensitivity analyses varying public instrument selection

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 can be found in Table 2. This sensitivity analyses the relationship of the costs of the instruments and their impact on lowering wind energy 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 (see Table 7 below). 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 (see Table 8 below).

An important caveat is that the modelling cannot tell us whether a particular instrument is *necessary*. For example, less cost-effective financial derisking instruments, such as Government (Sovereign) Guarantees backing up PPA payments or public loans, may be necessary at this stage of the wind market development in Belarus. Likewise, power market risk activities targeting permit harmonization and the development or a register of available wind sites, 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 the full DREI wind energy investment target for Belarus.

Nevertheless, the modelling does tell us that implementing a conducive policy environment for wind energy targeting barriers in the power market risk category are particular cost-effective compared to all other instruments modelled. This means that instruments in the power market risk category (long-term national wind energy strategy and targets; transparent energy sector planning; well-designed and transparent procedures for quota and PPA tendering and a fixed tariff; and standard PPA with a well-designed, transparent policy on key clauses across all regions) come at relatively low costs while having a relatively high impact on reducing the financing costs.

(i) Sub-sets of instruments

While the base case scenario considers the complete set of instruments listed in Table 7, this type of sensitivity analysis examines the impact and cost-effectiveness of different sub-sets of public instruments. The modelling performs simplified versions of this type of sensitivity, examining several scenarios:
(i) only policy derisking or only financial derisking instruments are selected, and
(ii) only high impact risk categories instruments are addressed.

The key results for this type of sensitivity are summarized in Table 7 below, and shown graphically in Figure 17 in Annex B.

Table 7: Wind energy: summary of LCOE outputs for sensitivity analysis on subsets of instruments. Instrument costs and savings to the economy given in million USD, LCOE in USD cents per kWh)

TYPE OF SENSITIVITY	DESCRIPTION OF SENSITIVITY	COST OF DERISKING INSTRUMENTS		POST-DERISKING COST OF FINANCING		WIND POST-DERISKING LCOE	SAVINGS TO THE ECONOMY
		POLICY	FINANCIAL	EQUITY	DEBT		
Base Case	**None**; complete menu of derisking instruments is selected.	**3.8**	**189.2**	**14.9**	**7.6**	**9.3**	**370.8**
Policy or Financial Derisking	Only policy derisking instruments selected	3.8	0	17.9	10.5	10.1	278.4
	Only financial derisking instruments selected	0	192.9	16.9	9.1	9.8	312.3
High Impact Risks	Only instruments addressing the two risk categories with highest impact on financing cost (power market risk, financial sector risk)	1.6	113.6	18.6	11.0	10.3	258.9

Source: sensitivity modelling; see Table 10, Annex A for details of assumptions and methodology.

(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 cents 0.10 per kWh[38]. The lower the USD cost of this metric, the more cost-effective the instrument is. Table 8 sets out the results of the sensitivities on individual instrument cost-effectiveness.

Table 8: Summary of results for sensitivity analysis on the cost-effectiveness of individual instruments for 500 MW wind energy investment target

RISK CATEGORY	INSTRUMENT	WIND (500 MW) USD cost of instrument/ USD 0.10 cents of impact on post-derisking LCOE
	POLICY DERISKING INSTRUMENTS	
Power Market Risk	Various	$427,000
Permits Risk	Various	$2,000,000
Developer Risk	Various	$1,200,000
Grid/Transmission Risk	Various	$1,400,000
Counterparty Risk	Various	$1,400,000
Financial Sector Risk	Various	$800,000
	FINANCIAL DERISKING INSTRUMENTS	
Grid/Transmission Risk	Take or Pay Clause	$3,800,000
Counterparty Risk	Government Guarantee	$46,700,000
Counterparty & Financial Sector Risk	Public Loans	$14,400,000
Political Risk	Political Risk Insurance	$4,700,000
Currency Risk	Partial indexing	$ 600,000

Source: sensitivity modelling.

[38] This metric is sensitive to the investment target of 500 MW of wind energy; therefore it can be misleading, particularly for instruments with variable cost components, to compare this metric across investment targets or technologies.

3. 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 A. The key cost figures resulting from the different costing approaches are summarized in Table 9 below, and shown graphically in Figure 18 in Annex B.

Table 9: 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, and opportunity cost for government guarantee; loss reserves for public loans and PRI	66.5	122.7	0	189.2	1.9x	17.6 (-46.0 %)
High-cost approach	Actual cost for take or pay and partial indexing product; loss reserve for PRI; face value for government guarantee and public loans	18.5	9.1	576.0	603.6	0.6x	52.7 (+61.2 %)
Low-cost approach	Actual cost for take or pay and partial indexing product, loss reserve for PRI; no cost for government guarantee and public loans	18.5	9.1	0	27.6	11.8x	3.98 (-87.8 %)

* In parentheses: relative change compared to pre-derisking carbon abatement cost of 32.7 USD/t CO_2e.

4.3. Summary Data Tables

Table 10: Summary modelling assumptions for wind energy in Belarus

WIND TARGET AND RESOURCES	
2030 Target (in MW)	500
Capacity Factor (%)	30.0
Total Annual Energy Production for Target (in MWh)	1,314,000
MARGINAL BASELINE	
Energy Mix	
Natural Gas (Combined Cycle Technology) (%)	100
Grid Emission Factor (t CO_2e/MWh)	0.450
GENERAL COUNTRY INPUTS	
Effective Corporate Tax Rate (%)	18
Public Cost of Capital (%)	10

	Business-as-Usual Scenario	Post Derisking Scenario
FINANCING COSTS		
Capital Structure		
Debt/Equity Split	70 % / 30 %	75 % / 25 %
Cost of Debt		
Concessional public loan	н/п	7.0 %
Commercial loans with public guarantees	н/п	н/п
Commercial loans without public guarantees	12.0 %	7.6 %
Loan Tenor		
Concessional public loan	н/п	15 years
Commercial loans with public guarantees	н/п	н/п
Commercial loans without public guarantees	10 years	10 years
Cost of Equity	20.0 %	14.9 %
Weighted Average Cost of Capital (WACC) (After-tax)	12.9 %	8.1 %
INVESTMENT		
Total Investment (USD million)	807.7	807.7
Debt (USD million)		
Concessional public loan	0.0	454.3
Commercial loans with public guarantees	0.0	0.0
Commercial loans without public guarantees	565.4	151.4
Equity (USD million)	242.3	201.9
Private Sector Equity	NA	NA
Public Sector Equity	NA	NA
COST OF PUBLIC INSTRUMENTS		
Policy Derisking Instruments (USD million, present value)		
Power Market Risk Instruments	NA	1.1
Permits Risk Instruments	NA	0.6
Social Acceptance Risk Instruments	NA	NA
Developer Risk Instruments	NA	0.4
Grid/Transmission Risk Instruments	NA	0.6
Counterparty Risk Instruments	NA	0.7
Financial Sector Risk Instruments	NA	0.5
Total	NA	3.8
Financial Derisking Instruments (USD million, present value)		
Grid/Transmission Risk Instruments	NA	6.2
Counterparty Risk Instruments	NA	48.0
Financial Sector Risk Instruments	NA	NA
Public Loans	NA	113.6
Public Guarantees for Commercial Loans	NA	NA
Political Risk Instruments	NA	9.1
Currency/Macro Risk Instruments	NA	12.3
Total	NA	189.2
Direct Financial Incentives (USD million)		
Present Value of 20 year PPA Premium	386.4	15.6
Funded by domestic public sector	NA	NA
Funded by international public sector	NA	NA

Source: modelling; see Annex A for details of assumptions and methodology. Financing costs are average costs from 2017–2030.

