POLICY ENABLERS FOR NEW WIND ENERGY MARKETS

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EXECUTIVE SUMMARY

At the end of 2013, wind energy installations worldwide stand at 200 GW and are projected to double in 5 years. The annual growth rate of wind energy in the past 10 years has been 25%. The reason for rapid growth is that wind energy is the least cost option among utility-scale renewable energy sources. Given that the power sector is the biggest source of greenhouse gas (GHG) emissions, wind energy has contributed meaningfully to reduction of GHG emissions. Wind energy, therefore, has been a rare bright spot in climate change mitigation.

Electricity demand in emerging economies in Asia is growing at a very fast pace. In response to this, countries are using tried and tested generation technologies that use conventional resources (coal, gas, oil). This path will lead to carbon-intensive power industry. The People's Republic of China (PRC) and India have adopted "all-of-the-above" strategy with rapid deployment of wind, solar and conventional power plants. In many Organisation for Economic Co-operation and Development (OECD) countries like the US, electricity demand has plateaued, while wind energy is the largest source of new generation.

OECD countries along with Brazil, the People's Republic of China, and India have experimented with a variety of policies to support the sustainable development of wind energy, and through continuous improvement of policies they have succeeded in achieving significant growth. In a few countries, wind energy has reached grid parity in terms of cost, when the cost of CO_2 is taken into account. Many OECD countries are now rolling back incentives—at the beginning of 2014, production tax credit in the US expired, and in April 2014, the European Union (EU) approved a gradual end to subsidies and move to market-based support for renewable energy. This is a sign that wind energy is a mature technology with sustained improvement in efficiency and decrease in cost of energy produced.

The focus of this publication is on wind energy policies that can support sustained development of wind power in emerging wind energy markets. The policies are based on the work done by the Quantum Leap in Wind Power Development in Asia and the Pacific (QLW). QLW is a $2 million, three-year project funded by the Asian Development Bank, to facilitate wind power sector development in developing countries. The focus of QLW is on three countries—Mongolia, the Philippines and Sri Lanka. The success and failures of wind energy policies in the three countries are analyzed in this report and form the basis for the recommendations.

A wind energy policy framework is proposed for the emerging wind energy markets. There are two dimensions to the framework: the components of wind energy policy and the properties or characteristics that the components should possess in order to yield an effective overall policy.

The components of the policy are:

- **Incentives, which play a central role in policy.** An effective policy should balance supply-side and demand-side incentives. Often the focus is on supply-side incentives like feed-in tariff (FiT) with standardized power purchase agreement (SPPA). In most cases, policies contain weak demand-side incentives and often their implementation is ignored;
- **Grid integration policy.** SPPA is accompanied with "guaranteed interconnection" and "priority dispatch" for wind power plants. This is insufficient. Experience has shown that the grid can be one of the primary bottlenecks to wind power development. Therefore, grid integration is a vital component of policy and it must be based on an integrated power systems study of the network with various wind penetration scenarios. Such a study would assesses the current capabilities of the grid

and the upgrades required to transmission, substations, ancillary services, existing generators and dispatching process;

- **Wind exploitation policy.** Identification of wind corridors or preferred wind project zones, creation of long-term wind measurement campaigns and regular update of wind resource maps are policies that support reduction of lead time and cost of wind power installations in emerging wind markets;
- **Licensing guidelines.** One-stop shop that coordinates all the licensing, approvals, and permits is a policy that can attract investors to the wind industry;
- **Public awareness and human resource development.** Proactive public awareness policies can significantly reduce opposition of wind farms while proactive human resource development policies can increase the amount of work done by in-country personnel; thereby, increasing the benefits realized by the country's investment in wind energy.

The second dimension of the wind policy framework is properties or characteristics that make the components of policy effective. The framework contains three properties:

- **Comprehensive.** Each component of policy must balance the competing needs for stakeholders in order for the policy to be effective;
- **Certainty for long term.** Initial wind projects may take several years (in some cases, 5 years) from concept to commissioning, therefore certainty in policy for the long term is an imperative;
- **Continuous improvement.** Policy, no matter how well crafted, cannot address changes in technology, ground realities and financial environment. Therefore, it must be adjusted on a regular basis.

The above policy framework is used to develop prescriptions for the emerging wind markets. The policy prescriptions are summarized in Table A.

Table A: Policy Framework

Policy Components	Comprehensive	Certainty for Long Term	Continuous Improvement
Incentives	Demand- and supply-side incentives	At least 10-year horizon	Update to FiT model and other incentives
Wind resource exploitation	Countrywide wind resource map	Wind energy corridors	Long-term measurement
Grid integration	Integrated energy master plan	5, 10, and 20-year scenarios	Responsive to congestion and curtailment
Licensing guidelines	One-stop shop to manage the myriad of licenses/permits	Transparent with clear requirements and criteria	Adjustments
Public awareness and human resource development	All key issues are addressed	Long-term communications and research program	Adjustments

Fit = feed-in tariff.

1. INTRODUCTION

1. Wind energy is widely recognized as one of the cheapest forms of clean and renewable energies. In fact, in several countries, wind energy has achieved cost parity with new fossil fuel-based sources of electricity generation. In the US, the average PPA price was $23.90/MWh for contracts signed in 2013 (Wiser and Bolinger 2014). This is an average over 18 contracts for 2.7 GW of wind power. For the same year, the range of the wholesale price of electricity nationwide was $23.51 to $56.30/MWh. This data suggests that wind prices are not only competitive with the wholesale price of electricity in the US, but is in the lower range. Note that the PPA price does not include the production tax credit of $22.00/MWh.

2. The input raw material (feedstock) for wind turbines is wind, therefore, there is no pollution or environmental degradation due to mining and/or transporting of raw materials. The output is clean electricity with absolutely no pollutants—no CO_2, no SO_x, no NO_x. Generation of electricity from wind does not use water, which is becoming a scarce resource. This is in contrast with traditional power plants, which are one of the largest consumers of freshwater. Wind energy, therefore, has a prominent role in the clean energy future.

> In 2005, power plants in the US accounted for more than 40% of freshwater withdrawals. Wind power is water-smart power, because it uses no water.

3. GWEC and IRENA (IRENA 2012), IEA (International Energy Agency 2013), and others (Bird et al. 2003) have analyzed wind energy policies primarily in developed wind energy markets. In these reports, success and failures of policies in leading wind power markets are analyzed and best practices are synthesized.

4. This publication focuses on wind energy policies in the emerging wind energy markets. It is based on the work done by the Quantum Leap in Wind Power Development in Asia and the Pacific (QLW) from 2011 to 2014. It is based on the assimilation of formal and informal inputs from private developers, policy makers, licensing authorities, utilities, and financiers in three emerging wind markets—Mongolia, the Philippines, and Sri Lanka,. The policy prescriptions and implementation guidelines cover five areas: wind energy incentives, wind resource exploitation, grid integration, licensing guidelines, and public awareness and human resource development.

5. The second section of the report describes the overall framework for wind energy policy. The third section presents the evolution of wind energy policy in Mongolia, the Philippines, and Sri Lanka, and the impact the policies had on the wind industry. The policies and its implementation are different in each country, and so are the outcomes. Analysis of the three countries forms the basis for subsequent recommendations.

6. The subsequent sections fill in the gaps in policies and its implementation in the five areas described in the framework. It develops policy prescriptions and implementation guidelines that are grounded in the three countries, but applicable to new and emerging wind markets in general. Each section is organized along three characteristics or properties of effective policies, and it describes the implementation prescriptions and methodological guidelines with a view towards three properties for keeping the policies relevant as the wind industry evolves.

Questions answered in this publication:

1. What are the components of an effective wind energy policy that supports sustained development of wind energy?
2. What are the properties of effective wind energy policies?

2. WIND ENERGY POLICY FRAMEWORK

7. Wind energy policy is one of the most important drivers of investment in the wind power sector. The common goals of a wind energy policy are to promote:

a. Significant reduction in greenhouse gas (GHG) emission from the power sector, which will lead to lower health-care costs and lower impact due to climate change;

b. Energy security—rely on indigenous source of energy while reducing import of fuels thereby reducing variability in cost of feedstock;

c. Energy access—provide electricity to population with minimal or no access to electricity;

d. Other goals like reduction in deficit of power, promotion of local industry, and development of human resources.

8. Wind energy policy is part of the bigger renewable energy policy of a country. Renewable energy (RE) policy is typically created by the Ministry of Power and approved at the highest level by the executive branch and the legislature. The starting point of RE policy is a statement about the long-term targets of percentage of RE in the grid. Wind energy policy's targets are therefore derived from the RE policy targets. An example of targets in wind energy policy is 5% wind power by 2015, 10% by 2020, and 20% by 2030; here the percentages are with respect to total installed generation or peak load.

