Discussion Paper No. 3

Economic Commission for Europe

Committee on Sustainable Energy

Group of Experts on Renewable Energy

First Session
Geneva, 18–19 November 2014
Item 5 of the provisional agenda
Best practices in renewable energy in the United Nations Economic Commission for Europe region

A Framework for Developing Best Practice Guidelines to Accelerate Renewable Energy Uptake[1]

Contents

[1] The designations employed and the presentations of the material in this paper do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This paper has been issued without formal editing. Mention of firm names and commercial products does not imply the endorsement of the United Nations.

I. Introduction

The Group of Experts on Renewable Energy (GERE) is mandated to carry out concrete, results-oriented activities that help significantly increase the uptake of renewable energy in the region and that help achieve the objective of access to energy for all in the United Nations Economic Commission for Europe (ECE) region, in line with the “Sustainable Energy for All” Initiative of the United Nations Secretary General. Among various activities, the Group of Experts will encourage the exchange of know-how and best practices between relevant experts of all member States on how to significantly increase energy production from renewable sources as a means of sustainable development and climate change mitigation.

Despite unprecedented growth of renewable energy (RE) as a mainstream energy resource, the implementation of RE technology is not happening fast enough, or at the scale necessary to achieve global commitments for a low-carbon future. The potential for RE to meet current and future energy demand is not realized, and in some cases underestimated, due to a suite of multidimensional barriers. Implementation of supportive policy measures, focused on eliminating or minimizing these RE barriers is necessary if nations want to achieve affordable and clean energy services.

What framework conditions support overcoming RE barriers? What are the specific elements of barriers that impede the RE market? What is generally the most effective way to develop and implement RE projects in the ECE region? Answering these key questions is imperative for developing RE best practice guidelines. This paper proposes a *best practice framework* for developing effective RE best practice guidelines in the ECE region using a bottom-up approach. This is an alternative to the often centralized top-down approach towards RE practices. More specifically, this framework offers a de-centralized analysis of RE challenges, opportunities to overcome each, and examples of policy-driven success stories, best practices, and lessons learned that lay the groundwork for accelerating RE uptake (Figure 1).

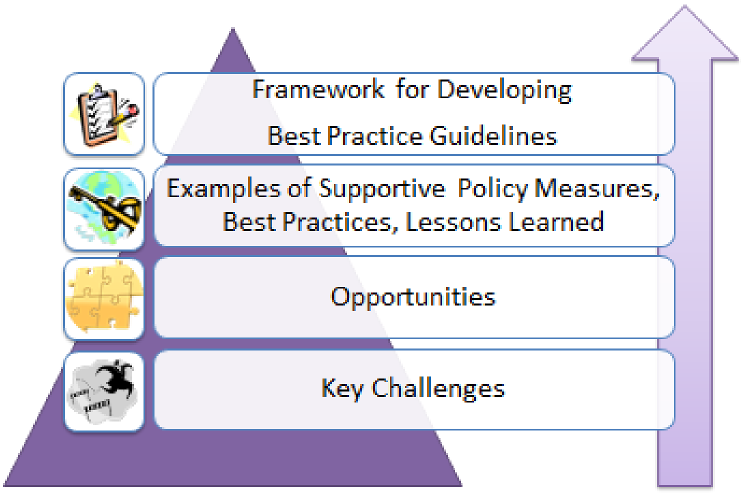

Figure 1. Schematic of *Best Practice Framework*, a bottom-up approach for developing best practice guidelines.

The goal of this report is to unravel the details of developing and implementing RE projects the ‘right ways’, thus increase understanding on how varying nations may contribute to a common set of goals using *different* approaches. The following chapters outline the elemental challenges and opportunities within three specific RE dimensions, technical, structural, and social. The report concludes with a matrix for each RE dimension, which is used as a tool to highlight supportive policy options for overcoming specific RE challenges. For consistency, each matrix is organized by the type of policy instrument. The following research and matrices are not exhaustive, and require refinement from member States and stakeholders. Nonetheless, establishing a preliminary framework for designing RE best practice guidelines will enable:

(1) *Identification* of appropriate cross-boundary challenges and opportunities within RE dimensions
(2) *Consideration* of the design and implementation of supportive measures addressing RE challenges
(3) *Adaptation* of appropriate policy mechanisms to unique national situations
(2) *Progression* towards developing national action plans that support significantly increasing RE uptake

II. Challenges & Opportunities

1. Technical Dimension

Regardless of socio-economic conditions, there are key technical limitations that apply generally for every country. The most commonly cited technical challenge to RE uptake is the reliability of renewable energy sources. While RE is characterised by low marginal operating costs for certain technologies such as solar or wind, natural resource intermittency creates a myriad of challenges to the industry. Further, though RE resource potentials are often significant, the amount of RE that is actually transformed into usable energy may only be a small fraction of the potential. Given the high up-front capital costs of developing RE potential, such impediments related to the reliability of RE may discourage uptake.

To ameliorate the reliability of RE, a holistic view of the RE technical dimension is necessary. Inconsistent RE terminology, data quality and quantity issues, low global project efficiency, and complications that arise from integrating RE power into the electricity grid are elemental technical challenges that impact the economies of energy markets and deter investment (Figure 2). Investigating the intricacies of the RE industry's technical dimension elucidates high-impact opportunities to overcome challenges and accelerate RE uptake.

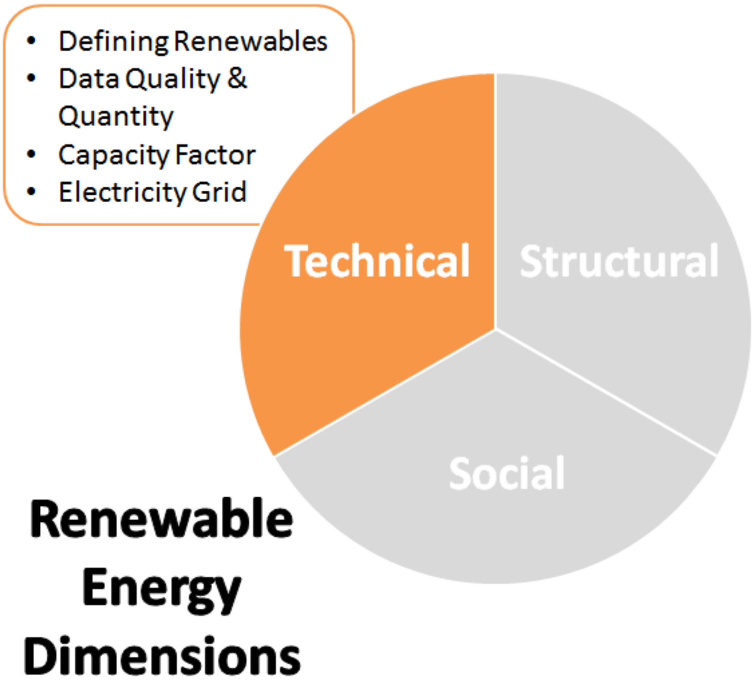

Figure 2. Elements within the technical dimension of renewable energy challenges and opportunities.

- **Defining Renewables**

In order to target best practice areas, it is important to have a common understanding of RE terminology. While there is generally a broad consensus that renewable energy refers to energy sources that are naturally replenished, there is no universal definition on which *types* of energy sources are considered renewable.[2] Traditional biomass represents nearly half of the 18% global share of RE. However, traditional biomass may not be considered sustainable because widespread extraction of wood slows the forest's natural rate of carbon sequestration. The extraction of biomass may lead to deforestation and localized air pollution when the biomass is burned for cooking purposes.[3] Similarly, hydropower, the second leading RE technologies in the global energy mix, is also not unanimously considered renewable[4]. The environmental impacts of traditional or 'big hydropower' on fisheries and water flows leave long lasting impacts and raise questions regarding the sustainability of this technology. Moreover, 'big hydropower' relies on the natural water cycle, which can be disrupted from unpredictable weather and the future impacts of climate change.