Conclusions and Next Steps

5

Today's investment environment for wind energy in Belarus has a number of investment risks that result in high financing costs. The results in this report confirm that financing costs for wind energy in Belarus are currently high, particularly in comparison to countries with more favorable investment environments. The cost of equity (USD) for wind energy in Belarus today is estimated at 20 %, and the cost of debt (USD) at 12 %. The modelling starts from nine different risk categories and evaluates to what extent they contribute to higher financing costs in Belarus. 2 of these – power market and financial sector risk are large contributors to high financing costs, increasing the cost of equity by more than 250 basis points (2.5 %) each.

The report then systematically identifies a comprehensive package of public derisking measures to target these risks and to achieve a 2030 target of an additional 500 MW in private sector investment in wind energy, building on the 2020 target found in 'Government Program "Power Saving" for 2016 – 2020'. The full instrument package is set out and itemised in Table 1 and comes with an estimated cost of USD 189.2 million until 2030.

A key conclusion from the modelling is that investing in derisking instruments is a cost-effective approach for achieving the 2030 target of an additional 500 MW in private sector investment in wind energy. The comprehensive package of public derisking measures that are modelled bring down the generation cost of wind energy from USD cents 12.6 per kWh to USD cents 9.3 cents per kWh which is at parity with the country's unsubsidized current costs for producing electricity using gas power plants (USD cents 9.1 per kWh).

If these derisking measures are implemented, this can result also in:

- Attracting USD 807.7 million of private sector investment in wind energy while saving an estimated USD 649.8[39] million of gas imports over the lifetime of the wind energy assets.
- Generating savings to the economy of USD 370.8 million when compared to commissioning 500 MW wind energy generation capacity under the current policy and investment environment.
- Lowering carbon emissions by 11.8 million tonnes of CO_2 over the next 20 years, thus contributing to climate change mitigation and environmental preservation.

The modelling thus clearly demonstrates that investing in the identified package of public derisking measures creates significant economic savings in achieving a 2030 investment target of 500 MW in wind energy in Belarus. The modelling also confirms that, when analysed on an individual basis, each public derisking measure is cost-efficient for Belarus, compared to the alternative of higher generation costs. Particularly instruments addressing power market risk, such as improving the current bidding mechanism and implementing a fixed price tariff for wind energy, will be key to unlocking investment at scale. These priority measures come at a relatively low cost of USD 1.1 million until 2030, and in turn have a relatively high impact on reducing associated risks. Thus, all derisking instruments that can be immediately implemented should, if possible, be prioritized.

As such, implementing these public derisking measures is indeed an opportunity for policymakers in Belarus. The end result can be affordable, locally produced and clean wind energy benefiting the people, economy, and environment in Belarus.

The results in this report should not be interpreted as a definitive quantitative analysis of wind energy in the Belarus but, rather, as one contribution to the larger policy decision-making process. It is hoped that the findings in this report can be compared, contrasted and combined with other analyses. There is also a need for further data gathering and a constant update and refinement of assumptions to keep the modelling results up-to-date and useful. A good point of time for a re-assessment could be in 2020, i.e. when the UNDP-GEF "*Removing Barriers to Wind Power Development in Belarus*" project will close implementation.

[39] Assuming avoided gas imports necessary to produce an equivalent of projected cumulative electricity from 500 MW of wind over the lifetime of investment; assuming USD 136 per 1 thousand m^3 for 2017 and using IEA's WEO gas growth price projections for the remaining years; discounting at 10 % estimated public cost of capital.

Annexes

A. 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 Levelized Cost Stage (Stage 3) and the Evaluation Stage (Stage 4).

In addition, the modelling uses the financial tool (in Microsoft Excel) created for the DREI report framework. The financial tool is denominated in nominal US dollars and covers a core period from January 1, 2017 (approximating the present time) to December 31, 2030 (the yearby when this study assumes that additional 500 MW of wind energy is commissioned). US dollar inflation is assumed at 2 %. All present values in the model are discounted back to 1st January, 2017. Generation technologies may have asset lifetimes which go beyond 2030, which 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 comes mainly from 10 structured interviews with wind energy investors and project developers in Belarus. Findings from these interviews have been complemented with 4 qualitative interviews with wind energy investors and experts and 2 qualitative interviews with international finance institutions active in the Belarusian market.

In order to gather these data, the authors made several field missions to Belarus in May, August and November 2016.

Deriving a Multi-Stakeholder Barrier and Risk Table

The multi-stakeholder barrier and risk table for wind energy is derived from the generic table for large-scale, renewable energy introduced in the DREI report (2013; Section 2.1.1) and adapted to the context in Belarus. It is composed of 9 risk categories and 20 underlying barriers. These risk categories, barriers and their definitions can be found in Table 2 in the body of this report.

Calculating the Impact of Risk Categories on Higher Financing Costs

The basis of the financing cost waterfalls produced by the modelling are structured, quantitative interviews undertaken with wind energy 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 3 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. The typical interview took between 60 and 100 minutes.

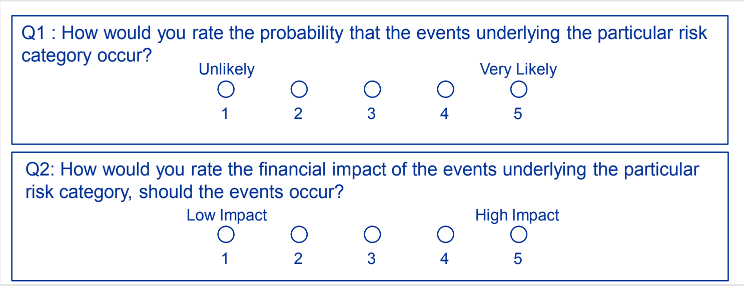
Box 3: Methodology for quantifying the impact of risk categories on higher financing costs

1. Interviews

Interviews were held with investors and developers active in wind energy in Belarus, 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 15.
- 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 15: Interview questions to quantify the impact of risk categories on the cost of equity and debt



2. Processing the data gathered

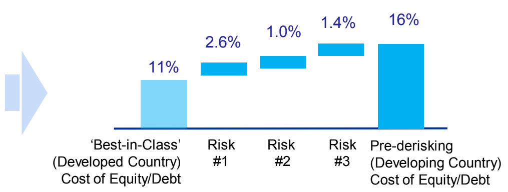
The data gathered from interviews are then processed. The methodology involves identifying the total difference in the cost of equity or debt between the high risk country (Belarus) and the best-in-class developed country (Germany). This figure for the total difference reflects the total additional financing cost in the high risk 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 16.