9. Starting from targets, the following five components of wind energy policy lay out the course of action to reach the targets:

a. **Incentives.** It covers supply-side and demand-side inducements. Supply-side incentives are targeted at producers of wind energy, while demand-side incentives are targeted at the primary buyer, which is typically the transmission company;

b. **Licensing guidelines.** It covers regulations related to approval and permitting of wind energy projects;

c. **Wind resource exploitation policy.** It covers the approach to exploiting the full potential of wind energy. This includes policies like wind energy corridors or preferential zones;

d. **Grid integration policy.** It covers policies related to interconnecting wind power plants to the grid. It includes policies related to grid code for interconnection, system operations, and enhancing flexibility of grid;

e. **Public awareness and human resource development.** It covers policies related to increasing public awareness of advantages of wind energy and developing talent in the area of wind energy.

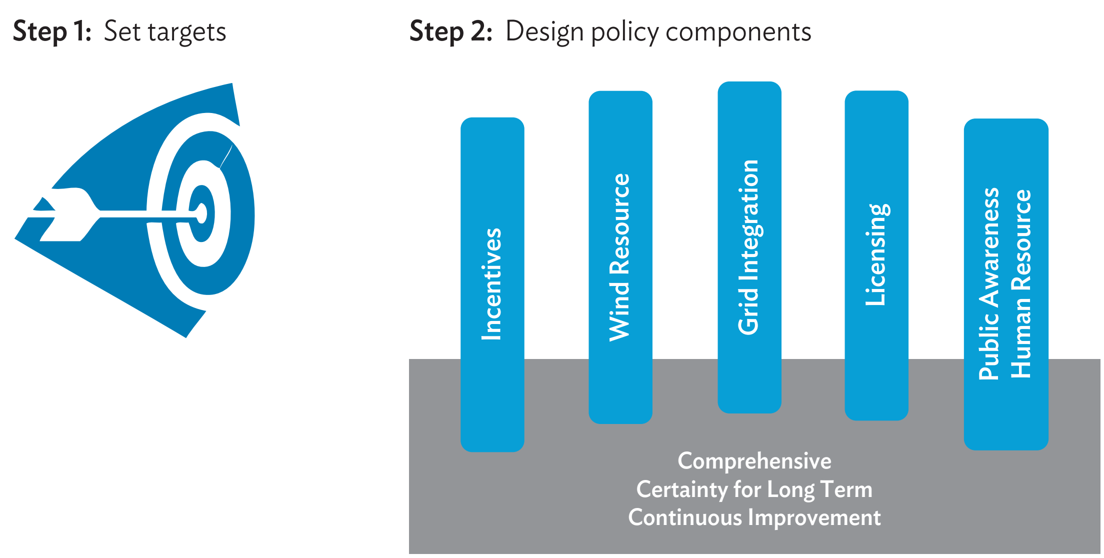
10. For a wind energy policy to be successful, the five components should possess these three properties, for an illustration see Figure 1:

a. Comprehensive, which means that the policy is designed to balance the needs of all the stakeholders. The primary stakeholders are (i) the developer or owner of WPP; (ii) the utility, which interconnects the WPP to the grid and buys electricity from WPP; and (iii) the consumers of electricity;

b. Certainty for long term, which means that there is confidence about the long-term stability of the policy. It is important for policies to be defined for at least 10 years, and there should be sufficient certainty that the policies will last beyond the current term of the political party in power;

c. Continuous improvement, which means that mechanisms are in place to adjust the policy based on progress towards achieving targets. First round of policies are never perfect, therefore the design of policies should incorporate necessary tweaking.

Figure 1: Framework of Wind Energy Policy



Source: Authors.

11. An illustration of the properties of the five components of policy that are most relevant to the emerging wind energy markets is in Table 1. It contains the mappings of the five components to the three properties. Section 3 presents the policies in Mongolia, the Philippines, and Sri Lanka according to the map in Table 1. Sections 4 to 8 elaborate on the individual components of policy.

Table 1: Properties of Successful Policy Components

Policy Components	Comprehensive	Certainty for Long Term	Continuous Improvement
Incentives	Demand- and supply-side incentives	At least 10-year horizon	Update to FiT model and other incentives
Wind resource exploitation	Countrywide wind resource map	Wind energy corridors	Long-term measurement
Grid integration	Integrated energy master plan	5, 10, and 20-year scenarios	Responsive to congestion and curtailment
Licensing guidelines	One-stop shop to manage the myriad of licenses/permits	Transparent with clear requirements and criteria	Adjustments
Public awareness and human resource development	All key issues are addressed	Long-term communications and research program	Adjustments

FiT = feed-in tariff.

3. REVIEW OF THE WIND ENERGY POLICY OF MONGOLIA, THE PHILIPPINES, AND SRI LANKA

12. The Quantum Leap in Wind Power Development in Asia and the Pacific (QLW) provided a wide variety of technical assistance to executing agencies responsible for wind energy in Mongolia, the Philippines, and Sri Lanka. The policy framework described above is a result of this work. This section describes the five components of the wind energy policies and the three properties in Mongolia, the Philippines, and Sri Lanka.

3.1 Mongolia

13. In Mongolia, a renewable energy law was passed in 2007. The first wind farm with installed capacity of 50 MW was commissioned in June 2013. Five wind projects with a combined capacity of 502 MW are in the pipeline; these projects hold generation licenses but have not reached financial closure.

	Current Policies	Gaps
Incentives	• Feed-in tariff (FiT) from $0.08 to $0.095. All six projects mentioned above were awarded $0.095. • Standardized Power Purchase Agreement (SPPA) • The 2007 law required the setup of a Renewable Energy Fund (REF) to compensate the buyer of wind energy for difference between FiT and price of coal-based generation of combined heat and power (CHP) plants. • Certainty for long term: FiT is in place for 10 years; duty-free import of and no value-added tax on power generation and related equipment.	• Comprehensive: Only supply-side incentives exist. Demand-side incentives are not in place—Renewable Energy Fund (REF) is empty and no meaningful incentives to enhance off-peak demand. • Continuous improvement: (a) FiT model update has not occurred based on learning from first wind farm: high cost of logistics and transmission, expensive in-country financing, and higher risk of curtailment. Metrics like the P75 and P90 were not used in the original FiT model. (b) Proposed mechanism to populate REF has failed and new mechanism has not been created. (c) Plan for market-based tariff is under preliminary consideration, but no serious plan.

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	Current Policies	Gaps
Grid Integration Policy	• High level of curtailment by Mongolia National Dispatch Center of wind energy produced by 50 MW Salkhit wind farm. • Energy master plan has been developed, which emphasizes continued use of coal for electricity generation with minimal wind energy. • Certainty for long term: Wind projects are guaranteed connection to grid and priority dispatch. • Continuous improvement: New dispatching process is under development for wind; new legislation is planned for wind energy policy.	• Comprehensive: (a) Energy master plan does not reflect goals for wind energy and targets for wind energy in Mongolia's EMP do not match the licenses issued to wind developers; (b) system-wide or project-specific analysis of impact of wind energy on power systems and on grid operations was not performed; (c) overall economics of import/export to the Russian Federation, payments to CHP power plants and payment to wind plant have not been resolved; (d) no grid code for integrating wind power; (e) weak plan to enhance flexibility of the grid.
Wind Resource Exploitation Policy	• National target: 20% to 25% renewable energy by 2020 • National Renewable Energy Center performed wind measurements for a few years at a few locations. • Off-grid applications of small wind were funded by the government. • Certainty for long-term: (a) ADB has funded a long-term wind measurement campaign.	• Comprehensive: (a) no wind corridors have been defined • Continuous improvement: (a) no efforts to map the wind resource rich areas of the country in detail; and (b) no efforts to update the 2001 NREL wind resource map.
Licensing Guidelines	• Renewable energy law specifies high-level requirements for obtaining a construction and generation license	• Comprehensive: (a) No one-stop shop for licenses, the process to obtain permits and approvals is tedious with lots of duplication; (b) a comprehensive list of licenses, approvals, and permits required for wind farm development does not exist. • Certainty for long term: (a) Detailed licensing requirements do not exist or the requirements are not clearly stated. • Continuous improvement: (a) No updates have been made to licensing guidelines; (b) licenses were issued for utility scale wind farms with no onsite wind measurement using tall (>50m) meteorological tower, and to projects with nonbankable feasibility study; (c) there are no requirements for the financial capabilities of the wind developer.
Public Awareness and Human Resource Development	• Human resources: National Renewable Energy Center was setup for measuring wind resources and implementing off-grid wind/solar hybrid systems.	• No public awareness campaigns to promote wind or other clean energy sources, despite poor air quality in the capital. • No university programs in wind energy.