Modern biomass and *small* hydro are used to describe sustainable practices for biomass and hydropower; however, such terminology is not universally accepted leading to an aggregation of both sustainable and sustainable practices in indicators. The SE4All Global Tracking Framework[5] report recognizes the "need to develop internationally agreed-upon standards for sustainability for each of the main [RE] technologies which can then be used to assess the degree to which deployment meets the highest sustainability standards". Renewable energy targets may change dramatically depending on the RE definition used.

<u>Opportunities</u>

Renewable energy technology standards provide a platform for certification and marketability of high-quality products. In addition to RE equipment and project procedures, standards may also provide a foundation for RE terminology. The International Organization for Standardization (ISO) represents a global network of national standard institutes and works to design *voluntary* international RE standards ranging from energy management to specific RE resources.[6] Similarly, the International Electrotechnical Commission organizes numerous committees to address RE technical performance, certification schemes and technology safety standards. Joint efforts by the ISO and IEC to harmonize common international RE definitions and develop RE terminology standards are on-going.[7] In particular, their work developing RE resource sustainability criteria and measureable sustainability indicators for bioenergy are examples of concrete activities that mitigate ambiguity in RE resource terminology.

[2] UN Sustainability For All: Overview Global Tracking Framework 2013 (http://www.iea.org/publications/freepublications/publication/global-tracking-framework.html)
[3] RE traditional biomass vs. Modern biomass
[4] Renewable Energy Policy Network for the 21st Century: Renewables 2014 Global Status Report (http://www.ren21.net/ren21activities/globalstatusreport.aspx)
[5] UN Sustainability For All: Overview Global Tracking Framework 2013 (http://www.iea.org/publications/freepublications/publication/global-tracking-framework.html)
[6] http://www.iso.org/iso/home/standards_development/list_of_iso_technical_committees/iso_technical_committee.htm?commid=585141
[7] ISO & Energy: Working for a cleaner, sustainable future 2012 (http://www.iso.org/iso/iso_and_energy.pdf)

- **Data Quality and Quantity**

Data quality and quantity challenges add to the complexity of designing effective RE policies that reflect achievable and affordable RE targets. In order to properly assess the feasibility of RE projects, timely, appropriate, consistent and reliable data are necessary. Although a plethora of international organizations are dedicated to RE resource and policy data collection[8], information gaps and data inconsistency in the ECE region are prevalent.[9]

As a foundation, an accurate picture of the share of renewable energy resources in the national energy mix is necessary. However, methodological differences in calculating RE resources indicators are a reality (biomass vs. traditional and modern biomass or hydropower vs. big and small hydropower). RE indicators may also not be available in an immediate timeframe, due to the lengthy data gathering process. The reliability of RE indicators, particularly in cases when it is believed to not exist, is another particular data challenge facing the industry.[10] Likewise a comprehensive picture of RE policy and framework implementation is needed to share best practices and lessons learned. The observed discrepancies between policy datasets aimed to deliver the same information create challenges in maintaining a reliable source of comparable information on effective measures for increasing RE uptake. Finally, accurate and consistent data on RE costs or RE levelized cost of electricity (LCOE) would be beneficial for evaluating a RE policy's *impact* on the overall competiveness of various RE technologies.

When evaluating challenges surrounding RE indicators, it is also important to consider the quality and quantity of tangential data sources that may also be appropriate for developing effective long-term RE frameworks. Trends in energy supply and demand are relevant for RE target setting as population growth and development will modify a fundamental component in the calculation of renewable energy 'share'. In other words, the total *pie* of total final energy consumed will grow contemporaneously with increased renewable energy consumption. The consideration of reliable energy demand forecasts at the national level may be important for drafting renewable energy consumption targets.

A theoretical plan to power the entire world with renewable energy has been demonstrated[11], yet information gaps exist regarding RE resource potential at the regional, national and local level. Typically, once a RE project is chosen for development, experts perform in-depth analysis on the viability of the resource potential. However, prior to this stage there is limited information or a reliable 'first look' of RE resource potential. Understanding resource potential also implies understanding characteristics beyond natural elements of renewables (sunlight, wind, waves, etc.). Therefore, RE potential data in tandem with information on population density, topography, land use and protected areas is needed to provide insight on RE project feasibility prior to the development of supportive policy mechanisms.

[8] Report on selected international actors on renewable energy in the ECE region may be found : http://www.unece.org/index.php?id=35377

[9] Discussion Paper Number 1: Status Report on Renewable Energy in the ECE Region (http://www.unece.org/index.php?id=35377#/)

[10] Discussion Paper Number 1: Status of Renewable Energy in the ECE Region (http://www.unece.org/index.php?id=35377#/)

[11] Jacobson, Mark Z., and Mark A. Delucchi. "A plan to power 100 percent of the planet with renewables." *Scientific American* 26 (2009).

Electricity infrastructure varies by nation; thus strategies to integrate potential RE technologies into existing energy architecture may not be universal. However, the cross-border exchange of experience regarding smart grid technical solutions and electricity market design, are recommended to improve the flexibility, regularity and reliability of the grid.[12] General data indicating the scope of national centralized and decentralized grid infrastructure, the roles and responsibilities of transmission and distribution operators (TSO or DSOs), as well as those communities not connected to the grid would accelerate this exchange of know-how and capacity building regarding optimal RE electricity delivery.

Opportunities

Renewable energy technology and policy data sources may lack thoroughness in the provision of information. The rise of specialized RE international organizations, represent an opportunity to fill RE technology and policy specific data gaps and improve existing quality. For example, the World Bioenergy Association (WBA) is the leading global bioenergy expert, with the goal to promote the use of sustainable of bioenergy. Since its inception in 2008, the organisation has significantly contributed to a more complete picture of national bioenergy statistics, including work on the global potential and certification criteria for sustainable biomass for energy.[13] Similar associations for other RE technologies[14] also contribute to championing data improvements and sustainable practices in their respective sectors. Launched in 2005, the Renewable Energy Policy Network for the 21st Century (REN21) cooperates with leading international RE organizations to accelerate RE uptake with a distinct focus on policy development.

The International Energy Agency's (IEA) World Energy Outlook (WEA), provides an annual projection of future energy demand/supply and is often used for informing public and private stakeholders' policy, planning and investment strategies to accelerating sustainable energy. The data is updated annually, available on the national level and may be helpful for planning long-term policy frameworks.

Efforts to significantly improve RE resource potential indicators are being realized through International Renewable Energy Agency's (IRENA) Global Atlas Project.[15] Created with feedback from over 65 countries, the Global Atlas Project provides a global map of national RE resource potential based on climate and scientific parameters (wind speed, cloud-cover, etc.). This objective, high-quality, visualization of RE resource potential may also be overlaid with additional information such as population density, topography, protected areas, and infrastructure, to aid users in identifying favourable areas for further RE project inquiry. Future work integrating economic calculations (RE costs) will assist in assessing RE resource potential and the competiveness of RE technologies.

[12] World Smart Grid Forum 2013: Results and Recommendations 2013 (http://www.iec.ch/about/brochures/pdf/technology/WSGF2013-results-and-recommendations.pdf)

[13] World Biomass Association Position Paper: Certification Criteria for Sustainable Biomass for Energy, Global Potential of Sustainable Biomass for Energy (http://www.globalbioenergy.org/bioenergyinfo/sort-by-date/detail/fi/c/39210/)

[14] International Hydropower Association (IHA), International Solar Energy Society (ISES), International Geothermal Association (IGA), and World Wind Energy Association (WWEA)

[15] http://globalatlas.irena.org/Publication.aspx

A similar tool for assessing the current and future supply of renewable energy resources is being considered by the UNECE Group of Experts on Framework Classification as they assess the opportunity to extend the UN Framework Classification (UNFC-2009) application to RE (currently only available for fossil energy and mineral reserves and resources). The UN Framework Classification (UNFC-2009) provides an operational internationally applicable scheme for classifying resources based on economic and social viability (including markets and policy frameworks), project feasibility and geological knowledge. A resource classification for RE would provide a uniform system to ensures all global RE resource potential are understood with a high-degree of confidence and would establish an appropriate level of project consistency, regardless of the commodity.