Figure 16: Illustrative simplified application of the methodology to determine the impact of risk categories on increasing financing costs

Cost of equity					
Developing County	16%				
Best-in-class Developed Country	11%				
Total Difference	5%				
Average 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					
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%
					5.0%



In addition, the following key steps have been taken to calculate the financing cost waterfalls:

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

Box 4: The seven investment assumptions for wind energy in Belarus

1. Please answer all questions based on the *current* status of the risks in the country's investment environment today
2. Assume you have the opportunity to invest in a 10-100 MW on-shore wind park
3. Assume a 2-3 MW class turbines from a quality manufacturer with proven track record (eliminating certain technology risks)
4. Assume an O&M insurance contract (eliminating certain technology risks)
5. Assume that transmission lines with free capacities are located relatively close to the project site (within 10 km)
6. Assume a build-own-operate business model and a construction sub-contract with high penalties for contract breach (eliminating certain technology risks)
7. Assume a project finance structuring

- 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, 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. 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.

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 8.4 % (Damodaran, 2016), resulting in a (rounded) 10 % public cost of capital for Belarus.

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 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 as a risk, policy derisking instruments for fossil-fuel subsidy reform (part of 'power market risk') are excluded from the modelling.
- Following investor feedback who did not consider social acceptance as a risk, policy derisking instruments for social acceptance risk are 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 (Box 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.

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 modeled in terms of the costs of: (i) full-time employees (FTE) at average yearly costs of USD 4,000 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 modeled for the operation of an instrument (e.g. the full-time employees required to staff an energy regulator), and external consultancies/services are modeled 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 modeled for up to the 14-year period from 2017 to 2030. Data have been obtained from local experts and the UNDP's in-house experience. See Table 10 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 (after 20 years) are shown in Table 11. As certain policy derisking instruments may take time to become maximally effective, a linear ("straight-line") approach to time effects is modeled over the 20-year target investment 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 11: The modelling assumptions for policy derisking instruments' effectiveness

Risk Category	Policy Derisking Instrument	Effectiveness	Discount for Time Effect	Comment
Power Market Risk	– Establishment of transparent, long-term national wind energy strategy and targets; transparent energy sector planning particularly related to excess electricity supply once NPP comes online – Legislative wind energy reform which includes (i) establishing well-designed and transparent procedures for quota and PPA tendering; (ii) a revised quota regulation which includes a fixed tariff (and not only fixed coefficient), and a standard PPA with a well-designed, transparent policy on key clauses in the PPA, optimally adopted by a new RE law; (iii) and PPAs which are granted in the development stage prior to power plant commissioning	**75 %**	**50 %**	Interview responses: high effectiveness
Permits Risk	– Permit harmonization (regional vs. federal permits) and reduction of process steps; – Development of a register of available wind sites; – Enforce transparent practices, renewable energy related corruption control and fraud avoidance mechanisms; establish effective recourse mechanism	**50 %**	**50 %**	Interview responses: moderate effectiveness
Developer Risk	– Capacity building for resource assessment – Feasibility studies; networking; training and qualifications Research and development; technology standards – Exchange of market information (e.g., via trade fairs and the establishment of a wind energy association)	**50 %**	**50 %**	Interview responses: moderate effectiveness
Grid/ Transmission Risk	– Strengthen Belenergo's operational performance, grid management etc., i.e. by knowledge exchange with Ukrainian wind parks – Regularly update grid code	**25 %**	**50 %**	Interview responses: moderate to low effectiveness
Counterparty Risk	– Strengthening Belenergo's and regional grid operators management & operational performance for existing operations	**25 %**	**50 %**	Interview responses: moderate to low effectiveness
Financial Sector Risk	– Promote financial sector policy favorable to long-term infrastructure, including project finance – Strengthen investors' familiarity with and capacity regarding renewable energy projects i.e. with industry-finance dialogues and conferences; workshops/training on project assessment and financial structuring	**25 %**	**50 %**	UNDP experience.

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 achieving 500 MW wind energy capacity in Belarus by 2030 and thus 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.

- **Financial Derisking Instrument Cost.** Estimates of public cost of financial derisking instruments are set out in Table 12 below.

Table 12: 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[40]	—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 Government of Belarus provides "Letter of Support" for each PPA entered into between Belarusneft and the private wind energy developer —The public cost of this type of guarantee are modelled as opportunity cost to the Government of Belarus from setting aside 12 months' worth of PPA payments at 8 % cost of capital (public cost of capital of 10 % minus 10y US Treasury bond rate of 2 %)
Financial Sector Risk	Public Loans	—Assumes a mix of mildly concessional (7 % and 15-year tenor) USD loans from multilateral development banks to cover 75 % of total debt needs. 25 % of total debt needs are assumed to be provided by non-concessional (7.5 % (USD) and 10-year tenor) USD loans from commercial banks. —Public cost: • Assumes the public cost is 25 % (loss reserve) of the face value of the loan to the wind energy developer (World Bank, 2011)
Political Risk	Political Risk Insurance (PRI)	- Assumes 4 point MIGA-type coverage for equity holders covering expropriation, political violence, currency restrictions, and counterparty risk. - Covers 45 % of the original face value of the equity invested (to reflect that not all IPPs might seek PRI and full coverage). - Public cost: • Assumes the public cost is 10 % (loss reserve) of the equity amount covered - Private cost: • Assumes a 20 basis points (0.2 %) front end fee • Assumes a 100 basis points (1 %) premium payment, calculated annually
Currency/ Macro-economic Risk	Partial Indexing	—Assumes illustrative mechanism, whereby private wind energy developers can request partial indexing of Belarusian Ruble-denominated PPA tariffs to USD. —Costs of the hedging instrument are assumed to be 50 % of the anticipated inflation rate differential between USD and BYR inflation projections (8 %), being in the range of costs of similar hedge premium. —Assumes illustrative 50 % of PPA tariff denominated in Belarusian Ruble are indexed. —Assumes 10 % annual depreciation of Belarusian Ruble to USD. Source: author's assumptions, informed by current difference in Belarus and US inflation rates.

- **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 13. The qualitative investor feedback on financial derisking instruments' effectiveness is provided in Table 5 of the report.

[40] 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.