3.2 Philippines

14. In the Philippines, a renewable energy law was passed in 2008. The first wind farm with installed capacity of 33 MW was commissioned in Ilocos Norte in 2005. Twelve wind energy projects with a combined capacity of 709.5 MW have received "Certificate of Confirmation of Commerciality," as of June 2014.

	Current Policies	Gaps
Incentives	• Feed-in tariff (FiT) is $0.19. • Standardized Power Purchase Agreement (SPPA) • Award of FiT is made after successful commissioning of a project; only the first 200 MW of wind capacity will qualify the $0.19. • The 2008 law required the setup of a Renewable Energy Fund, called "FIT-All fund" to compensate the buyer of wind energy for difference between FiT and wholesale price. • Renewable portfolio standard requires all distribution utilities to source certain percentage from renewable energy (RE); however, no implementation details have been announced. • RE projects get priority connection to transmission and distribution system and priority dispatch. • Income tax holiday and low income tax rate; duty-free import of and no value-added tax on power generation and related equipment. • Tax credit on domestic capital equipment; exemption from universal charge and transmission charges	• Comprehensive: (a) FiT is attractive, however, the policy of (i) awarding FiT only after commissioning of wind project and (ii) awarding the FiT to the first 200 MW of wind projects, has caused significant uncertainty among investors, leading to a difficult financing environment. This has caused only the financially strong developers to move ahead, and race against other wind projects to avail of the first round of FiT; (b) FIT-All fund, the Renewable Energy Fund, will be populated by charge to consumers; however, the amount has not been determined and the fund is currently empty. • Certainty for long term: (a) FiT after the first 200 MW allocation is not known; (b) 709.5 MW of wind projects have been awarded certificate of commerciality (which is a green light to start construction), but the tariff these projects will qualify for is unclear. • Continuous improvement: (a) The Philippines Department of Energy (PDOE) has stated that the cap of 200 MW for projects to qualify for the FiT may be increased; however, as of the end of June 2014, this cap has not been raised.
Grid Integration Policy	• Guaranteed connection to the grid • Priority dispatch • Grid code for interconnecting wind projects exists	• Comprehensive: It is unclear if there is an Energy Master plan with targets for wind energy (for example, 200 MW by 2014, 700 MW by 2015, and 2,350 MW by 2030). • Certainty for long term: (a) It is unclear if system impact studies have been performed to understand the long-term impact of wind energy on island grids with significant wind resources (Luzon, Visayas, Mindanao, and others), and long-term upgrades required to power systems and system operations. • Continuous improvement: (a) It is uncertain if there is a process to update the energy master plan and system impact studies based on planned deployment of wind projects.

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	Current Policies	Gaps
Wind Resource Exploitation Policy	• PDOE performed wind measurements for a few years at a few locations • Certainty for long term: (a) ADB has funded a long-term wind measurement campaign. • Continuous improvement: (a) As of June 2014, NREL is developing an updated wind resource map.	• Comprehensive: (a) No wind corridors have been defined.
Licensing Guidelines	• Certainty for long term: (a) A process has been developed for obtaining various approvals—Certificate of commerciality, Certificate of electro-mechanical completion, Certificate of compliance, and Certificate of endorsement for FiT eligibility. • Continuous improvement: (a) PDOE publishes status of wind projects on its website.	• Comprehensive: (a) No one-stop shop—lack of coordination among PDOE, Department of Environment and Natural Resources, Bureau of Investments, National Commission of Indigenous Peoples, and others. • Certainty for long term: (a) Certificate of commerciality is issued without PPA. • Continuous improvement: (a) No process in place to receive input from stakeholders.
Public Awareness and Human Resource Development	• Solar and Wind Energy Management Division measures wind resources, performs wind resource assessment, and monitors various aspects of licensing.	• Comprehensive: (a) No public awareness campaigns to promote wind or disseminate its benefits; (b) no university programs in wind energy.

3.3 Sri Lanka

15. In Sri Lanka, the national energy policy for renewable energy was created in 2008. Eighty-eight megawatts of wind power is in operation. Thirty-one megawatts is under construction and 200 MW is in the planning stages.

	Current Policies	Gaps
Incentives	• Two feed-in tariff (FiT) options are available for 10 MW or smaller wind power plants: Front-loaded 3-tier, and flat tariff of $0.17. • Continuous improvement: FiT was reviewed and updated in 2012.	• Comprehensive: (a) Demand-side incentives have not been implemented. The Renewable Energy Fund, the mechanism to compensate the buyer (CEB) for the incremental cost of wind energy has no funds. • Certainty for long term: (a) Tariff for larger (>10 MW) wind projects has to be negotiated with CEB; (b) CEB has stopped issuing licenses to wind projects in the Puttalam area.
Grid Integration Policy	• Guaranteed connection to the grid • Priority dispatch • Grid code for interconnecting wind projects exists • CEB delayed interconnection to about 50 MW to 60 MW of wind plants in Puttalam. It has refused to issue new interconnections in Puttalam.	• Comprehensive: (a) It is uncertain if an integrated energy master plan exists—(i) thermal generation is growing rapidly while off-peak demand is low, and (ii) ratio of must-run plants to off-peak demand is high; (b) system impact studies have been performed but the results were rejected by CEB, and new studies are underway, but have not been completed as of June 2014. • Certainty for long term: (a) System impact study scenarios for the integration of long-term wind energy targets do not exist. • Continuous improvement: (a) It is uncertain if there is a process to update the energy master plan and system impact studies based on planned deployment of wind projects.

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	Current Policies	Gaps
Wind Resource Exploitation Policy	• Comprehensive: (a) 300-plus MW wind corridor is planned for Mannar based on market-based tariff (options like reverse auction are being explored). • Certainty for long term: (a) ADB has funded a long-term wind measurement campaign. • Continuous improvement: (a) Additional wind measurements are planned.	• Comprehensive: (a) No policies for other wind rich areas like Jaffna, Trinco, and Hambantota. • Continuous improvement: (a) No update to wind resource map has been published.
Licensing Guidelines	• Comprehensive: (a) Sustainable Energy Authority of Sri Lanka (SEA-SL) has published licensing guidelines.	• Comprehensive: (a) No one-stop shop • Certainty for long term: (a) Certificate of commerciality is issued without PPA. • Continuous improvement: (a) No process in place to receive input from stakeholders.
Public Awareness and Human Resource Development	• Comprehensive: (a) SEA-SL was established in 2008 as the focal agency for renewable energy. • Certainty for long term: Moderate amount of research and education in wind energy.	• Comprehensive: (a) No public awareness campaigns to promote wind or disseminate its benefits.

4. INCENTIVES

16. The early 1980s to the end of the 1990s was the early phase of wind energy globally. The first decade of the 21st century was the rapid growth phase. Now, the wind energy industry is entering the mature phase. Since the 1980s, countries have experimented with various forms of incentives. The most successful schemes that have led to rapid exploitation of wind resources are:

a. Feed-in Tariff (FiT), a cost-based tariff, has proven to be the most effective during initial stages of wind development. This publication will therefore focus on FiT. This policy is usually accompanied with: (i) standardized PPA, (ii) guaranteed interconnection, (iii) priority dispatch, and (iv) renewable energy fund (REF) to compensate the buyer for the difference between the FiT and the avoided cost of generation;[1]

b. Premium FiT is an alternative in which a premium is paid on top of a base tariff. The base tariff in this case is either the market price of electricity or one that is negotiated with the buyer. For a wind power investor, it does not provide the certainty of FiT. For the system operator, the tariff is linked to the market price of electricity at the point of interconnection;

c. Reverse-auction is a market-based approach in which wind power investors compete for tenders based on tariff. It is successful only if the auction is conducted in a manner with strict eligibility criteria and harsh penalties for nonperformance.

[1] Avoided cost of generation in markets with excess generation is the highest cost of generation that is displaced by wind; and in markets with perennial scarcity of electricity it is the highest cost generation (in $/kWh) in the grid.

17. A more detailed comparative analysis of incentives related to wind power development is in the IRENA report (IRENA, 2012). It analyzes incentives in 12 countries: Brazil, the People's Republic of China (PRC), Denmark, Germany, Greece, India, Ireland, Italy, Portugal, Spain, the United Kingdom, and the United States.