Finally, in terms energy infrastructure data and capacity building for optimal RE integration, the Electric Power Research Institute's Smart Grid Demonstration Project[16] is conducting several regional smart grid demonstrations that showcase opportunities to integrate RE energy resources at a system-wide scale, defining requirements for the technologies themselves as well as the communication, information, and control infrastructures that support integration of the technologies.

- **Capacity Factor**

RE capacity reflects the ability for a certain technology to provide energy. In the policy arena, RE targets and standards are often measured based on *installed capacity* and may be specified for certain energy sectors. Although tracking RE installed capacity is appropriate for monitoring incremental progress, it provides little insight into *how fully a RE unit's capacity is utilized*, masking important realities of optimizing RE projects.

Specifically, a RE's installed capacity represents the maximum power output of a generating unit, typically in megawatts (MW) and does not reflect the *actual energy* produced, measured in megawatt-hours (MWh) per given year. Rather, the RE electric generation *capacity factor* describes how often RE is putting electricity on the grid, and is expressed as the ratio of the RE unit's actual energy output (MWh) to its maximum possible output (MW) (installed capacity). Capacity factors vary significantly by fuel type. For new RE electricity projects, high capacity factors are more attractive since the owner has a greater opportunity to recover return on investment, thus a lower energy price to ratepayers. Capacity factors for *existing* RE projects are also insightful, and elucidate opportunities for certain RE resources to provide more power to the grid and to reduce output from conventional fuels as RE prices fall and/or more capital is needed for conventional fuels to meet environmental compliance.

Despite technology developments and innovation, RE capacity factors may fall well below state-of-the-art-levels. Reasons for low or declining RE power capacity factors are multifaceted, but are mainly related to maintenance performance issues, such as equipment failures, routine maintenance interruption, curtailment of electricity output because it is unneeded and/or electricity prices falling below actual cost for generation. Due to the intermittency of RE such as solar, wind and hydro, and limited large-scale energy storage technology, the capacity factor may also be determined by the availability of the resource (sunlight, wind blowing, water), transmission line capacity, as well as plant/project design.[17]

[16] http://smartgrid.epri.com/Demo.aspx
[17] The Energy Collective: What are the Capacity Factor Impacts on New Installed Renewable Power Generation Capacities? http://theenergycollective.com/jemillerep/450556/what-are-capacity-factor-impacts-new-installed-renewable-power-generation-capaciti

International standard setting organizations assist in reducing uncertainty in RE project design, by recommending scientifically-sound resource assessment techniques of the potentially available RE resource. Depending on the project, by fulfilling the standard-set methodology for resource assessment, a RE project may be considered ‘bankable’ or robust enough (low uncertainty) for project financing. However, the declining trend of RE capacity factors, even at the global level,[18] raises concerns on whether standards are progressing at the pace needed to implement the innovation that provides the greatest reduction in project design uncertainties. In the offshore wind energy industry, research suggests standard requirements for mitigating wind project design uncertainties are different from data and analyses needed for successful offshore wind farm operations. Specifically, the pre-construction ‘bankable’ paths for ensuring low uncertainty and project financing are based on requirements that are “artificial, inadequate, and an artefact of limitations in our measurement opportunities that no longer apply”.[19]

For the ECE region, RE electric generation installed capacity has steadily increased, reaching 47.9% of global installed capacity in 2011. However, since 1991, the average RE electric capacity factor has declined by 5%.[20] Interestingly, the growth of RE installed capacity in the ECE region does not necessarily reflect improvements in capacity factors as member States with the smallest fraction of RE electric installed capacity have significantly higher capacity factors than member States with the lion’s share of RE electric installed capacity. Considering RE installed capacity in tandem with capacity factors exposes nuances embedded in mechanisms used to accelerate RE uptake. For the case of RE electric generation, further investigation into these issues by technology type would provide a more accurate representation on how the actual mix of RE electric generation compares to non-renewable resources and elucidate opportunities to increase RE power to the electric grid.

Opportunities

For specific RE technology projects that require financing for large up-front capital investments, such as utility-scale wind power, efforts to improve capacity factors focus on the optimization of project design/layout through better characterization of wind variability. For example, the impact of ‘non-standard’ inflow conditions on a wind turbine can lead to turbine underperformance, thus large discrepancies between the projected and actual economics of a project. The formation of technical working groups, such as the European Wind Energy Association ‘Power Curve’ Working Group, is an opportunity for wind energy stakeholders to exchange best practices for improving capacity factors.

Through dissemination of state-of-the-art technology standards and resource characterization techniques, international standard setting organizations are key players in paving the road to reduce uncertainty in RE project design. However, standardization efforts also require dedication to keep pace with developments in a variety of fields. The reality of omission and therefore incompleteness in standards for optimizing RE project

[18] Calculations made by UNECE Sustainable Energy Division using Global Tracking Framework database

[19] Squrr Energy: A unified approach to full Lifecycle wind assest compatibility with real world Wind Conditions 2014 (http://www.sgurrenergy.com/about-sgurr-energy/download-centre/webinars/)

[20] Calculations made by UNECE Sustainable Energy Division using Global Tracking Framework database

performance is acknowledged by academia and the private sector.[21] Efforts to advance certain industry-standard techniques that lead to sub-optimal project design, performance, and ultimately low capacity factors are on-going and will reduce uncertainty in RE project investments.[22]

- **Electricity Grid**

The explanations for why renewable energy uptake has been limited are often couched in a traditional utility perspective. RE sources of electricity deliver electricity to the grid much differently than fossil fuel power plants. While the costs of RE technologies are decreasing, additional costs incurred by the inability of existing power grids to accept dynamic power from decentralized, distant, and intermittent RE sources poses a significant challenge to increasing the uptake of RE.

Electricity produced from RE sources is usually inconsistent and unpredictable. Non-hydro RE resources such as wind and solar are the most common RE used for centralized electricity grid generation but solar panels and wind turbines can only produce electricity when there is sufficient solar and wind resources. These technologies lack the ability to match grid demand the same way a coal fuelled power plant can simply combust more coal to produce more electricity. This intermittency presents a distinct set of challenges for generation owners and grid operators (utilities). Specific challenges related to intermittent RE grid integration may be categorized by non-controllable variability, partial unpredictably, and location-dependent.

The effects of the natural variability in wind and solar resources (such as from a cloud passing over a solar panel or a drop in wind speed) and its effect on grid operations is regarded as non-controllable variability. This fluctuation in power requires additional services for frequency regulation and voltage support to balance the instantaneous demand. According to the IEC, “On the seconds to minutes scale, grid operators must deal with fluctuations in frequency and voltage on the transmission system that, if left unchecked, would damage the system as well as equipment on it.’’. In some cases, operator responsibilities can become particularly difficult when large demand shifts occur contemporaneously with weather events that alter power output from wind or solar resources. While these are not completely novel problems for operators, as even conventional resources need services to handle variable energy loads, the additional variability introduced by high penetrations of intermittent RE significantly increases the demand for such services.[23]

A third obstacle associated with RE grid integration is partial unpredictability**,** referring to the industry’s inability to accurately predict the availability of intermittent RE resources like solar or wind on the timescales of an hour to day ahead. This challenge is particularly significant for grid management activities or ‘unit commitment’, which involves scheduling energy generation hours to a day ahead of time in order to meet the expected grid load. Since conventional resources such as coal, gas and hydropower are relatively predictable and controllable, the process of ‘unit commitment’ and the

[21] Wind Power: Capacity Factor, Intermittency, and what happens when the wind doesn’t blow? Wind Energy Center, University of Massachusetts Amherst (http://www.umass.edu/windenergy/publications/published/communityWindFactSheets/RERL_Fact_Sheet_2a_Capacity_Factor.pdf)

[22] Squrr Energy: A unified approach to full lifecycle wind assest compatibility with real world Wind Conditions 2014 (http://www.sgurrenergy.com/about-sgurr-energy/download-centre/webinars/)

[23] (http://www.iec.ch/about/brochures/pdf/technology/WSGF2013-results-and-recommendations.pdf)

calculation of reserves needed are more certain. This inability to accurately predict future RE generation introduces complexities into the traditional ‘unit commitment’ activity that can lead to over generation and under generation peaks. Such generation fluctuations widen the gap between actual energy production and production *prediction* and also increase managing costs at the expense of the ratepayers (or government subsidies put in place).