Table 13: The modelling assumptions for financial derisking instruments' effectiveness

Risk Category	Financial Derisking Instrument	Effectiveness[41]	Discount for timing effect	Comment
Grid/ Transmission Risk	Include take-or-pay clause in the standard PPA	**50 %**	**0 %**	Interview responses: high effectiveness; however residual risk remains
Counterparty Risk	Government (sovereign) Guarantee	**25 %**	**0 %**	Interview responses: low effectiveness.
	Public Loans	**25 %**	**0 %**	Interview feedback: public "buy-in", especially from international donors, reduces also counterparty risk
Financial Sector risk	Public loans for renewable energy developers provided by development banks and international finance institutions	**0 %** [impact comes via lower interest rate in concessional loans]	**0 %**	Interview responses: high effectiveness
Political Risk	Risk sharing products by development banks to address political risk (Political Risk Insurance)	**50 %**	**0 %**	Interview responses: high to moderate effectiveness
Currency/ Macroeconomic Risk	Partial-indexing of the PPA tariff	**50 %[42]**	**0 %**	Interview responses: high effectiveness but residual risk remains

A.3. Stage 3– Levelized 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

$$\frac{\%\,Equity\ Capital * Total\ Investment + \sum_{t=1}^{T} \frac{(O\&M\ Expense)_t + (Debt\ Financing\ Costs)_t - Tax\ Rate * (Interest\ Expense_t + Depreciation_t + O\&M\ Expense_t)}{(1 + Cost\ of\ Equity)^t}}{\sum_{t=1}^{T} \frac{Electricity\ Production_t * (1 - Tax\ Rate)}{(1 + Cost\ of\ Equity)^t}}$$

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

Tax-deductible, linear depreciation of 95 % of fixed assets over the lifetime of investment is used. The standard effective corporate tax rate for Belarus of 18 % was used. No tax credits, or other tax treatment, are assumed.

[41] Grid/Transmission, Counterparty and Financial Sector Risk have multiple instruments (both policy and financial derisking instruments). The sum of the effectiveness percentages cannot exceed 100 %. For example the policy derisking instruments "Strengthen Belenergo's operational performance, grid management" and "regularly update the grid code" addressing Grid/Transmission risk have an effectiveness of 25 %. (See table 11 above). Therefore, the effectiveness of the take-or-pay clause cannot exceed 50 %, which would reflect the highest effectiveness. However, within this a take-or-pay clause mechanism residual risks remain. To reflect this, the take-or-pay clause has an effectiveness of 50 %.

[42] It should be noted that despite a factual indexation of the wind energy tariff to the USD under the current policy regime due to the design of the basic tariff the effect of an indexation instrument has not been included in the modelling of the BAU scenario. Although both instruments in theory create a protection to currency depreciations, the current indexation mechanism is determined in the legislation and exposed to changes in the future. For example, the amount of indexation has been decreased lately and interview responses confirmed insecurities on the value of indexation (in its current form) as result of legislation changes in the future (i.e. due to the impact of the upcoming nuclear energy capacity on the basic tariff). For this reason, the current indexing mechanism creates insecurity on future currency depreciation protection and is assumed to have only little effect on decreasing risk perceptions of investors. On the contrary, the partial-indexing instrument in the post-derisking scenario will be included in the specific PPA of each developer, thus representing an effective individual protection to potential currency deprecations and legislation changes in the future.

Baseline Energy Mix Levelized 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:

- Wind energy investments are made in the context of an existing electricity generation mix that is mainly comprised by natural gas. Belarus is not characterized by a significantly increasing energy demand forecast, and in the context of adding additional nuclear power capacity to the energy mix over the next years, new wind installations will likely need to replace existing capacity. As the existing gas power plant fleet has the highest marginal generation costs in the country's current electricity mix, gas would be the first technology to be phased out if additional capacity comes online. The modelling therefore takes a 100 % *operating margin* approach to estimate baseline costs, assuming new wind energy plants are partially replacing electricity generation from existing single cycle combustion turbines (SCGT). However, although new wind energy is assumed to partially replace existing gas generation, existing gas power plants are not decommissioned. Instead, existing gas power plants are assumed to decrease their annual electricity output equaling the amount of electricity which is generated by additional wind energy capacity. Since fully depreciated gas power plants are assumed, gas generation costs are comprised by O&M and fuel costs only.

- Since the current gas power plant fleet is operated by state owned enterprises, financing costs of SCGT gas power plants are assumed to equal the public cost of capital in Belarus Financial modelling also considers the fuel type of the existing power plants.

- Fuel costs are obtained from Belarusian gas experts reflecting current gas prices in Belarus today. According to these estimates, the gas fuel costs in Belarus today are at 14.9 USD/MWh. Future fuel prices are projected using the International Energy Agencies (IEA) World Energy Outlook (WEO) projections for gas[43]. According to these projections, the gas price is expected to increase to 34.2 USD/MWh until 2036 (20 years lifetime of the asset).

- The modelling assumptions for SCGT are shown below in Table 14.

Table 14: The modelling assumptions for the baseline energy technology (SGGT)

Technology Item	Assumption	Source / Comments
Initial investment cost (USD/MWel)	0	Authors/ assume fully depreciated gas generation infrastructure
Initial O&M cost excl. fuel (USD/MWel)	52,560	Authors; cross-checked by Belarus experts
O&M Inflation	2 %	Authors
Lifespan (years)	20	Authors/to compare with wind energy lifespan (20 years)
System Efficiency	30 %	Authors; cross-checked by Belarus experts
Capacity Factor	30 %	Authors/ assumes that wind replaces gas capacity when wind power plants run; therefore the same capacity factor as for wind
Emission Factor	0.45 t CO_2e/MWh	EBRD (2009)
Financing Item		
Capital structure	30 % equity, 70 % commercial loan	Authors; cross-checked by IFIs
Cost of Equity (Discount Factor)	10 %	Public cost of capital of Belarus (bottom-up approach, for details refer to Annex A ' Public Cost of Capital')
Depreciation allocation	NA	Authors/generation capacity is full depreciated

[43] Source: IEA (2016)

Wind Energy – Technology specifications

The technical assumptions for the wind energy LCOE calculation are set out in Table 15 below.

Table 15: The modelling assumptions for wind energy technology specifications

Technology Item	Assumption	Source/Comments
2030 wind energy installed capacity	500 MW	Hypothetical target, within the economic wind energy potential.
Turbine size	2-3 MW class	Authors
Park size	50-100 MW	Authors
Core investment costs, including balance of plant costs (civil works, transformers), 2023 Cost	1,530,000 USD/MW	Belarusian project developers, extrapolated to 2023 using IRENA projection (IRENA, 2016); 2023 is the mid-point of the model period from 2017-2030
Annual O&M costs at start of operation	32,445 USD/MW	Belarusian project developers
Annual increase	2 %	Authors
Lifetime	20 years	Authors
Wind energy capacity factor	30 %	Belarusian project developers
Emission Factor	0 t CO_2e/MWh	Authors (only direct emissions from RE asset are considered)

Wind Energy– Terms of Finance

The financial assumptions used for wind energy modelling are set out in Table 16 below.