> Incentives are often necessary but never sufficient for rapid exploitation of wind energy resources. Other factors include readiness of grid, and sustained commitment to clean energy.

18. The three properties of effective incentives in emerging markets are described below.

4.1 Comprehensive

19. A comprehensive package of incentives should be designed to balance the needs of all the stakeholders, which can be done by examining incentives from the perspectives of supply-side and demand-side. Supply-side incentives are provided to owners of WPP to compensate them for the higher levelized cost of wind energy compared to coal-, gas-, or hydro-based power plants. Demand-side incentives are provided to the buyers of wind energy to compensate them for the differential between payment for wind energy and the avoided cost of electricity in the system. If the differential is negative, then there is no need for demand-side compensation; however in most cases the differential is positive, therefore there is need for demand-side incentives.

20. The Quantum Leap in Wind Power Development in Asia and the Pacific (QLW) has found that although demand-side incentives are mentioned in policy documents, it is not implemented.

> Experiences in Mongolia and Sri Lanka have demonstrated that supply-side incentives are not enough. Demand-side incentives are necessary to remove the resistance of the buyer, if not create demand for wind energy.

4.1.1 Demand-side Incentives

21. Often the focus of policy makers is on supply-side, with little or no attention paid to demand-side incentives. Demand-side incentives are inducements to the buyer to purchase wind energy. Most emerging markets are single buyer market, that is, the buyers are state-owned enterprises. Nevertheless, their performance is measured on ability to breakeven or to make profit. If no incentive is provided, then the tariff differential for wind energy reflects negatively in their income statement. Therefore, buyers are reluctant to add wind energy.

22. There are three types of demand-side incentives:

a. Renewable Energy Fund (REF). Most incentive schemes have provisions for a REF, which pays the wind energy price differential to the buyer. However, in most countries the REF is empty, because the government is unable to agree on sources of funds. A good design of REF and the political will to fund it is therefore important for the long-term sustainability of wind power. Without funds in REF, the transmission company pays excess tariff from its own budget. Most transmission companies are government-owned enterprises, so the excess tariff is passed on as subsidy from the government.

This is not sustainable because of the ad hoc nature of funding; during a budget squeeze, wind projects may not be paid. This also raises the uncertainty of a wind project because of risk associated with payment. In countries with REF, there is no dearth of ideas for raising funds for REF; what is lacking is implementation. Following is a short list (not a complete list) of potential sources for REF:

i. Use funds from certified emission reductions (CERs) or other bilateral mechanisms for emissions reductions.

ii. Levy on high energy users (industry and/or residential).

iii. Levy on the most polluting electricity producers.

iv. Levy on natural resource companies like coal and fossil-fuel mining.

v. Other source of funding REF is to raise tariffs on consumers of electricity. Regulators loathe to increase tariffs because it is politically unpalatable.

In Mongolia, REF is empty; it was designed to be funded by coal power plants. The coal power plants are loss-making units and do not funds to pay into REF.
In Sri Lanka, the REF is empty as well. The mechanisms to populate REF have not been implemented.

b. Renewable Portfolio Obligation (RPO). RPOs are requirements that the transmission company and all the distribution companies source certain percentage of electricity from renewable sources. In a single-buyer market, RPOs are difficult to implement for the same reasons as REF.

c. Demand-side management[2] (DSM) to increase off-peak demand. Wind energy faces the biggest challenge during hours of off-peak demand. The dispatch center schedules all the must-run base-load plants and if this level of generation plus wind energy production exceeds the off-peak demand, then wind energy is curtailed. Off-peak demand may be increased by lowering consumer tariff during off-peak hours, thus encouraging large consumers of energy to shift demand from peak hours to off-peak hours.

4.1.2 Supply-side Incentives and Incomplete FiT Models

23. Feed-in tariff (FiT) and other supply-side incentives are described in detail in Couture et al. (2010). FiT is a cost-based model for setting tariffs. In this cost-based approach, a levelized cost of energy (LCOE) is computed by making assumptions about total expected annual energy production, installed cost of the wind plant, operations and maintenance costs, debt/equity ratio, interest rates, expected rate of return on equity and several other parameters. This publication will focus on areas that are often overlooked in setting appropriate level of FiT, as observed by QLW:

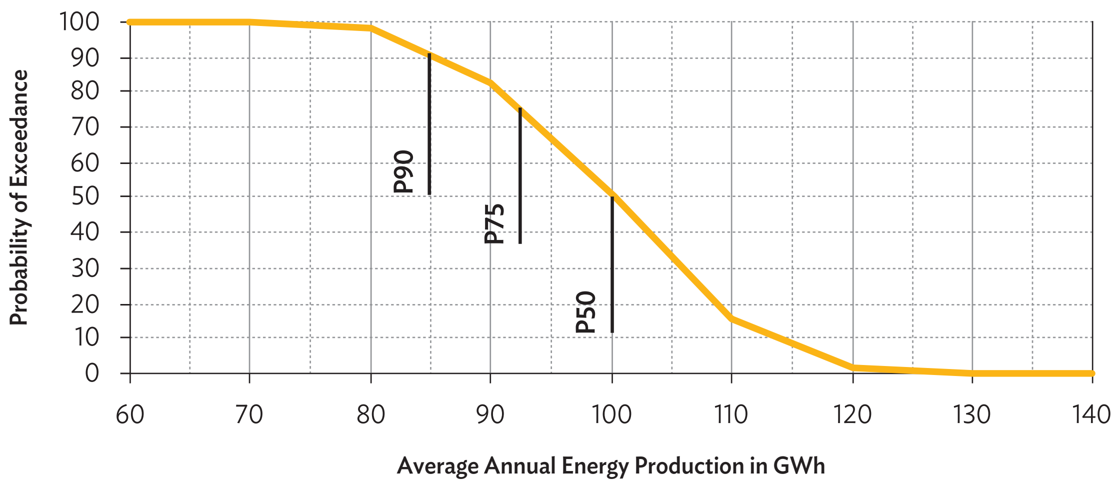
a. P50[3] estimate of annual energy production (AEP) is used in FiT model. This exaggerates the energy output of the wind plant and does not reflect the AEP estimates used by financiers. Typically, debt financiers use P90-AEP while equity financiers use P75-AEP; estimates of P90-AEP and P75-AEP

[2] Demand-side management has various facets; managing off-peak demand is one of them. This publication will limit the DSM discussion to off-peak demand.

[3] P50, P75, P90, or PN are exceedance probabilities. For example, at least P90-AEP or higher amount of energy will be produced each year with a probability of 90%.

are 15% to 10% less than P50-AEP for high quality projects. FiT computed using P50-AEP, therefore, does not reflect the risk associated with energy production; as a result it underestimates the tariff required for a profitable project. See Figure 2 for details.

Figure 2: Illustration of Exceedance Probabilities



Note: Illustration of exceedance probabilities for a wind project with average AEP of 100 GWh and standard deviation of 10 GWh. P50-AEP = 100 GWh, P75-AEP = 95 GWh, and P90-AEP = 85 GWh.

Source: Jain. 2010.

b. An important metric often not considered in the FiT model is the Debt Coverage Service Ratio (DSCR), which is the ability of a project to meet its debt obligations in each year for the duration of the debt. All lenders assess the amount of debt based on DSCR, so when this metric is not used in the FiT model, the result is a lower FiT tariff. It is recommended that the FiT model use P75 and P90 estimates of AEP to combine the evaluation criteria of debt and equity investors. The following simple method is an illustration of how the FiT may be computed from LCOE by using P90-AEP and P75-AEP.

   i. Step 1: Compute LCOE from the perspective of debt investors using P90-AEP. In this computation, start with debt-equity ratio in the country for such power projects (debt of 70% is common) and compute the LCOE such that the average debt service coverage ratio (DSCR) is equal to or higher than the desired threshold. Typical DSCR threshold used by debt investors is 1.3 to 1.35.

   ii. Step 2: Using LCOE from the previous step, P75-AEP production and 25% equity, compute the return on equity (ROE). If the ROE is above the threshold ROE, then use this LCOE to determine the FiT. On the other hand, if the ROE is below the threshold ROE, then increase the tariff above the LCOE until the threshold ROE is reached. This tariff should be used to determine the FiT.

c. The total installed cost of wind power plant is underestimated because the cost estimates are derived from actual costs in mature wind markets. There are two components to the cost: cost of turbine and balance of plant. In mature markets a ratio of 70:30 is assumed. However, the ratio can be lower (example, 60:40) because all the equipment, engineers and technician are imported for the project. So the practice of starting with price of turbine and assuming that it is 70% of the total cost of project will lead to a lower cost estimate.

d. The estimates of operations and maintenance (O&M) costs are too low. In new wind energy markets, the O&M costs are initially high because a new O&M infrastructure has to be setup and the cost is not spread across multiple WPPs, but is borne by the first WPP.

e. Other common shortcomings of FiT models are:

   i. Use of high-level wind resource maps and other upper atmospheric wind data which typically has an inaccuracy of +/−50% in AEP. Often the inaccuracy is biased on the positive side, which leads to use of a high estimate of AEP in the FiT model.

   ii. Use of Class III turbines, with large rotors and high hub heights, for computing AEP. This exaggerates AEP used in the FiT model. It is recommended that FiT models construct three scenarios by separating regions in the country that are suitable for Class I, II, and III turbines. Although the class selection criteria are complex (specified by IEC 61400-1), an acceptable simplification for illustrate purposes is: Class I is suitable for sites with wind speed between 8.5 m/s and 10 m/s; Class II is suitable for wind speed between 7.5 m/s and 8.5 m/s; and Class III turbines are suitable for wind speed less than 7.5 m/s. All wind speeds here are at hub height. For the three classes of turbines the FiT model should be used to compute the levelized cost with the respective capacity factor. Equipped with three LCOE for the three classes, FiT may now be determined based on the average or median of the three values.