Further, because RE resources are location-dependent, transporting energy from RE resources in remote areas to regions of concentrated demand introduces supplementary integration obstacles. Limited regional cross-border integration agreements make the necessary planning for RE transmission lines across political borders a contentious and complex process. Finally, due to a combination of limited grid flexibility and the traditional utility rate-based business model, energy may be wasted (i.e. forecasted for use but instantaneously not needed), yet still paid for at the expense of the ratepayer. The crux of this problem arises from the traditional rate-of-return regulation where the set of incentives do not align with electric grid efficiency or the integration of RE.

Opportunities

Methodological advancements to the RE ‘unit commitment’ process present opportunities to mitigate extra energy management related costs. These advancements are striving to “cost-effectively maintain sufficient flexibility on the system, such that the integration of RE resources neither exposes the system to unacceptable reliability risks nor overscheduled reserves in a way that unnecessarily burns fuel and emits pollution”.[24] Improvements in weather prediction technology and therefore the predictions of RE generation output on an efficient time-scale are also lowering the trickle down costs of RE to consumers. In addition, efforts to communicate weather forecasts properly so that grid operators may optimize the scheduling and dispatch of resources are also a work in progress.

The consideration of centralized vs. decentralised power generation is important for framing a discussion on RE integration opportunities. For centralized systems, grid flexibility may also be enhanced through cross-border RE integration activities, which ease transmission line obstacles as well as energy storage technology. In particular, the availability of inexpensive batteries would contribute immensely to improving integration, serving as either energy generation or load.[25]

Natural gas power plants also present opportunities to balance the impact of RE intermittency for centralized energy systems. Unlike coal plants, natural gas plants can be turned on and off relatively quickly creating a viable solution to fill supply gaps when RE supply is low. Research on the viability of natural gas to provide massive overproduction energy storage is also on-going. Specifically “power to gas” technology transforms the surplus of energy into a form that can be injected into the gas network, creating a bridge from the electrical system to the gas network.[26]

[24] IEC White Paper: Grid integration of large-capacity Renewable Energy sources and use of large-capacity Electrical Energy Storage 2012 (http://www.iec.ch/whitepaper/gridintegration/?ref=extfooter)
[25] IEC White Paper: Grid integration of large-capacity Renewable Energy sources and use of large-capacity Electrical Energy Storage 2012 (http://www.iec.ch/whitepaper/gridintegration/?ref=extfooter)
[26] NorthSea Power To Gas (http://www.northseapowertogas.com/documents)

The Green Gas Grids[27] project, co-funded by the Intelligent Energy Europe Programme of the EU, aims to upgrade biogas into biomethane. The advantage to using biomethane is that it may be fed into the natural gas grid, allowing the use of the energy from biogas in locations far away from where the energy is generated. The biomethane resource is introduced as an alternative to biofuels and will assist in achieving renewable energy targets. Since the production of biomethane may not equal national demand, a cross-border trading system could be established to provide a balanced market. While a cross-border trade of biomethane currently exists, it is very limited.

Decentralized, or distributed energy resources, in which energy is generated and used locally on a micro-grid provides one opportunity to improve grid flexibility. Microgrid technology would reduce the need for long-distance electricity transmission and would also contribute to lowering costs. Although microgrids are only referred at the distribution voltage level, there is potential for increased voltage capabilities and therefore the potential to comprise a greater capacity of existing power grids.[28] However, the decentralisation of power systems may also introduce significant challenges in meeting universal energy demand. Decentralisation can also magnify socio-economic issues in regards to the cost of re-designing existing infrastructure; thus, opportunities should be assessed and adapted given distinct national situation.

The performance-based ratemaking model is an emerging opportunity to respond to the need for a redesigned utility business model. Focused on “delivering value rather than accounting for costs”,[29] the model responds to the way electricity is generated and consumed. For example, when a utility’s performance metrics are high, it is allowed a higher rate of return. The goal of a performance-based ratemaking is to minimize costs, maximize reliability and environmental performance, and align the goals of customers, utilities and regulators.

Collectively, modernizing grid infrastructure system design, control strategies and energy business models present a cost-effective opportunity to achieve grid-friendly RE generation. Smart grid technology is touted as an opportunity to move forward, enabling both centralized and decentralized energy systems to respond digitally to volatile demand. Similar to the internet, digital smart grid technology allows for two-way information flows between utility, customers, transmission lines, and system equipment. The fiscal advantage of the smart-grid systems is well known, as they enable lower costs for both utilities and consumers.[30] However, additional advantages such as improvements in national energy security, increased awareness of electricity and the environment to consumers, as well as the opportunities to address aging energy infrastructure may be possible with smart-grid technology.

Finally, improvements in system-level integration standards, defining RE power plant performance and interaction with the existing power system, including requirements for the interconnection, design, modelling, testing, monitoring, control and operation are opportunities for optimizing RE integration. Efforts are on-going to update grid codes at

[27] http://www.greengasgrids.eu/
[28] IEEE : Microgrids : An emerging solution to combat reduced power reliability (http://www.eecl.colostate.edu/documents/Microgrids%20-%20An%20emerging%20solution%20-%20Article.pdf)
[29] http://www.utilitydive.com/news/can-performance-based-ratemaking-save-utilities/252683/
[30] http://www.sgip.org/

the national, industry-wide and grid company level.[31] However, greater standardization is needed and regularly updated to reflect advances in RE technology and grid-friendly RE integration.

The Smart Grid Interoperability Panel[32] (SGIP) aims to resolve interoperability coordination issues and gaps of smart grids in order to accelerate the digital modernization of the electrical grid. By expanding supplier and service provider markets in both the United States and internationally SGIP facilitates standards-based grid modernization. The SGIP organizes a catalogue of standards to help educate stakeholders on best practices and lessons learned.

[31] IEC White Paper: Grid integration of large-capacity Renewable Energy sources and use of large-capacity Electrical Energy Storage 2012 (http://www.iec.ch/whitepaper/gridintegration/?ref=extfooter)
[32] http://www.sgip.org/

2. Structural Dimension

The global increase in RE investments and relatively swift transformation towards cost-competitiveness between RE and conventional resources is evidence that access to affordable, reliable, and sustainable energy services is achievable. Similar to any maturing industry, the market may be expanded, price parity accelerated, and investments increased if sophisticated policies founded on long-term government commitments are developed. Unravelling the details of RE market failures, distortions, RE costs, financing, and effective policy design will elucidate high-impact opportunities to overcome structural challenges and accelerate RE uptake.