Table 16: The modelling assumptions for wind energy terms of finance

Finance Item	Assumption		Source/Comments
	BAU	Post-derisking	
Capital structure	30 % equity, 70 % commercial loan	30 % equity, 70 % debt	Authors; cross-checked by IFIs
Cost of equity (USD)	20 %	14.9 %	This study; cross-checked by Belarusian experts and IFIs
Debt structure	100 % commercial loan	75 % mildly concessional public loan, 25 % commercial loans	Authors; cross-checked by IFIs
Loan terms	Commercial: 12 % (USD), 10-year tenor	Concessional public: 7 % (USD), 15-year tenor, Commercial: 7.6 % (USD), 10 years	Authors; cross-checked by IFIs
Depreciation allocation	Straight line, 95 % depreciable		Authors (5 % non-depreciable reflects land)

Wind Energy – Grid Interconnection Costs

Grid interconnection costs are also included in the LCOE for wind energy. The modelling assumes that all wind energy plants are within 10 km of the power grid (see Box 4). The assumptions used for grid interconnection costs are set out in Table 17 below.

Table 17: The modelling assumptions for wind energy grid interconnection costs

Technology Item	Assumption	Source
Cost per km of Individual 110 kV Transmission Line	USD 245,000	Belarusian experts
Number of Transmission Lines (Redundancy)	2	Belarusian experts
Typical length of Transmission Line	10 km	Authors (as laid out in the general assumptions of the study)
Typical size of wind energy plant	75 MW	Authors
Cost of Sub-Station	USD 1.5 million	Belarusian experts

A.4. Stage 4 – Evaluation

Wind Energy Sensitivities

The modelling performs a number of sensitivities for wind energy.
Table 18 below sets out the assumptions and sources used for the sensitivities to investment costs, capacity factor, fuel costs and financing costs (sensitivities of Type 1 in main report).

Table 18: The modelling approach to sensitivities of key input assumptions for wind energy

Sensitivity	Assumptions / Approach	Source/Comment
Investment Costs	Wind energy Base case (2023 cost):1,530,000 USD/MW Sensitivity (2016 cost): 1,700,000 USD/MW	Belarus project developers, extrapolated to 2023 using IRENA projection (IRENA, 2016); The reduction for wind energy amounts to 10 % between 2016 and 2023. 2023 is selected as this reflects the mid-point of the 2017-2030 modelling period.
Capacity Factor	Wind energy: Base case: 30 % Sensitivity: 33 % / 27 %	Authors, informed by existing wind energy sites, as well as project developers and investors.
Fuel Costs	± 20 % difference to IEA WEO projection (gas)	Authors
Financing Costs	± 1 % difference on financing costs from interviews	Authors

For the sensitivities to different instrument packages (Type 2 in main report), the following sub-sets of derisking instruments were considered (see Table 2 for an overview over all risks and instruments):

- Scenario 'policy derisking only' considers exclusively policy derisking instruments. They address power market risk, permits risk, developer risk, grid/transmission risk, counterparty risk, and financial sector risk.
- Scenario 'financial derisking only' considers exclusively financial derisking instruments. They address gird/transmission risk, counterparty risk, financial sector risk, political risk and currency/macroeconomic risk.
- Scenario 'high impact risks' considers both policy and financial derisking instruments addressing power market risk and financial sector risk.

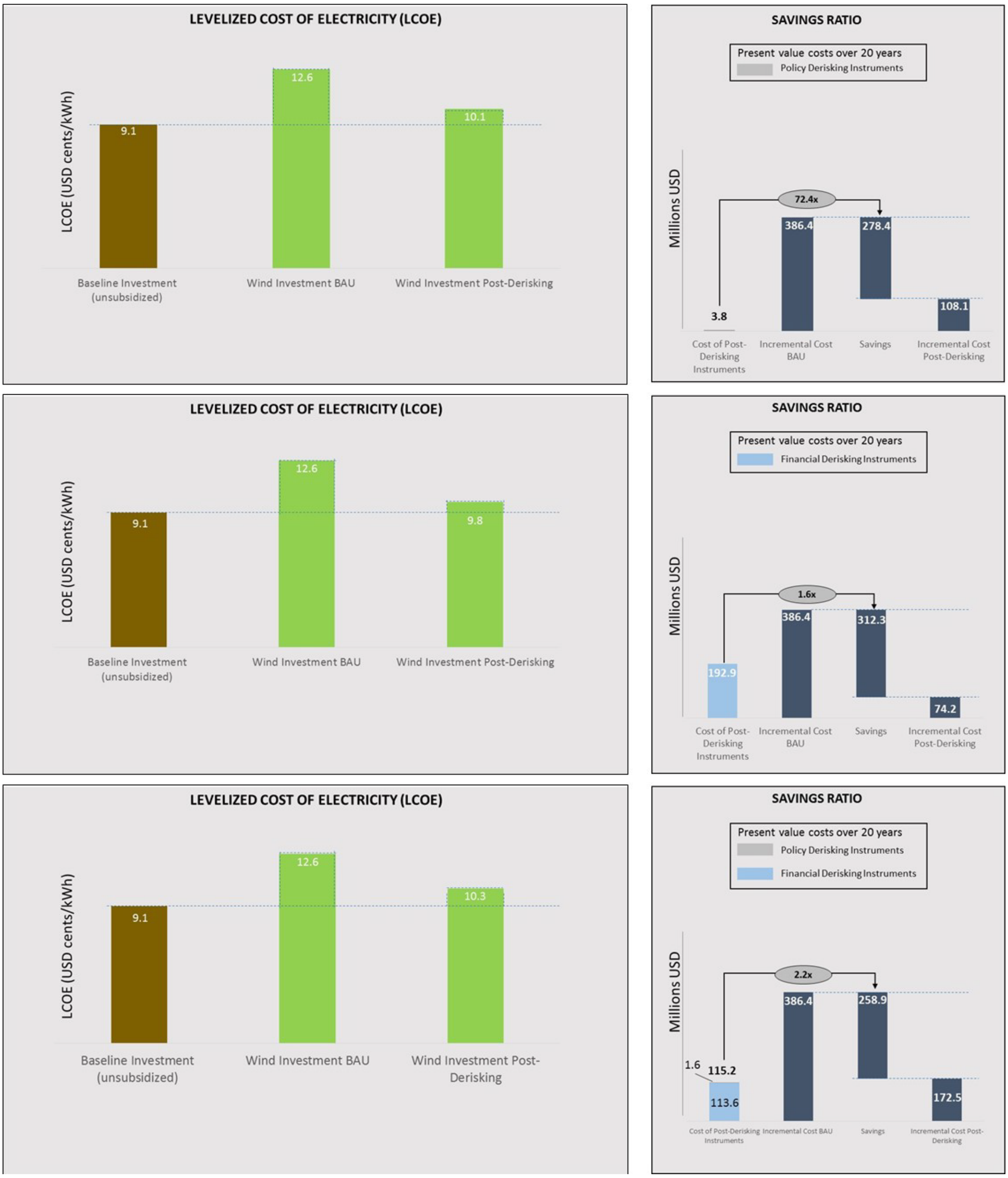
Table 19 below sets out the assumptions used for the sensitivities to two additional approaches for financial instrument costing, namely a more conservative, high-cost approach and a more aggressive, low-cost approach (sensitivities of Type 3 in main report).