24. These recommendations are intended to close two gaps in current FiT models used in new wind markets. The implications/benefits of the recommended changes to the FiT model are determination of a tariff that is based on (a) Realistic estimates of total installed and O&M costs, (b) AEP estimates of the appropriate class of turbines, and (c) uncertainties in AEP as seen by debt and equity investors.

4.2 Certainty for Long Term

25. Tariff certainty should be a property of any wind energy policy. Under the FiT scheme, a standard PPA is valid for 20 years. Often the FiT is available to all projects from the date of announcement of FiT to 10 years in the future. The Philippines adopted a different approach. In June 2013, it made the FiT available to only the first 200 MW of wind projects. This created a high degree of uncertainty in the developer community at the time of announcement, because (a) FiT would be assigned not after completion of bankable wind resource assessment, but only after project had reached 80% electromechanical completion; (b) future FiT, for projects after the first 200 MW, was not announced. Since June 2013, the PDOE has publicly stated that the 200 MW target will be increased, without disclosing a new target.

26. Regular adjustment of FiT is a desirable property, but it must be balanced against the uncertainty of FiT. An approach to overcome the uncertainty would be to specify a range for change in FiT. An example of such an approach is a policy that requires that the FiT be revised by at most 10% after every 200 MW allocation.

The primary supply-side incentive in the US wind energy market has been the production tax credit (PTC). PTC is at the mercy of the legislature, which has to approve an extension. From 2005 to 2012, when the PTC was continuously in place the wind industry grew nine times over, resulting in $105 billion of private investment. Domestic content rose sharply from 25% to 72% from US factories, and jobs reached 80,000 including 30,000 in the US manufacturing. Uncertainty over the future of the PTC at the end of 2012 caused private investment to fall from $25 billion in 2012 to $2 billion in 2013 (AWEA 2014).

4.3 Continuous Improvement

27. There are several aspects to continuous improvement of policies related to incentives. No policy can hit the mark and balance the competing interests perfectly. In some cases the incentives are too low (example, Viet Nam) and it is evident that with the current level of incentives the wind energy targets will not be met. In other cases there are a flood of projects but the offtaker or buyer is unwilling to buy power because it will create a large budget deficit (example, Sri Lanka). In these two cases and others, tweaking of incentives should enable policy makers to make adjustments.

28. After an initial batch of wind projects, improvement may entail transitioning from FiT to market-based system. The disadvantage of FiT is that it is not a market-based mechanism for setting tariff, which creates a perception in the minds of consumers and others that the subsidy for wind energy is high. A popular market-based system is reverse auction, which is a method to issue licenses to wind projects based on competitive bidding. In this method, bidders who offer the lowest price of electricity (hence the name reverse auction) while meeting all the other requirements of the bid are awarded wind energy licenses.

Brazil has adopted the reverse auction model. The prospects for the Brazilian wind market for 2014 look promising: the Brazilian wind industry is looking to install 4 GW of new wind power, to reach 7.5 GW of installed capacity. This is supported by the impressive results of the auction in December 2013 in which 2.3 GW of wind capacity was contracted with the low average price of $49.22/MWh.

29. In order for reverse auctions to be successful in a country with an emerging wind market, the following is recommended:

a. Initial batch of 5 to 10 wind projects should be based on FiT to allow the wind project developers to understand the nuances of implementing wind technology in a new market;

b. Bidders in reverse auction should be qualified based on both technical and financial strength. One method to reduce the chances of nonperformance by the lowest bidder is, requiring the winning bidders to post a significant amount of deposit (2% to 5% of the cost of project) at the time of contract signing, with the condition that the deposit is forfeited if the project is not completed within a specified timeframe;

c. All the bidders have access to good quality wind resource data and significant uncertainties associated with wind projects in the proposed regions and their impacts are well understood.

30. In absence of these prerequisites, the reverse auction method leads to aggressive bids that cannot be fulfilled because the awardees later realize that the projects are not financially viable.

5. GRID INTEGRATION POLICY

31. Grid integration is a key bottleneck to rapid deployment of wind power. QLW has observed that before the first wind farm is commissioned, the attitude of most grid managers and operators is "integration of less than five percent of wind power capacity (or less than 2% of wind energy) is no problem." After the initial integration, the attitude is replaced by caution and in some cases fear that the grid is not ready to absorb additional wind energy (or other forms of variable energy sources). Now that several Asian countries have a few wind project installations, additional project development is predicated on a grid integration policy that resolves system-wide and locale-specific issues related to ability of grid to absorb wind energy from areas with good wind resources.

5.1 Comprehensive

32. Although development of an integrated energy master plan (EMP) is not a prerequisite, it is an important step in the process of successful development of wind energy. EMP is typically a 5, 10, and 20-year system-wide forecast of the electricity sector, with forecast of load, generation and transmission. A comprehensive EMP that incorporates wind power targets provides utilities with a plan for and associated costs related to upgrade of transmission/distribution lines, substations, and ancillary services. Examples of EMP with wind penetration scenarios are: 2% wind power in 2 years; 4% in 5 years; 10% in 10 years; 20% in 20 years.

33. A comprehensive system-wide economic analysis of cost of curtailment, cost of thermal power plant cycling, cost of thermal or battery storage, cost of exporting/importing energy from neighboring balancing areas and others is crucial to determining the most cost effective options for integrating the target amounts of wind energy. Each option has a different timeline, therefore proactive evaluation of options is key to lower cost integration of wind energy and sustainable development of the wind industry.

34. The three properties of a comprehensive grid integration policy are:

a. The integrated EMP provides policy makers with feasible wind power installation targets and includes an estimate of the investments required in the grid to achieve the targets. In order to make implementable policy decisions about level of wind power penetration, insights from power flow, dynamic stability analysis and system operations assessment, of the various scenarios of the EMP is required. The analysis determines the feasibility of scenarios and the associated upgrades required to the grid in order to meet quality of power, reliability of power and system stability requirements and standards.

b. The integrated EMP should lay out a strategy for exploiting the wind energy resources that have the lowest system-wide cost. This may take the form of wind energy corridors or preferred zones, which is described in the next section. Another aspect that is often overlooked is the sharing of grid infrastructure. Wind corridor close to an existing or planned power plant should be preferred compared to a wind corridor that requires building of a dedicated grid, even if the former corridor has marginally lower wind resources, but lower system-wide cost.