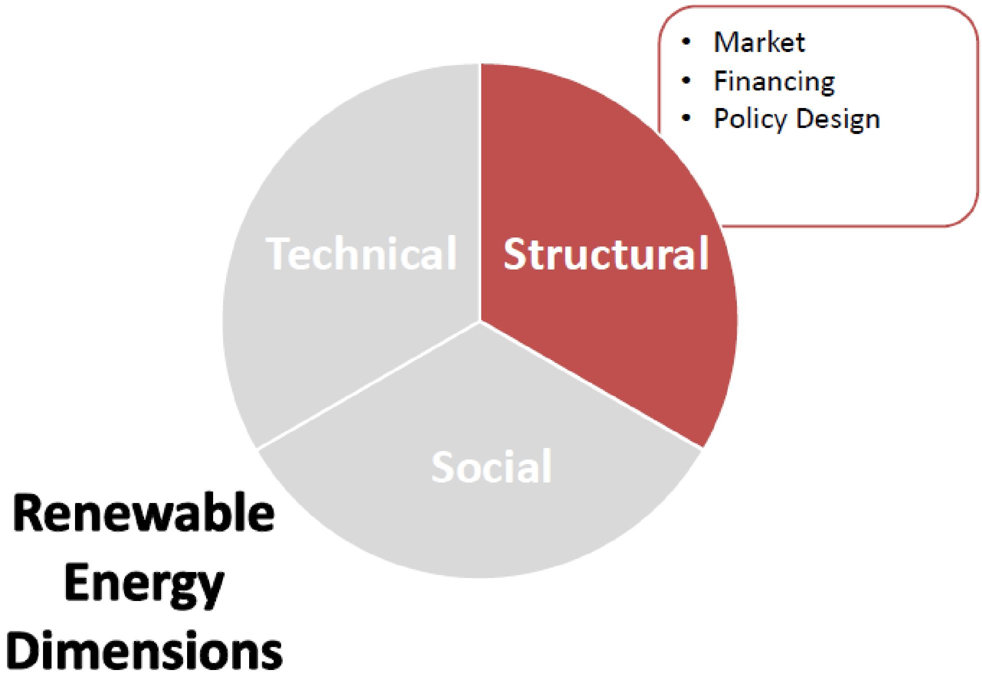

Figure 3. Elements within the structural dimension of renewable energy challenges and opportunities.

- **Market**

To a large extent, the RE market is a policy-driven market, making it particularly sensitive to falsification of supply and demand from sub-optimal incentive schemes. It has been postulated many times that achieving a strong RE market is challenging. Particular challenges arise from economic policies aimed to promote the positive externalities[33] of RE, but rather generate subsidized supply and compulsory demand. Part of this challenge arises from the complexity of getting the RE price "right", as it too is a function of supply and demand.

For the RE electricity market, the primary metric for calculating the cost of electricity produced by a generator is the Levelized Cost of Electricity (LCOE). Specifically, LCOE divides the expected project lifetime costs from start to finish (construction, financing, fuel, maintenance, taxes, incentives, etc.) by the system's lifetime expected power output. For the utility industry, LCOE is a critical financing tool for comparing and ultimately choosing a range of generation options with low uncertainty.[34] Ideally, if energy is being produced at low cost, LCOE will be low, and higher returns for the investor are plausible, with less costs passed on to the ratepayer.

Reaching price or grid parity with conventional energies is an important milestone for the RE industry. While price parity occurs when a RE resource generates energy at a LCOE less than or equal to the price of conventional sources, grid parity occurs when electricity is generated at a LCOE less than or equal to the price of purchasing electricity from the grid. Although the costs of RE have decreased in recent years, most notably the installed unit cost of photovoltaic systems and wind power,[35] reaching grid parity is particularly more complicated when integrating RE into existing centralized energy architecture that is primarily built for conventional energy sources.[36] The often-unanticipated additional costs arising from large-scale RE integration into sub-optimal energy architecture is another impediment to getting the RE price "right". Further, distortions in the market from unequal governmental fossil fuel incentives, high trade import tariffs on RE equipment and lack of consideration of fossil fuel externalities are limitations to the expansion of the RE market.

Finally, energy prices and market structures may vary by nation. While it is evident that some national RE energy markets face similar failures and distortions, others may be at less mature stages, and therefore encounter a different set of challenges. These energy market challenges may be related to gaps in the relevant RE information needed to base decisions for future growth.

Opportunities

The relationship between RE uptake and the scale of policy support is modelled by the IEA, which considers the market ramifications from a range of policy 'scenarios'. As expected, the more aggressive the set of policies to promote RE is, the greater the expansions of RE capacity. The Bloomberg New Energy Finance (BNEF) also forecasts global power demand based on detailed modelling of the electricity market, technology cost evolution and both national and regional policy. The BNEF's 2030 Market Outlook projects that by 2030, modern RE (excluding large-hydropower) will constitutes 20%

[33] increase supply and demand that generate external benefits
[34] Fraunhofer Institute: Levelized Cost of Electricity Renewable Energy Technologies 2013 (http://www.ise.fraunhofer.de/en/publications/veroeffentlichungen-pdf-dateien-en/studien-und-konzeptpapiere/study-levelized-cost-of-electricity-renewable-energies.pdf)
[35] IPCC (2011): IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. Prepared by Working Group III of the Intergovernmental Panel on Climate Change (http://srren.ipcc-wg3.de/report)
[36] Renewable Energy Advisors: http://www.renewable-energy-advisors.com/learn-more-2/levelized-cost-of-electricity/

(up from 5%) of global power generation. This is a significant increase and is result of a predicted average $362 billion in capital investments per year[37] through 2030.[38]

As technologies improve and the market succeeds in achieving economies of scale, the trend in declining costs will accelerate. Nonetheless, promulgating policies that foster long-term government commitment to the RE market through carbon pricing is another opportunity to catalyse green investment and increase the market share of RE. At the September 2014 UN Climate Leadership summit, China along with 73 additional countries, 22 states, cities and over 1,000 businesses and investors demonstrated support for carbon pricing by signing the *Put a Price on Carbon Statement.*[39] Together, the countries promoting expansion of carbon pricing represent over half of the global greenhouse gas (GHG) emissions and gross domestic product (GDP). Planning efforts are underway for national carbon trading systems with nearly 40 countries in development stages and pilot program implementation. The anticipation of carbon pricing is also witnessed in the private sector, where more than 150 businesses are incorporating internal carbon pricing into their decision-making processes.[40] Pricing carbon also creates an opportunity to increase the demand for innovation that reduces carbon emissions and prices the externalities of conventional energy sources.

The positive economic case for RE technology is becoming undeniable in both developing[41] and developed countries. Solar is leading the race towards grid parity. As a technology, rather than a fuel, solar power's improvements in efficiency are driving down costs, which are expected to undercut even the cheapest fossil fuels.[42] Solar is projected to be the world's largest single source of electricity by 2050,[43] which would create an enormous opportunity for the RE market.

Regarding trade tariff challenges, members of the World Trade Organizations (WTO) have begun negotiations on the possible liberalization of environmental technologies or "green goods".[44] Members are discussing ways to eliminate tariffs on environmental goods ranging from waste management to those that generate RE. If agreed upon, the *Environmental Goods Agreement* would provide an opportunity to eliminate unnecessary costs on expanding the market share of RE technologies as well as enhance the market for green good exporters. Finally, research suggests that policies designed to support a stable market for RE, coinciding with incentives for local RE technology manufacturing, are most likely to establish an internationally competitive market.[45]

[37] 2014 dollars

[38] Bloomberg New Energy Finance: Six Eye-Catchers in Our Picture of World Energy in 2030 (http://about.bnef.com/blog/mccrone-six-eye-catchers-2030-picture-world-energy/

[39] The World Bank: 73 Countries and over 1,000 Businesses Speak Out in Support of a Price on Carbon 2014

[40] The World Bank: 73 Countries and over 1,000 Businesses Speak Out in Support of a Price on Carbon 2014

[41] Financial Times: Developing countries begin to take lead in green energy growth 2014 (http://www.ft.com/intl/cms/s/0/4832b922-5de8-11e4-897f-00144feabdc0.html#axzz3IOAlah43)

[42] Bloomberg: While you were getting worked up over oil prices, this just happened 2014 (http://www.bloomberg.com/news/2014-10-29/while-you-were-getting-worked-up-over-oil-prices-this-just-happened-to-solar.html)

[43] IEA: How solar energy could be the largest source of electricity by mid-century 2014 (http://www.iea.org/newsroomandevents/pressreleases/2014/september/how-solar-energy-could-be-the-largest-source-of-electricity-by-mid-century.html)

[44] Joint Statement Regarding The Launch of The Environmental Goods Agreement Negotiations 2014 (http://eeas.europa.eu/delegations/wto/documents/press_corner/final_joint_statement_green_goods_8_july_2014.pdf)

[45] Earnest Orlando Lawrence Berkeley National Laboratory: Fostering Renewable Energy Technology Industry: An International Comparison of Wind Industry Policy Support Mechanisms

- **Financing**

Trends in RE installations are reflected in RE investments. The global capacity of wind power has increased over tenfold between 2000 and 2010.[46] However, the size of future RE investments depends on both falling costs of RE and the implementation of RE policies founded on a long-term commitments to sustainable energy services. Despite an increase in RE investment trends globally, the recent scaling back in some of the largest planned offshore wind farms in Europe is prevalent.[47] A redesigning of the way renewables subsidy budgets are managed is needed to bring down the RE costs. A RE developer summarizes their challenges stating,

> "The industry needs visibility of available budget much further ahead and assurance that it will grow into the 2020s, as well as availability in larger chunks. Without these changes, offshore wind will be more expensive that it needs to be."[48]

Many business groups echo this vantage, and are taking the lead demonstrating why audacious climate action makes "good business sense".[49] The *We Mean Business* coalition articulates the significant challenges in achieving the scale of investment needed for a low carbon economy without forward-looking, long-term legislation and the necessary market signals fostered by governmental RE encouragement.