Table 19: The modelling approach to sensitivities for the costing of financial derisking instruments

Sensitivity	Assumptions / Approach	Comment
Public cost associated to Take-or-Pay clause	Base case: actual cost acc. to author's assumptions High-cost and low-cost approach: same as base case	Base case: See Table 12 for approach and assumptions behind costing of Take-or-Pay clause in PPA.
Public cost associated to "Letter of support" from the Government of of Belarus to guarantee PPA	Base case: opportunity cost for setting aside 12 months' worth of PPA payment at 8 % cost of capital (public cost of capital of 10 % minus 10y US Treasury bond rate of 2 %) High-cost approach: 100 % of 12 months' worth of PPA payments Low-cost approach: no public cost	High-cost approach: assumes that Belarusneft defaults to pay the IPPs during a total of 12 months over the lifetime of the project. Low-cost approach: assumes that no public costs are attributed to such a letter.
Public cost associated to public loans	Base case:25 % of face value as loss reserve High-cost approach: full face value Low-cost approach: no public cost	High-cost approach: corresponds to the unlikely case that all of the borrowers will default. Low-cost approach: assumes that loans should be paid back in full, and that any default risk and cost of capital are covered through the loan's terms and fees.
Public cost associated to political risk insurance	Base case:10 % of equity covered as loss reserve High-cost and low-cost approach: same as base case	Base case: See also Table 12 for approach and assumptions behind costing of PRI.
Public cost associated to partial indexing of the PPA tariff	Base case: actual cost acc. to author's assumptions High-cost and low-cost approach: same as base case	Base case: See Table 12 for approach and assumptions behind costing of partial indexing of the PPA tariff.

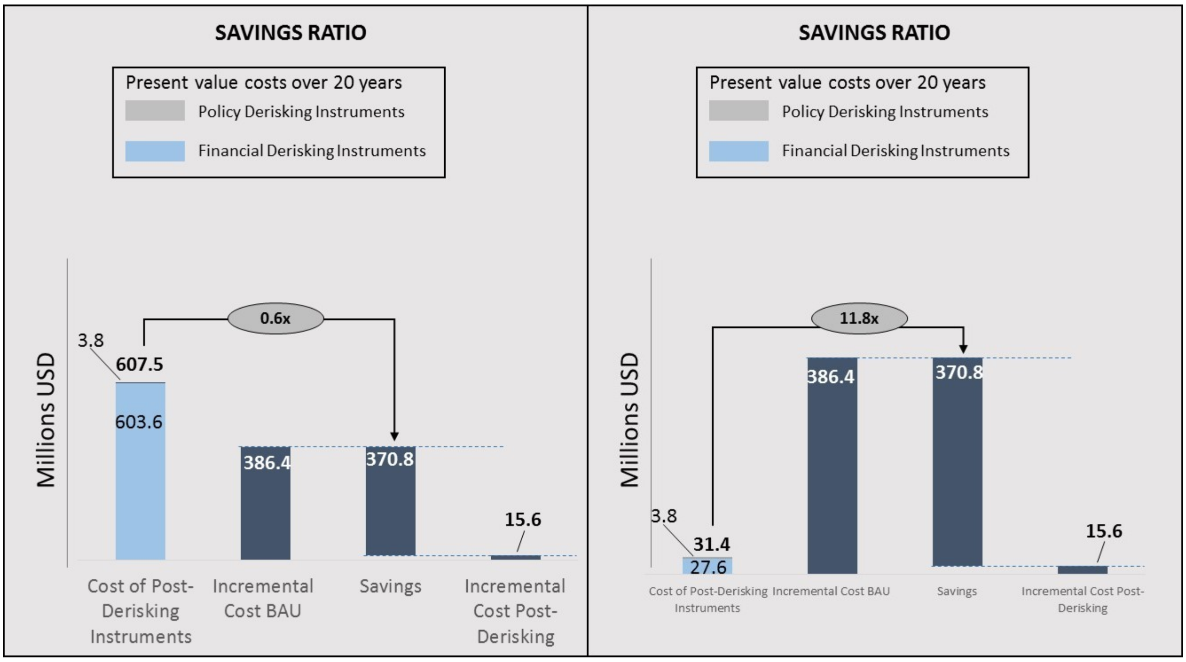
B. Graphical Representation of Sensitivity Analyses

Figure 17: Summary of LCOE (left) and savings ratio (right) outputs for sensitivity analyses



Source: sensitivity modelling; considering only policy derisking instruments (top row), only financial derisking instruments (middle row), and only instruments targeting the two risk categories having the highest impact on financing cost, i.e. power market risk and financial sector risk (bottom row); see Figure 13 and Figure 14 for base case scenario, see Table 10 and Annex A for details of assumptions and methodology.

Figure 18: Summary of savings ratio outputs for sensitivity analyses using a high-cost (left) and low-cost (right) approach to financial derisking instrument costing



Source: sensitivity modelling; see Figure 14 for base case scenario, see Table 13 and Annex A for details of assumptions and methodology

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Review

of report by the project «BELARUS: Derisking Renewable Energy Investment. Selecting Public Instruments to Promote Wind Energy Investment in the Republic of Belarus»

The report «BELARUS: Derisking Renewable Energy Investment. Selecting Public Instruments to Promote Wind Energy Investment in the Republic of Belarus» (hereinafter - the Report) was developed within the framework of a five-year project funded by the Global Environment Facility (GEF) "Removing Barriers to Wind Power Development in Belarus", currently implemented by the Government of the Republic of Belarus and UNDP.

Structurally, the report is divided into the following main sections:

– overview of the DREI methodology for quantifying different public instruments for promoting renewable energy investments,
– current status of wind power in the Republic of Belarus,
– modeling of wind energy,
– conclusions and further steps.

The report indicates that the simulation was carried out on the basis of the innovative DREI methodology ("Reducing the risks of investing in renewable energy sources"), submitted by UNDP in 2013.The objective of the methodology is to create a structured and transparent process that allows to clearly define the contribution of various instruments for regulating the development of renewable energy sources, while the main factor for assessing and comparing risks is the discount rate in financing renewable energy facilities.

The simulation was performed using software tools of financial analysis based on Microsoft Excel.