> The most effective wind energy policy is not to deploy wind power plants at sites with the highest wind resources, but to deploy at sites that offer the lowest system-wide cost. System-wide costs include fixed cost like transmission and substations, and costs associated with losses due to transportation of energy to load centers. Often, wind rich areas are not near load centers and are not concentrated in one part of the country.

c. Enhancing the flexibility of the entire grid should be an integral component of the comprehensive grid policy. There are several components to grid flexibility.

   i. Integrating wind forecasting in system operations and rethinking of unit commitment timeframes. Flexibility is enhanced by integrating forecasting of variable generation, while encouraging shorter dispatch schedules (15 minutes to hourly) to reduce curtailment of variable generation and efficiency of other generators. This greatly reduces the need for flexibility in the other parts of the system because generation can be more closely balanced with load. As the number of variable power plants increases, more sophisticated tools and processes may be used: Ensemble forecasting methods that are based on multiple forecasting methods, and centralized forecasting systems that forecast for all variable generation plants in the entire balancing-area. These methods can contribute to lower forecast errors.

   ii. Requiring high speed real-time transfer of data from wind farm to the system operations. The data stream should contain wind speed, power production, and number of turbines available. Visibility into wind farm provides system operators data to operate the network.

   iii. Enhance the flexibility of other generators on the grid. A generator is considered to have high degree of flexibility if (a) the minimum operating level is low, (b) ramp rates in up and down directions are high, (c) start-up and shut-down time are low, and (d) minimum up-time and down-time are low. Most conventional generators will require refurbishment in order to realize one or more degrees of flexibility. Generation flexibility is achieved through installation of peaking plants that are able to follow the net load.

   iv. Enhance transmission capacity in zones that are likely to be bottlenecks in terms of thermal loading of conductors. Injection of wind energy into a grid can change the flow of energy and cause bottlenecks in transmission, especially during peak load and peak wind production. Relieving the bottleneck with increased transmission capacity enhances the flexibility of the grid.

   v. Require wind turbines to have fault ride-through, provide reactive power and in general be grid friendly. These features make the job of system operator easier by supporting the grid during times of faults and emergencies.

   vi. Encourage wind power plants to be partially dispatchable, that is use the ability of wind plant to control reduction in energy production. Fully dispatchable resources can control both reduction and increase in energy production. Exploiting the downward control of wind power plant will assist system operators to reduce congestion and improve the overall efficiency of the system. Increasing the flexibility of a wind power plant can reduce the amount of flexibility required in the grid. One method to accomplish this would be to compensate wind power plants for partial curtailment.

vii. Load flexibility is achieved through programs like demand response in which load is modulated depending on the temporal profile of net load (load minus generation). Demand response is an effective method to shave peaks from net load.

viii. Electricity storage or thermal storage can enable smoothing out the peak of net load. Electricity storage can also support voltage and frequency control. It is the one of the most expensive forms of flexibility.

ix. Inter-regional transfer of energy enhances flexibility because (a) geographical diversity of renewable generation leads to lower variability and (b) larger load balancing area leads to sharing of expensive peaking resources.

> First wind farm in Mongolia is facing curtailment during off-peak hours because of inflexibility of thermal CHP power plants.

5.2 Certainty for Long Term

35. Coordinated and integrated planning is crucial to enhance flexibility in the system in order to integrate larger amount of variable energy. Most system impact studies are done in response to specific wind farm interconnection. For long-term certainty, what is required are studies that analyze impact from multiple projects over multiple years on the entire system. A comprehensive system impact study should take into account:

a. Long-term load forecast from country's electricity master plan, which includes:
   i. mix of load, and
   ii. diurnal and seasonal profile of load.
b. Long-term generation forecast from country's electricity master plan, which includes:
   i. conventional power plants—coal, diesel, and nuclear;
   ii. peaking power plants;
   iii. hydro power plants;
   iv. wind/solar/biomass and other variable generation;
   v. other power plants like: geothermal, waste to energy, etc.; and
   vi. trade of energy between different systems.
c. Long-term plan for transmission network, which includes:
   i. transmission lines,
   ii. substations, and
   iii. FACTS controllers.
d. All neighboring grid in order to capitalize on
   i. geographic diversity of variable generators and
   ii. enlarged balancing authorities

36. The recommendations of the system impact study should provide a roadmap for the building of infrastructure to support long-term grid integration of wind energy. The key to higher renewable energy generation over the long term is system flexibility, which is the ability of the entire system to respond to injection of energy from variable sources. Transitioning to a flexible system, as described, is a long-term initiative. It comes at cost and there are winners and losers. Market rules should therefore be designed to support cost effective solutions to increasing flexibility. The following recommendations (adapted from Cochran) are appropriate for emerging wind energy markets:

a. Use zonal or nodal pricing to achieve reduced congestion (IRENA 2012) by encouraging development of resource in bottleneck areas. This is an efficient method because market forces are effective at allocating investments in reaction to pricing differences between zones.
b. Design equitable pricing mechanisms to support storage, variable generators and base-load power plants with the goal of cost effective and reliable network. Variable generators often reduce the market price of power thereby reducing the price of electricity paid to base-load plants; variable generators also cause higher amount of cycling of base-load plants. Base-load power plants should be compensated for this. Similarly variable generation must be compensated for curtailment during low net load.
c. Physical solutions to increasing flexibility are technical challenges that are easier to solve. However, institutional, legislative and market barriers to market-based flexibility are challenging and require longer time horizon to implement.

37. In countries with nascent or no market-based electricity pricing, the challenge of market-based solutions is enormous. In such cases, simple and incremental approaches with a long-term roadmap are preferable.

5.3 Continuous Improvement

38. The wind energy installation targets in the EMP are based on a wind energy roadmap (WER), which is a bottom-up analysis of wind resources, technologies and constraints. The installation targets are usually specified in five year increments. It is unlikely that the integrated EMP and wind energy roadmap will be perfectly coordinated and synchronized; however it is imperative that the two documents be adjusted and updated as new information becomes available. For example, as cost of wind energy falls and cost of coal plants rises to meet stringent emissions requirements, the energy mix and wind energy penetration scenarios should be appropriately adjusted.

6. WIND RESOURCE EXPLOITATION POLICY

39. The goals of policies in the area of wind resource exploitation should be to invest in initiatives that reduce the following:

a. Time from concept to commissioning. In emerging wind power markets, lead time for development can be as high as 4–5 years, compared to 1–2 years of comparable size wind projects in developed wind markets.
b. Development cost. The development cost in emerging markets may be 50% higher than comparable projects in developed wind markets.

c. Investment risk. Uncertainty associated with wind resources are 15%–20% in emerging wind markets compared to 10%–12% in developed wind markets. In most cases, the wind resource is sufficient, but the resource assessment is lacking. Criteria like those described above both educate and set expectations of developers. Thereby encouraging developers to perform rigorous due diligence.

40. Three policy initiatives will be described aiming to address the above goals.

6.1 Comprehensive

41. A comprehensive approach to wind resource development is to define zones or corridors for wind development. Wind energy corridors are regions screened for wind resources, land availability, infrastructure and other factors with the goal of focusing the efforts of all agencies to the identified regions. WPP development involves a long list of considerations—infrastructure, logistics, permits, land; some of these are listed below:

a. High voltage transmission lines are required in the vicinity of the wind farm, with sufficient capacity to evacuate wind energy generated by WPPs in the area.
b. Good road network from importation point to the WPP site is required, with sufficiently wide roads, wide turning radii, sufficient clearance from overhead electricity and telephone lines, strong bridges, and wide and high tunnels.
c. WPP requires large tracts of land that must be purchased or leased from government or private landowners.
d. A variety of permits must be obtained before WPP can be built—environmental impact assessment (EIA), visual impact, and impact to cultural and historical artifacts.

42. In developing countries, it can be onerous, time consuming and costly for each developer to manage the items listed above. These items can cause significant delays and cost overruns. The act of creation of wind corridors shows commitment by the government to work with developers to bring down the above barriers to wind projects. In the wind energy corridors government may choose to provide support for the critical issues that a developer is likely to face. For instance, the government may choose to invest in the following:

a. High voltage transmission line to the wind energy corridor.
b. Installation of weather stations with tall permanent met-towers to measure wind speeds with high quality instruments.
c. Transportation infrastructure like roads, bridges, tunnels, railroad, etc.
d. Conduct EIA for the region while identifying key issues a developer should address. Conduct other studies like obstruction to aviation, microwave and telecommunication interference, and weather/defense/homeland security radar interference.
e. Procurement of land for wind development or create standard land lease procedures and contracts for government owned land.
f. Expedited permitting and approval of wind projects in the corridor.

43. Such a focused approach can attract domestic and foreign capital because several of the uncertainties are reduced, which leads to reduced cost and shorter lead time for wind project developers. It is important to note that such an approach also reduces cost to taxpayers because investment in common infrastructure is likely to be used by multiple projects, and the resulting development in the area would bring tax revenue and jobs.

> In the state of Texas, Competitive Renewable Energy Zones (CREZ) were created by the legislature in 1999 in which RE resources and land availability would lead to development of RE generation capacity. It authorized construction of transmission lines from CREZ to load centers. It allowed generation and transmission to be developed in coordinated manner. This started the wind energy boom in Texas.

6.2 Certainty for Long Term

44. One of the critical components of a Bankable Wind Resource Assessment (WRA) is the long-term correction of annual energy production (AEP). In order to perform long-term correction, good quality long-term wind data is required. Methods like MCP are then are used to compute the long-term corrected AEP. Financiers require a project to have good quality long-term wind data with high correlation to measured data, lacking which financiers require the project to measure wind speed for 3 to 5 years.