A reallocation of investments from fossil fuels may also send a meaningful market signal to the financial community. At current stock market values, fossil fuel[50] energy companies are estimated to be worth nearly $5 trillion dollars, and preferred by investors due to the industry's scale, liquidity and expansion.[51] However, with global pressure to accelerate clean energy services, a fast-paced fossil fuel divestment movement has emerged. Fossil Fuel divestment solicits investors to remove funds (stocks, bonds etc.) from their portfolio, claiming that "fossil fuel investments are a risk for both investors and the planet". Yet a global fossil fuel divestment also introduces a number of challenges. The BNEF reports:

> "If the fossil fuel divestment is to expand, the movement requires orders of magnitude more financial commitment. It is easy for an individual to move assets out of one index fund and into another, it is much hard for an institution to move billions of dollars (and the growth and yield that they have enjoyed) out of one company and into another. Fossil fuel divestment is a major challenge for those institutional investors that aim to pursue it, just as it is a challenge to many of the investment vehicles in clean energy that could receive new capital''.[52]

Although the clean energy sector is reported to be a trillion dollar sector, it is not a "like-for-like" investment with fossil fuels. A paradigm shift, in which the scale of RE investments significantly expands, investment vehicles such as green bonds proliferate,

---

[46] Renewable Energy Policy Network for the 21st Century: Renewables 2014 Global Status Report (http://www.ren21.net/ren21activities/globalstatusreport.aspx)

[47] Scottish Power-East Anglia wind farm, London Array, RWE Galloper (Scottish Power-East Anglia wind farm, London Array, RWE Galloper)

[48] Fostering a Renewable Energy Technology Industry: An International Comparison of Wind Industry Policy Support Mechanisms (http://www.oregon.gov/energy/RENEW/docs/RPS_Feedlaw_LBL_Nov05.pdf)

[49] WE MEAN BUSINESS: The Climate Has Changed 2014

[50] oil, gas, and coal

[51] Bloomberg New Energy Finance: White Paper- Fossil fuel divestment: a $5 trillion challenge (http://about.bnef.com/white-papers/fossil-fuel-divestment-5-trillion-challenge/)

[52] Bloomberg New Energy Finance: White Paper- Fossil fuel divestment: a $5 trillion challenge (http://about.bnef.com/white-papers/fossil-fuel-divestment-5-trillion-challenge/)

and perception of high financial risk need to come to fruition order to accelerate a fossil fuel divestment that is “neither imminent nor inevitable”, nor impossible for ambitious shareholders.[53]

Opportunities

Atypical investments in RE technologies are beginning to emerge, in which conventional energy groups look to RE as way to increase production.[54] During the steam injection process of enhanced oil recovery, in which steam is used to enhance the flow of heavy oil, companies are replacing natural gas with solar energy as a heating agent. Realizing the benefits of solar power for oil recovery and designing the equipment to take advantage of this potential presents a unique business opportunity to accelerate RE investments.

Key players in the financial community are responding to the fossil fuel divestment movement, announcing to scale back fossil fuel investments and reallocation of funds for RE. The successors of the Rockefeller oil wealth united fossil fuel divestment efforts announcing they will join a campaign to revoke $50 billion dollars from fossil fuels and tar sand funds, a symbolic move given the family history.[55] The President of the Rockefeller Brothers Fund expressed the importance of the clean energy transition stating:

> “John D. Rockefeller, the founder of Standard Oil, moved America out of whale oil and into petroleum… We are quite convinced that if he were alive today, as an astute businessman looking out to the future, he would be moving out of fossil fuels and investing in clean renewable energy”.[56]

Although divestment in fossil fuels does not imply nor guarantee a reallocation of funds to RE, it does present an opportunity for RE investment expansion.

Finally, through the standardization of technology, assessment of resource potential and dissemination of information by standard setting organizations, the high up-front investment requirement and perceived financial risks for renewable energy projects are being mitigated. The Carbon Trust[57] is a partnership of organizations from around the world assisting with commercialization of RE technologies. Among many services, The Carbon Trust helps prioritize and design large-scale renewable energy projects, providing harmonized solutions that alleviate high-up front investment requirement.

- **Policy Design**

There are a large variety of incentive structures that may be applied to accelerate RE uptake. While the effectiveness of policy may be subjective, there is consensus that they should be “clear, consistently applied, and flexible enough” to accommodate adjustment if needed.[58] Nonetheless, technical barriers may hinder the effectiveness of renewable

[53] WE MEAN BUSINESS: The Climate Has Changed 2014
[54] Financial Times: Shell looks to solar power to lift oil output 2014
[55] The Guardian: Heirs to Rockefeller oil fortune divest from fossil fuels over climate change 2014 (http://www.theguardian.com/environment/2014/sep/22/rockefeller-heirs-divest-fossil-fuels-climate-change)
[56] The Guardian: Heirs to Rockefeller oil fortune divest from fossil fuels over climate change 2014 (http://www.theguardian.com/environment/2014/sep/22/rockefeller-heirs-divest-fossil-fuels-climate-change)
[57] http://www.carbontrust.com/about-us
[58] Global Climate Network: Low- Carbon Jobs in an Interconnected World 2010 (http://cdn.americanprogress.org/wp-content/uploads/issues/2009/12/pdf/gcn_jobs.pdf)

energy support policies, specifically by inadvertently increasing RE costs.[59] Realizing the *economic value* of RE expansion and designing effective policies that bring value to this process is a key challenge facing the industry.[60]

Furthermore, renewable energy technologies are at different stages of development and maturity. Experts suggest that governments should apply policy mixes that are increasingly based on market principles as technology matures from the development stage, niche market and mass market stage when technology is largely deployed.[61] However, political economy analysis indicates that policies focused on encouraging RE uptake through a regulated market-based approach, may not be the most appropriate policy design for addressing RE *economic* challenges.[62] Rather, policy frameworks striving to *understand and align the varied interests of important stakeholders* (electricity utilities, regulators, businesses with stake in fossil fuels, investors, local government, public, etc.) could be a more appropriate strategy for increasing RE uptake, albeit challenging.