The current status of wind power in the Republic of Belarus is described on the basis of the basic legislation for the development of the energy sector: the Concept of Energy Security to 2035 and the State Program "Energy Saving" for 2016-2020.Renewable energy resources, incl. wind energy, are determined on the basis of the Energy Charter report "In-depth review of policies and programs in the field of energy efficiency: the Republic of Belarus" (2013) and the Atlas of the winds of Belarus. The existing normative legal acts in the field of renewable energy were also used.

The analysis of the status of wind energy is made with a deep study of the basic documents and fully reflect the actual state of the sector at present.

Input data for the simulation were obtained risks based on interviews with 10 Belarus and international developers and investors, considering or participating in a large-scale investment in wind power in the Republic of Belarus. Although the number of interviewed investors may seem insufficient in terms of sample representative ness, one should take into account the low number of distributed quotas for wind energy: 47.1 MW for 2016-2018 and 11 MW for 2019. In such conditions, the number of investors interested in funding in wind energy is extremely limited.

As a result of calculations performed by the authors of the Report in conjunction with the interviewed investors, it was determined that the discount rate of equity for wind energy in the country currently stands at 20 %, and borrowed capital - 12%.These results are fully consistent with the data accepted for conducting similar feasibility studies in Belarus.

In addition, based on interviews, qualitative characteristics of various categories of investor risks were determined. The risks that have a high impact on the discount rate included:

– the risks of the electricity market,
– the risks associated with the uncertainty of the prospects for wind energy development,
– the risk of changing tariffs for the purchase of electricity from renewable energy sources, the non-transparency of the quota allocation mechanism,
– financial sector risks, including difficulties with lending to wind energy projects.

The results are fully supported by the findings of the local consultants of the project, reflected in the relevant reports on the previous stages of the project. In particular, the same risks were identified by consultants as the main barriers to the development of wind power.

At the second stage of modeling, the authors of the Report defined state instruments for reducing investment risks and their estimated value.

The most important tools for institutional risk reduction include the following:

- development of a long-term national strategy and goals for wind energy development;
- transparent energy sector planning;
- well-structured and transparent procedures for granting quotas and conducting competitive procedures for agreements on the supply of electricity and fixed tariffs;
- the development of a standard agreement (grid code) on the supply of electricity with elaborated, transparent provisions include the specifics for all regions of Belarus.

These conclusions also correspond to the conclusions and recommendations of the Belarusian project consultants. In particular, the consultants proposed specific mechanisms for determining quantitative volumes of allocated quotas in order to increase the transparency of the mechanism, as well as their distribution among investors taking into account integration into the Belarusian energy system. In addition, a number of decisions were proposed to improve the tariff policy.

At the third stage of the simulation, the authors of the Report determined the levelized cost of electricity (LCOE) in three ways: the base one based on existing GTUs of gas power stations, with investments in wind energy according to the inertial scenario and option after reducing possible risks. Based on the results of the simulation after the introduction of risk reduction measures, the levelized cost of electricity will be 9.3 US cents per kWh, which is comparable to the base cost of 9.1 cents per kWh.

The resulting ratio was correlates with the ratio of similar parameters of the countries with advanced development of renewable energy.

The Report does not provide a justification for choosing gas power plants with simple-cycle gas turbines a basic option, which is especially important in the context of energy system development plans for the coming years.

The concept of "levelized cost of electricity", which is widely used in foreign countries, is not currently applied in the Republic of Belarus. The term "cost of production" is used to characterize the costs of power generation. Nevertheless, the use of generally accepted international terminology seems to be a positive development, as it allows the most complete analysis of the experience gained by other states and energy systems, as well as international comparisons.

Despite the deep study of the topics discussed, some issues important for the development of renewable energy have not been reflected in the Report.

Thus, the cost of state instruments for reducing investment risks is estimated at $ 189.2 million, while no possible sources of funding are indicated, and the issue of availability of capital, including borrowed capital, for investors is not considered.

In the report does not pay attention to the impact of the introduction of state instruments for the development of wind energy and, as a result, the construction of new generating capacities, on the Belarusian energy system, including in the context of its development and the planned commissioning of the Belarusian nuclear power plant.

It should be noted that the results of the work presented in the Report are relevant to the development of private investment.

Under current conditions for the development of renewable energy, based on the mechanisms for allocating quotas, investors' offers are several times higher than the distributed volume of generating capacities. In case of a changing the legislation with a change in the mechanism for allocating quotas, making decisions on increasing the share of electricity generated from renewable energy sources, the conclusions and proposals presented in the Report can form the basis for the development of effective state instruments aimed at increasing the use of renewable energy resources funding by private investors.

In general, the work was carried out at a high professional level, using advanced modern methods of assessing economic and technological risks. The results of the work can serve as a guide for interested government bodies and decisions makers on the further development of wind power in the Republic of Belarus, and in improving the legislation of the directed to development of renewable energy sources in general.

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Review

of the report "Republic of Belarus: Derisking Renewable Energy Investments",
developed under the United Nations Development Programme UNDP/GEF Project (UNDP, 2017)
(title: "Selecting Public Instruments to Promote Wind Energy Investment in Belarus")

Satisfaction of the short and medium term demand for energy provides for restructuring energy generation towards sustainable development and expanded use of renewable energy. Wind energy is a key direction of the green economy. With an installed generating capacity of 9.9 GW, Belarus has serious intentions to build them up in future (to ≈ 13.5 GW), inter alia, with renewable energy (biomass, biogas, water, sun, wind) – 961 MW.

There are plans to allocate private investments into wind energy providing for generation of 500 MW of wind energy by 2030 in accordance with the 2016-2020 Energy Saving State Program targets.

The key project concept is that efficient public instruments of environmental/economic control would promote private investments into wind energy.

Wind energy development remains within the context of the plans and obligations of the Government of Belarus, whereupon the share of renewable energy in the national energy mix should reach 9 % by the year 2035, with simultaneous 28 % emission reduction (as compared to 1990) by 2030.

This research is based on the DREI methodology. The methodology is aimed at developing public instruments to support an environment for bringing private capital to renewable energy.

The methodology emphasizes upon the tender/bidding procedure as a key instrument to support independent power producers with conclusion of long-term power purchasing agreements.

This key instrument is complemented by three main types of public instruments:

- instruments that mitigate risks determined by root causes of the investment process (*policy derisking*)
- instruments that shift risks from private to public sector (investment risks are transferred to such public actors, as development banks). This type of instruments is referred to as *financial derisking*. These instruments may include public loans and guarantees, political risk insurance and public equity co-investments
- instruments that compensate for risks (referred to as *direct financial incentives*). Unless risks may be mitigated or transferred to other actors, investors are provided with financial incentives (tax breaks and price benefits).

Along with power purchasing tendering and quotas, the key instrument provides, in an adequate institutional/financial environment, for:

- risk mitigation with policy instruments
- risk transfer from private to public sector
- risk compensation with financial incentives and privileges.