Although reanalysis data and meso-scale numerical weather model data (referred to as derived datasets) are publicly available for past 30+ years, the quality of such wind data is poor in the developing countries. The reason is there are few or no long-term quality measurements at 50+ meters above the ground level, which form the primary input to computing long-term wind datasets.

6.2.1 Long-Term Wind Measurements

45. From a policy standpoint, a country can significantly impact the risk profile of wind projects through collection of long-term reference wind data. This is done by installing tall permanent met-masts, with a life of 10+ years, in regions with the highest resource prospects to measure wind speed in order to generate a high quality reference wind speed dataset. Such data can significantly reduce the duration and cost of wind projects (International Energy Agency 2013) (Footnotes 1 and 4).

> ADB's Quantum Leap in Wind Program is funding long-term wind measurement campaigns in Mongolia, the Philippines, and Sri Lanka.

> The World Bank's ESMAP program funds long-term wind measurement and country-wide resource mapping in 10 countries.

6.2.2 Grant/Loan Program for Project-Specific Wind Resource Assessment (WRA)

46. In emerging wind markets, private seed investments are not available to fund the development (feasibility) phase of a wind project. Because wind power is new to a country, investor and developers are cautious and unwilling to fully fund the development phase. In most cases, feasibility is performed

on a shoestring budget. Often, first-time developers take shortcuts with wind measurement—use shorter met-tower, use uncalibrated and lower accuracy instruments, do not replace damaged or faulty instruments, and do not pay attention to data processing and data recovery. Invariably, these shortcuts delay the project because financiers require a rigorous WRA. For a first time wind project developer, the WRA activity may seem too long and expensive--typical length of WRA for a medium wind farm of size 20 MW or higher is 2+ years at a cost of approximately $150,000 (for two measurement towers).

47. A policy prescription to accelerate wind development is to provide grants or low interest loans to qualified developers for the WRA stage of a wind project. The grant/loan program may be used as a vehicle to improve the quality of wind measurement by private developers. Following is a list of possible avenues:

a. Use international wind energy experts to review the grant/loan applications.
b. Publish a checklist that covers the following aspects of a measurement campaign: Location, personnel, instruments, installation and operations and maintenance. A grant/loan application should be required to follow the checklist.
c. Require a meteorologist or climate scientist on the team with experience in onsite measurements.

48. Encourage partnership with in-country research organizations, with the goals of both injecting scientific rigor in measurement and enhancing the capabilities of the scientific community within the country.

6.3 Continuous Improvement

49. Developers in emerging wind markets rely on meso-scale wind resource maps (WRM) that were developed in late 90s or early 2000s by NREL, SWERA of UNDP, ESMAP of World Bank, Global Atlas of IRENA, and other international agencies. These WRMs have a resolution of about 5 kilometers. In countries with poor quality on-ground measurements, WRMs may have an annual energy production accuracy of ±50%. When these WRMs are used to prospect for sites with good wind resources, large numbers of false starts occur—the initial sites selected for wind farm turn out to have lower wind resource after no-ground measurement. This increases lead time and development cost.

6.3.1 Develop and Frequently Update Meso-scale Wind Resource Maps

50. The first policy initiative is to update old WRMs with the best upper atmospheric data, high quality measurement data and advanced wind flow models. Furthermore, it is recommended that WRMs be updated at least once every 5 years, if not sooner, with as much measurement data as possible.

> In the Philippines and Mongolia, significant discrepancies were found between wind resource maps of the past two decades and subsequent onsite met-tower measurement.

51. 3Tier and AWS Truepower have produced online WRM for most regions of the world. These maps are available for a fee. In addition, users can request hourly wind speed data for past 30-plus years at hub heights (for example 80 or 100 meters) from three datasets. All three datasets are interpolated to a common 5Km grid, common height and hourly timeframe.[4] The three datasets are:

a. Downscaled NCEP/NCAR Global Reanalysis;

b. ERA-Interim Reanalysis Product from the European Center for Medium-Range Weather Forecasts; and

c. MERRA, a NASA Global Reanalysis Product.

52. Although the accuracy of 3Tier and AWS Truepower is better than WRM from two decades ago, it is often lacking because the ground measurement data (from tall met-masts) required to validate the models is unavailable. Measurement data with met-masts that are 50 meters or higher, with anemometers at two or three levels is extremely valuable for meso-scale modeling because it can significantly improve the quality of WRM.

> In Philippines there were large number of false starts—the sites selected for measurement, based on older WRM, did not pan out because the measured wind speed was much lower than the predicted wind speed.

53. The advantages of accurate WRM are obvious—wind developers use the most updated information to make decisions and pick regions for prospecting and locations for onsite measurement. This saves developers time and money by reducing the number of false starts.

7. LICENSING GUIDELINES

54. Licensing guidelines for wind projects are effective when designed with these goals in mind:

a. reduce lead time and cost of wind project development;

b. increase confidence in investors and developers that the path to successful development of project is known; and

c. encourage financially and technically capable companies to bid for licenses, as opposed to politically connected companies.

55. The following approaches are recommended for licensing in order to meet the goals:

a. Coordinated guidelines among multiple agencies—one-stop shop for licensing;

b. Transparent guidelines with detailed description of requirements, process and outcomes;

c. Allocation of licensing resources to serious applications—Projects that meet the rigorous criteria specified in licensing guidelines.

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[4] From 3Tier, http://www.3tier.com/en/package_detail/wind-time-series-and-prospecting-tools/

7.1 Comprehensive

7.1.1 One-stop shop

56. Single application for all (or most) licensing and permitting requirements to a single agency significantly reduces the burden on developers. This coordinating agency would provide all the information and support to project developers. Behind the scene, this agency would define the overall interagency workflow, track the flow of application and provide update on status of applications. An effective workflow will remove redundant activities, resolve conflicting requirements of departments/agencies/ministries and implement the priorities of the government. A one-stop shop is a utopia; however, less ambitious coordinating agencies can cut down on the time and cost of the development phase of a project.

> In Denmark, the Danish Energy Agency acts as the one-stop shop for licensing of on- and off-shore wind farms. It has significantly reduced the lead time for development, as a consequence Denmark leads in wind energy development.

> In a limited way, the US Federal Aviation Administration (FAA) provides tools for Obstruction to Airport Airspace analysis, screening tools for impact to long-range air defense and homeland security radars, weather radars, military training routes, and special airspace.

7.1.2 Types of One-Stop Shops

57. There are various degrees of one-stop shop: minimalist, intermediate, and comprehensive.

a. a minimalist approach would be web-based dissemination of information with the goal of achieving transparency in licensing (Curren et al. 2009);
b. the end-to-end process with details about each activity in the process;
c. activity details include requirements, prerequisites, approval timeframes, and criteria for approval;
d. central government's licensing/permitting requirements and points of contact;
e. regional licensing/permitting requirements and points of contact; and
f. incentives available for wind development.

58. An example of an intermediate approach is setup of single agency to issue permits related to aviation, radar and telecommunications. A wind farm needs approvals from:

a. aviation authorities about obstruction to airspace;
b. various military and civilian agencies about interference with military, weather, and other radars; and
c. telecommunications agencies about interference with microwave signals and variety of radio and television signals.

59. All these agencies require information about the layout and total height of turbines in a wind farm. In a limited way, the US Federal Aviation Administration (FAA) provides online tools for Obstruction to Airport Airspace analysis, screening tools for impact to long-range air defense and homeland security radars, weather radars, military training routes and special airspace. After this preliminary analysis, formal analysis request may be filed with the National Telecommunications and Information Administration (NTIA), which acts as a one-stop clearinghouse for developers to reach many interested federal agencies—Department of Defense, Homeland Security, and Weather Radar Operations Centers. The NTIA forwards the proposal request to all the agencies for each to perform a case-by-case analysis at no cost to determine the potential for adverse impacts.

60. A comprehensive approach to one-stop shop entails coordination across all agencies like the:

a. Ministry of Power and/or energy regulatory authority to obtain generation license;
b. Ministry of Environment and/or Environmental Protection Agency to obtain environmental clearances based on Environment Impact Assessment. This would cover impact on local flora and fauna, migratory birds, wetlands and others;
c. Ministry of Finance to qualify project for incentives, procure import licenses, seek exemption from custom duties and others;
d. Department of Transportation to seek approval for transporting large equipment and parts to wind farm site;
e. Local zoning and land use agencies to obtain permits to use of land for energy generation. If wind farm is on government land, then lease of government land;
f. Regional government and municipal to obtain permits for land clearing, construction permits for roads, wind farm, transmission lines and other infrastructure.