Opportunities

Policy support throughout phases of the RE value chain is recognized as an opportunity to boost the economic value of RE projects. Specifically, policies targeting RE stages such as equipment manufacturing, distribution, project planning, project development, construction, installation, operation, maintenance, dismantling and recycling. Similarly, categorizing policies by demand, supplier and input/complementary may also help operationalize specific measures identified to overcome barriers. Once RE policy dimensions are identified, the IEA suggests high levels of policy effectiveness are associated with three factors *co-existing* at the same time:

- Level of policy ambition (level of targets)
- Presence of well-designed incentive schemes
- Capacity of the system for overcoming non-economic barriers that may prevent proper market function

By establishing *ambitious yet feasible RE targets*, government may send a clear and long-term signal of commitment to the RE industry. Well-designed incentives schemes, for different phases of the RE value chain, are also helpful and should reflect the *unique characteristics of RE technologies and local energy situation* rather than a one-size-fits-all approach. Finally, the *ability of the system to overcome technical barriers* that may limit the market from functioning (administrative obstacles, grid access/infrastructure, electricity market design, lack of information and training) is vital for increasing RE policy effectiveness. It has been demonstrated that policy frameworks which contemporaneously incorporate these three factors, have high policy effectiveness.[63]

[59] IEA and OECD: Deploying Renewables: Principles for Effective Policies 2008 (http://www.iea.org/publications/freepublications/publication/deploying-renewables-principles-for-effective-policies.html)
[60] IEA Renewable Energy Technology Deployment: RE ValuePolicies, Policy Instrument to Support REnewable En3ergy Indsutrial Value Chain Development (www.iea-retd-org)
[61] IEA and OECD: Deploying Renewables: Principles for Effective Policies 2008 (http://www.iea.org/publications/freepublications/publication/deploying-renewables-principles-for-effective-policies.html)
[62] United Nations Development Programme: Discussion Paper: The Political Economy of Renewable Energy 2011 (http://www.enterprise-development.org/page/greengrowth)
[63] IEA and OECD: Deploying Renewables: Principles for Effective Policies 2008 (http://www.iea.org/publications/freepublications/publication/deploying-renewables-principles-for-effective-policies.html)

3. Social Dimension

The social dimension of RE implementation is an emerging field of research. The impact of social acceptance on RE uptake may be just as significant as ambitious RE policy targets. As global RE production increases, the amount of socio-political disagreements also rises. This final chapter explores some of the difficulties in gaining support for RE uptake at the local level, highlighting opportunities to overcome social challenges and accelerate RE uptake.

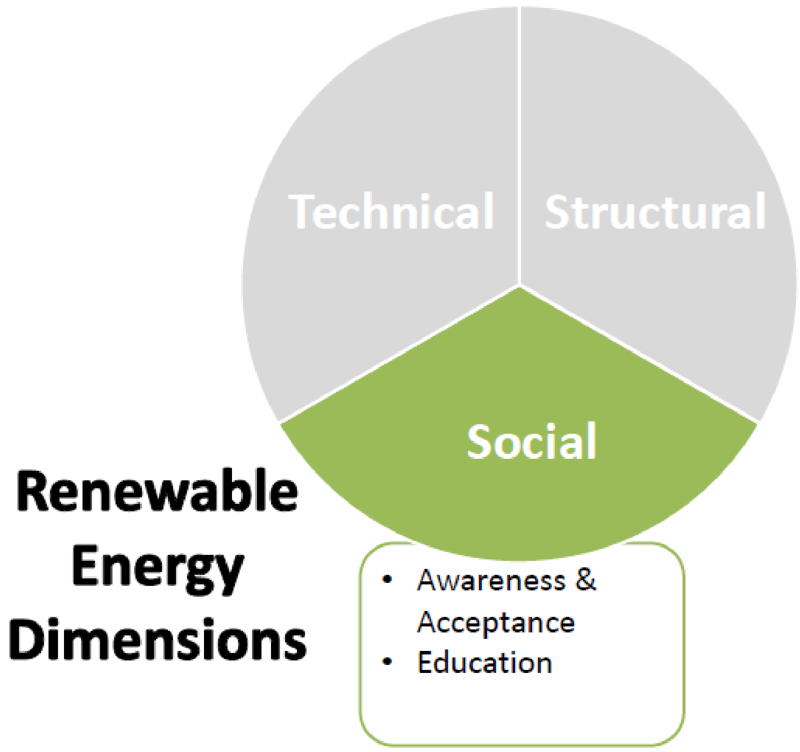

Figure 4. Elements within the social dimension of renewable energy challenges and opportunities.

- **Awareness & Acceptance**

Given the priority of ensuring a viable RE project first, communication strategies and outreach for impacted communities is often minimal. The reality of limited information platforms, leads to gaps in awareness of RE projects and societal benefits, creating a challenge to accelerating RE acceptance. Furthermore, a fundamental difference between conventional and RE resources is location. While fossil fuel energy sources are buried deep in the earth, many RE technologies require the harnessing of elements above ground, in regions that may impact society's daily line-of-sight. This geographical difference between energy sources has created new area of research regarding social acceptance of RE. Although RE has a positive image for some, social acceptance is not universal, and more is needed for large-scale RE deployment.[64]

Opportunities

A community ownership scheme is an opportunity to promote social awareness by allowing communities near RE project sites to purchase stakes in the resource.[65] Research suggests such activities could be implemented through joint venture, split ownership, shared revenues or bonds. Although community owned projects are common in some countries, expansion of the schemes is an opportunity to mitigate social challenges.

IRENA is also working to strengthen social acceptance and eliminate misconceptions about RE by hosting a series of workshops.[66] The workshops incorporate know-how from leading organizations advocating for RE and social acceptance research. Addressing specific concerns such as costs to consumers, land use priorities and community and gender perspectives during workshops, is an opportunity to improve public awareness and acceptance for RE technologies.

- **Education**

A large-scale shift to RE technologies will require a trained and educated workforce to support it. Although RE education is beginning to increase as the industry expands, the implementation of intensive, vocational, and tailor made courses are still not widespread, nor comprehensive, enough for the addressing specific needs of employers in the RE sector. Without supportive renewable energy education and training policies, the positive impacts of RE job creation are minimal.

Opportunities

RE education and training course may be delivered at the level of a company, industry or government, however, multi-level policies, originating from various stages are demonstrated to be the most effective.[67] IRENA recognizes the need for skilled RE workers, and has created a platform, Renewable Energy Learning Partnership (IRELP), to increase visibility of education and training resources and assess information gaps regarding the types and status of RE education opportunities. The group also provides

[64] IEA-RETD: Communication Best-Practices for Renewable Energies (RE-COMMUNICATE) 2013 (http://iea-retd.org/wp-content/uploads/2013/04/IEA-RETD-RE-COMMUNICATE-Report_Final_20130403.pdf)
[65] http://www.independent.co.uk/environment/local-communities-to-be-offered-stakes-in-wind-farms-and-renewable-energy-stations-9836134.html
[66] http://www.irena.org/menu/index.aspx?mnu=Subcat&PriMenuID=30&CatID=79&SubcatID=360
[67] IRENA Working Paper: Renewable Energy Jobs: Status, Prospects & Policies (http://www.irena.org/documentdownloads/publications/renewableenergyjobs.pdf)

support to education and training providers to ameliorate the *quality* of RE education. By dedicating efforts to 'learners', universities which provide the education and governments, IRELP is strengthening the market of qualified RE specialist.[68]

[68]http://www.irena.org/menu/index.aspx?mnu=Subcat&PriMenuID=44&CatID=109&SubcatID=447

III. Examples of Supportive Policy Measures, Best Practices and Lessons Learned

There are advantages and disadvantages to all policies. Therefore, it is important to adapt any policy recommendation to unique national situations. Given the diversity of the ECE region, this framework for best practice guidelines is designed to serve as tool for exchanging information on the various paths available to achieve a common objective of significantly increasing the uptake of RE. In line with the bottom-up approach, the following section briefly describes a range of RE policy instruments used to address RE technical, structural, and social challenges and specific examples[69] of supportive policy measures, best practices, and lessons learned that reflect opportunities to accelerate RE uptake. For consistency, examples are organized by relevant policy instruments and sub-divided into technical, structural, and social dimensions (Figure 5-7).

- **Policy Instruments**

There are a variety of policy instruments that support RE. Research and development (R&D) policy support for RE technology innovation and broader components of the RE industry drive the critical solutions needed to build a next-generation energy system to the forefront. Regulations and standards may support RE directly or indirectly. Direct regulations and standards generally aim to increase the demand for RE or remove non-economic barriers. Indirect RE regulations may target non-renewable power sources. For example, setting emission restrictions or other performance standards for fossil-fuel power plants indirectly boosts RE uptake, as well as designing policies that mitigate technical barriers such as limited of grid access.

Policy 'quantity' instruments are market-based policies based on the quota of RE production. Quantity setting instruments are unique, since they allow the prices of incentive amounts to be determined by the market. Two commonly implemented quantity instruments, which are often used in tandem, are Renewable Portfolio Standards (RPS) and Renewable Energy Certificates (REC). Renewable Portfolio Standards (also referred to as renewable electricity standards, renewable obligations, mandated market shares), mandate a certain percentage of RE or absolute quantity of RE capacity (or generation) at unspecified prices.