In spite of reduction of the renewable energy generation costs, private investors are still facing high cost of renewable energy financing in developing countries. The high financing cost (both equity and debt) reflects a range of technical, regulatory, financial and institutional barriers as well associated investment risks. In order to compensate for these risks in early-stage markets, investors require a high rate of return of energy generation and sale.

It is important that at present the wind energy financing cost in the Republic of Belarus amounts to about 20% for equity capital cost (in USD) and 12% for debt capital cost (in USD). These numbers are much higher than in the leading country, Germany, where they amount to approximately 7% for equity capital cost (in Euro) and 3% for debt capital cost (in Euro). The elevated financing cost has a high impact on the competitive edge of wind energy.

The higher financing cost is mainly determined by the following risk categories:

- power market risk depending on the fragmented quota system and variable wind energy tariff
- financial sector risk related to the impact of sanctions on limited financing (debt and equity) for wind energy, as well as lack of experience in financing wind energy projects

The following aspects also contribute to higher financing cost in the Republic of Belarus:

- counterparty risk associated with the off-takers' credit worthiness;
- political risk associated with public administration and legislation;
- currency and macroeconomic risk associated with the Belarusian Rouble depreciation against harder currencies;
- grid/transmission risk, e.g., due to introduction of additional power capacities in short-term.

Resulting from the research, a number of public derisking measures are suggested, which (the measures) are viewed as targeted governmental actions based on specific provisions, programs, financial products and implementation mechanisms/instruments.

These include: transparent power sector planning, national wind energy development strategy, bidding mechanism reform, orientation towards larger wind power stations, application of a fixed tariff and introduction of a standard power purchase agreement.

The cost of these priority measures will be relatively low: US Dollars 1.1 million until the year 2030, and they, in turn, will have a drastic impact on reduction of associated risks.

Implementation of the suggested derisking measures may bring the following positive results:

– attraction of about USD 807.7 mln private investments into wind energy, with approximately USD 649.8 mln gas import savings during the wind energy asset lifetime;
– reduction of wind energy generation costs owing to derisking form US cent 12.6 to 9.3 per kWh, almost on the level of the existing gas-based energy power generation cost (US cent 9.1 per kWh);
– savings of US Dollars 370.8 million, as compared to input of 500 MW wind generating capacity within the current political and investment frameworks;
– reduction of carbon emissions by 11.8 mln tons of CO_2 within the next 20 years, thus mitigating climate changes and facilitating environmental preservation.

Based on the DREI methodology, this report provides the modelling outcomes that allow assessing, how the selected public instruments facilitate private investments into wind energy in the Republic of Belarus.

The modelling was carried out for two scenarios with various risk means:

– business-as-usual scenario representing the current risk environment (with the present-day financing cost);
– post-derisking scenario based on implementation of a public instrument package (resulting in lower financing cost).

With the business-as-usual scenario, energy generation costs would highly exceed non-subsidized gas-based power generation costs (baseline).

The baseline power generation cost will amount to US cent 9.1 per kWh, the wind generation cost in the business-as-usual scenario will amount to US cent 12.6 cent per kWh, which will, accordingly, require a price adjustment (US cent 3.5 per kWh) with the baseline technologies.

In the post-derisking scenario, the generation costs will drop to US cent 9.3 per kWh. Owing to the government's investment derisking actions, lowering the financing cost, wind energy will occupy a position almost equal to that of non-subsidized baseline energy technologies. In other words, implementation of a package of integrated derisking measures will bring about almost equal local wind power generation costs, as compared to imported gas.

The public instrument assessment is based on the four following metrics (according tot the DREI methodology):

– leverage ratio;
– savings ratio;
– electricity prices (availability ratio);
– carbon emission reduction assessment.

Each metric reflects various aspects: the ability to catalyse investments (leverage ratio); savings generated for the society (savings ratio); the resulting electricity price for end-users (affordability), and the efficiency in mitigating greenhouse gas emissions (carbon abatement).

The leverage ratio and savings ratio are of a particular interest:

– the investment leverage ratio demonstrates that risk mitigation is an efficient way of utilizing public funds.
  The achievement of 500 MW of installed wind power will require private investments of USD 807.7 million. In the business-as-usual scenario, according to the model estimates, the target achievement will require direct financial incentives in the form of USD 386.4 million within 20 years. That will give a leverage ratio of 2.1., i.e., the investments raised will exceed about 2.1 times the funds spent on public instruments. In the post-derisking scenario, according to the model estimates, the same investment target may be achieved with a derisking package assessed at USD 193.0 million, and a much lower price adjustment of USD 15.6 million within 20 years. This will raise the leverage ratio to 3.9, indicating a much higher efficiency in terms of the cost of public instruments.
– the savings ratiodemonstrates that reduced wind power generation cost in the post-derisking scenario saves USD 370.8 million on public derisking measures (USD 193.0 million).

Also, the availability and carbon emission reduction ratios show that derisking instruments help reduce wind generation costs by 26.4 % and lower emissions by 46 % per ton of CO_2.

In general, the wind energy modelling outcomes point at improved economic efficiency owing to public investment derisking measures.

The modelling begins with nine different risk categories; it helps evaluating their impact on increased financing cost in the Republic of Belarus. Among others, the power market risk and the financial sector risk have a high impact on the financing cost, each of them exceeding the equity capital cost by more than 250 basis points (2.5 %).

The comprehensive instrument package is estimated at US dollars 193 million (by 2030).

The main conclusion from the modelling exercise is that investing into derisking instruments is a cost-effective approach to achievement of the 2030 wind energy investment target. The comprehensive package of public derisking measures will bring wind energy generation cost down from US cents 12.6 per kWh to US cents 9.3 per kWh, or almost onto the level of the gas-based power generation cost (US cents 9.1 per kWh).

The implementation of these derisking measures will also result in:

- attraction of USD 807.7 mln of private investments into wind energy, with imported gas savings equivalent of USD 649.8 mln during the wind asset lifetime;
- savings of USD 370.8 mln, as compared to commissioning of 500 MW wind power generating capacity within the current political and investment frameworks;
- carbon emission reduction of 11.8 mln tons CO_2 within the following 20 years, which will, thus, facilitate mitigation of climate changes and environment preservation.

The modelling demonstrates that investments into the mentioned package of public derisking measures create considerable economic savings in achievement of the investment target of 500 MW of additional wind energy capacity in the Republic of Belarus by 2030. The modelling exercise also confirms that each public derisking measure, if reviewed individually, is economically beneficial for Belarus, as compared to power generation alternatives with higher costs.

The submitted project is a highly qualified work in the field of environmental/economic substantiation of wind energy development in the Republic of Belarus, focused on the policy factor as the determinant in this sphere.

In general, the work is of high interest both in academic and practical aspects. It provides an extra argument and efficient tool for executive-level decision making in relation to sustainable development of wind energy in the Republic of Belarus.

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