61. The above list is country, region, and municipality specific. A comprehensive approach is therefore challenging in any country with layers and large number of jurisdictions.[5]

7.2 Certainty for Long Term

7.2.1 Criteria for Issuing Licenses

62. The licensing guidelines should encapsulate the best practices of wind project development. The criteria for issuing licenses should be rigorous and transparent. Such requirements not only cull out weak developers, but also attract foreign and domestic capital because financiers have a higher degree of confidence in the readiness of a project. In most developing countries, wind project generation licenses are issued with little due-diligence resulting in a pipeline that is clogged with large number of low quality projects. The low-quality projects are unlikely to be funded; nevertheless, these projects consume significant amount of licensing resources. As a result of which, even high-quality projects are slowed down by the bureaucratic process.

[5] https://energypedia.info/wiki/Permits_-_Wind_Energy#One-Stop_Shop.5B1.5D

An example of criteria for issuing licenses is requiring, a detailed WRA which contains the following:

a. At least 1 year of onsite wind measurement data with met-tower with a height of at least 60 meters and calibrated and high quality anemometers at 3 heights.
b. Computation of Annual Energy Production (AEP) based on linear wind flow model for simple terrain, or CFD model for complex terrain.
c. Computation of long-term correction of AEP to account for annual variability of wind climate.
d. Estimation of site-specific losses and uncertainty.
e. Estimation of extreme wind speed in order to select a class of turbine suitable for the site.
f. Financial feasibility of project based on the above data.

63. Provisional or temporary licenses may be issued for conducting a measurement campaign for a wind project, but a generation license must be reserved for projects that are bankable.

> Licensing guidelines in Mongolia, the Philippines, and Sri Lanka are lacking. It does not have requirements related to the key components of WRA.

7.3 Continuous Improvement

64. Licensing guidelines should be updated as the licensing agency learns about the effectiveness of licensing requirements. Often a clear picture of licenses and licensing requirements does not emerge until initial set of licenses are issued. A periodic review with developers can achieve the goal of simplifying the licensing process.

8. PUBLIC AWARENESS AND HUMAN RESOURCE DEVELOPMENT

65. Public awareness and human resource development should be an integral part of wind energy policy. There are a few persistent misconceptions about wind energy that must be addressed early on and in a systematic manner in order to avoid delays in wind development. Human resource development is another key component of policy because it ensures that most of the economic benefits related to employment, consulting services and others that accrue from the wind industry are realized by the country.

8.1 Comprehensive

66. In emerging wind energy markets in Asia, a few of the common drivers for wind energy are:

a. lack of electricity—higher demand compared to generation;
b. energy security—reliance on imported fossil fuel;
c. GHG emissions—electricity sector is one of the biggest or the biggest source of emissions.

67. Given these and other drivers it is imperative that a strong case be created with input from all stakeholders and the case be communicated to the public to justify higher incentives or higher level of public investments. The most common points of oppositions to wind projects that the public engagement should address are:

a. Cost of wind energy. In most emerging wind energy countries, FiT is higher than the price of electricity paid by consumers. Therefore, cost becomes the main argument against wind energy. The fallacy of this argument must be communicated to the cynics of wind energy and to the public at large.

   i. A comprehensive comparison of cost of wind energy and cost of existing fossil-fuel based generation, in which all the subsidies and external costs are taken into account. Several studies pertaining to subsidies and external cost (Kitson et al. 2011) of fossil-fuel based electric power generation provide a methodology for performing country-specific computation. This computation and analysis must form the basis for the public awareness campaign. Typical list of subsidies in fossil-fuel generation are: (i) sale of raw material like coal, diesel, gas, and others to electricity generation facilities at below prevailing market price; and (ii) government loans and guarantees, public funding of construction, regulatory support, and others. Typical components of the external costs of fossil-fuel generation are: (i) climate change damage costs associated with CO_2 emissions due to generation and the entire supply chain including mining and transportation of fuels; (ii) damage costs (such as impact on health, crops, etc.) associated with other air pollutants (NO_x, SO_x and others) in generation and the entire supply chain including mining and transportation of fuels; (iii) damage costs associated with consumption of freshwater and discharge of hot water into rivers by fossil-fuel and nuclear power plants; and (iv) nonenvironmental social cost.

   ii. Assign value to other benefits associated with wind energy like no variability in price of electricity, and energy security.

b. Environmental impact of wind energy. Although the environmental impact of wind energy is minimal compared to fossil-fuel based energy, wind energy may have some adverse impact on migratory birds and wildlife. Often this impact is exaggerated. This should be addressed by requiring environmental impact assessment that meets international standards. As a follow up to assessment, mitigation strategies must be designed to minimize impact on environment. An example of a mitigation strategy is curtailing wind production in the migratory bird season during hours when there is bird activity. From a public awareness standpoint, a campaign should be designed that provides a balanced view about the impact of wind energy: List of benefits to the environment; quantification of the tangible benefits where possible; list of the adverse impacts; mitigation strategies for the adverse impacts; and quantification of the adverse impacts after mitigation.

c. Impact on culturally sensitive and/or pristine areas. This should be addressed by requiring visual and cultural impact assessment that meets international standards.

8.2 Certainty for Long Term

8.1.1 Human Resource Development

68. All three phases of a wind energy project require specialized skills: development phase, construction and installation phase, and operations and maintenance phase. In most emerging wind energy markets, the talent required for each of the three phases is imported. A policy to develop the

scientific, engineering and management talent promises to provide significant economic impact to a country. The policy may take the form of:

a. Investment in research universities in the areas of meteorology, fluid dynamics, aerodynamics, power engineering, and others. An effective way to develop wind energy talent would be provide research grants to universities to (i) manage long-term wind measurement campaigns, (ii) conduct meso-scale wind flow analysis and computational fluid dynamics studies, (iii) conduct system-wide grid integration studies to assess impact of wind energy, and others;

b. Investment in undergraduate education and vocational education in a variety of areas related to wind engineering—mechanics, electricians, civil works, crane operators, and others.

Center for Wind Energy Technology (CWET) in India was established in 1998 to promote R&D. It has managed wind measurement, wind resource mapping, turbine certification and training of wind professionals. CWET is one the catalysts for 20.1G W of wind capacity installation in India (as of end of 2013), the fifth largest in the world.

69. In emerging countries with prospects for significant wind energy development, human resource development should be an integral part of wind energy policy.

8.3 Continuous Improvement

70. Public awareness and human resource development policies should be updated with input from all the stakeholders as issues arise in the two areas.

9. CONCLUSIONS

71. A framework for wind energy policies is developed, which may be used for creating country specific wind energy policies. The policies are derived based on QLW's work in Mongolia, the Philippines, and Sri Lanka, and experiences in other Asian countries.

It is important to note that there is no "silver bullet" or "one-size-fits-all" wind energy policy. The framework provides a methodology for a country to review its current wind energy policies and understand the gaps. The country may then develop policies to fill the gaps based on country-specific analysis using factors and approaches described in the framework.

72. The wind energy policy framework contains five components.

a. Incentives—supply-side and demand-side incentives should be part of a policy.

b. Grid integration—policies for integrating wind energy into the grid with upgrades to power systems infrastructure and systems operations.

c. Wind resource exploitation—policies for exploiting the wind resource in a manner that minimizes the system-wide cost as opposed to just the generation cost.

d. Licensing guidelines—policies like one-stop shop for licenses, approvals, and permits.

e. public awareness and human resource development—campaigns that address misconceptions of wind energy and policies that support human resource development for the wind industry.

73. Often the focus is on policies related to incentives. Although incentives are necessary, they are not sufficient for sustainable development of wind projects.

There are many stakeholders in wind energy development: project developers, financiers, offtaker (or buyer) of wind energy, transmission company, grid operator, energy regulatory body and other licensing agencies, ministry responsible for power and energy, and others. The five components of policy framework address the needs of the stakeholders. In addition to the components, the policy framework defines three overarching drivers for effective wind energy policies.

a. Comprehensive—each of the five components should balance the competing needs of stakeholders.
b. Certainty for long-term—initial wind projects can take about 5 years from concept to commissioning in emerging wind markets, so long-term policy certainty is required in each component of policy for sustainable development of wind projects.
c. Continuous improvement—policies must be constantly refined in response to results and changing conditions.

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Policy Enablers for New Wind Energy Markets

Accelerating wind development in new wind energy markets will require strong policy enablers in the areas of tariff, wind resource exploitation, grid integration, licensing, and others. This paper provides lessons learned from developed wind markets and three new markets—Mongolia, the Philippines, and Sri Lanka.

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