RECs are non-tangible, tradable commodities that represent proof that electricity was generated from a RE resource (per MWh). Often times, RECs are used to increase the flexibility of RPS policy and lower costs. RECs are supplied by RE producers and may be bought or sold with or without electricity (bundles or unbundled respectively). The demand for RECs is from consumers and utilities. Through voluntary markets, consumers can purchase RECs to demonstrate the use of clean electricity, providing further incentives for RE producers. On the contrary, in the compliance market, electricity distributors use RECs to meet the formal requirements of RPS policies, local and international targets.

Government procurement is another tool that requires purchasing RE, except in these cases, the responsibility for fulfilment is on national or sub-national governments. Procurement policies may leverage public-sector energy demand by requiring public facilities to meet a certain percentage of their demand with RE, allowing public-sector

[69] Policy mechanism introduced reflect best practices and success stories from IEA: World Bank: Energy Sector Strategies for Green Growth modules and the authors on research.

to meet part of a requirement with on-site RE power generation, and/or integrating governments into the RPS or REC schemes.

Price instruments such as fiscal incentives and Feed-in Tariffs (FITs) are additional mechanisms used to mature RE markets. Price instruments reduce costs and pricing-related impediments by establishing favourable RE price regimes. By lowering costs of RE project construction and operation, fiscal incentives increase the competitiveness between the RE and fossil fuel industry. FIT policy designs typically include a preferential tariff, guaranteed purchase of electricity produced over a significant period, and guaranteed access to the grid.

While FITs may be used to accelerate RE investments, concerns exist regarding the effectiveness of such schemes. In particular, issues arise around the price impacts and technology choices embedded in the design of FIT policies. In some cases it has been demonstrated that administratively set FITs are not sufficiently responsive to either the evolution of RE technology, prices in the broader power market, or non-price factors and consequentially may either expand to uneconomic proportions or have no impact. The disproportionate growth of subsidies can lead to unsustainable RE growth with significant unintended budget consequences that constrain the actual use of the incentive and damage future prospects for renewables.[70] Other non-FIT related fiscal incentives also exist, ranging from production/investment tax credits to public investment loans or grants.

Finally, international cooperation, particularly through data-sharing and national partnerships, may contribute to greening the energy sector. Policies designed to promote the collaboration and exchange of experience, whether lessons-learned or best practices, strengthen the impact of both domestic and national RE strategies. Data-sharing, including methodological choices for indicators, are further examples of effective capacity building through international cooperation policy mechanisms.

[70] Development And Integration of Renewable Energy: Lessons Learned From Germany (http://www.finadvice.ch/files/germany_lessonslearned_final_071014.pdf)

1. Technical Matrix of Supportive Measures

Figure 5 provides a menu of supportive policy measures, best practices and lessons learned for addressing RE technical challenges. The examples of supportive measures are categorizes by type of policy instrument and represent a collection of best practice policies identified by the IEA and World Bank, as well as through the authors' research. The list of polices are not meant to be exhaustive, but rather to provide a preliminary assessment for discussion of specific opportunities within the technical dimension of RE that may assist with accelerating uptake. A brief description and resource for more information is provided for each measure.

Technical Supportive Measures	Policy Instrument	Objective	Example
	R&D Support	Support Innovation: Electricity Market Reform	United Kingdom: Electricity market reform & Contracts for Difference Program (CFD)
		Support Innovation: Increase RE Technology Efficiency	United States: National Renewabl Energy Lab's software modelling tool for increasing wind farm efficiency
	Regulation & Standards	Direct Support: Clarifies RE Resources	Albania: Specifies small hydropower as a renewable energy resource
		Direct Support: Upgrading Grid Infrastructure	Germany Lessons-Learned: upgrade in power grid infrastructure necessary for RE integration
		Direct Support: Energy Storage Target	California: 'Energy Storage' target of 1,325MW of energy storage by 2020
		Direct Support: Flexible Grid Access	Turkey: Net-metering Scheme- allows a two way flow of electricity and only charges consumers for their net electricity use
	International Cooperation	Data-Sharing	CLEAN ENERGY MINISTERIAL, Accelerating the Transition to Clean Energy Technologies: Provides a global forum to share best practices that support solutions to technical challenges
		Partnership	National Association of Regulatory Utility Commissioners: Black Sea Regulatory Initiative: Focused on electricity grid regulatory developments in an expanded regional context

Figure 5. Matrix of technical supportive measures, best practices and lessons-learned.

- **R&D Support**

Support innovation for electricity market reform

United Kingdom: Electricity market reform & Contracts for Difference Program (CFD)[71]

Implemented through the Energy Act of 2013, the UK Electricity Market Reform is a programme that was created to promote secure investments and improve affordability in low carbon electricity generation. One of the key elements of the market reform program is the Contracts for Difference mechanism (CFD). CFD provides revenue stabilisation for producers of low carbon energy including renewables, nuclear power and Carbon Capture and Storage (CCS). The mechanism is designed to allow investments to be made with a lower cost of capital and at a lower cost to consumers by reducing the exposure to the volatile wholesale electricity price. The mechanism works by requiring new generators of low carbon electricity to sell energy into the market but with a provided variable top-up from the market price to a pre-agreed 'strike price'. When the market price is high, the payments are reversed and the generators are required to pay back the difference between the market price and the strike price therefore protecting the consumers from over-payment while stabilising the price. This innovative mechanism can help prepare the electricity market for increased renewable uptake.

Support innovation for increasing RE technology efficiency

United States: National Renewable Energy Lab's Simulator for Wind Farm Application (SOWFA)[72]

The Simulator for Wind Farm Application is a new computer program developed by the US National Renewable Energy Laboratory that will increase wind power efficiency. The program allows researchers to accurately analyse the performance of individual wind turbines under different atmospheric conditions and terrain. Previous programs were only able to calculate wind flows through an entire wind turbine farm as a whole without being able to analyse the performance of individual turbines. The SOWFA program uses advanced computers that can conduct trillions of calculations per second in order to accurately predict the motion of wind through a wind farm made up of up to a hundred turbines. The program can model the flows, counter flows, cross flow and temperatures in every square meter of the farm. Using the increased accuracy of the measurements and resulting information allows the wind farm to maximize energy production by adapting the individual turbines to current wind flows. The SOWFA programme can receive wind measurements from individual turbines and respond by adjusting the turbine's position. The information from the program reduces the uncertainty gap between average energy production and the worst-case energy production of a wind farm. The more accurate information should lower the interest rates for financing a wind farm while increasing RE technology efficiency.

- **Regulations & Standards**

Direct support: Clarifies RE resources

Albania: small hydropower as a renewable energy resource[73]

---

[71] tps://www.gov.uk/government/uploads/system/uploads/attachment_data/file/267735/EMR_-_Update_on_Terms_for_the_Contract_for_Difference_v8.pdf

[72] http://gcn.com/Articles/2014/10/16/Wind-farm-modeling.aspx?Page=1

[73] http://www.irena.org/DocumentDownloads/events/2013/December/Background_Paper-A.pdf

Albania has increased its target for energy from renewables by 2020 from 31.2% to 38%. The increased renewable goals have been part of a recent government initiative to improve the legal and regulatory frameworks of renewables. Albania has created a Feed-in Tariff system for small hydro plants up to 15 MW and tax exemptions for all renewable energy equipment. Albania also started to give priority dispatch to renewable energy producers in 2013. Most of this electricity will be produced from hydropower. Albania currently produces 90% of its electricity from hydropower.

Direct Support: Upgrading Grid Infrastructure

Germany: Lessons Learned- upgrade in power grid infrastructure necessary for Re integration[74]

In order to enhance renewable integration into the power grid, Germany has introduced a Power Grid Development plan. The plan is intended to update German infrastructure in order to better facilitate the radically changing patterns of electricity production and consumption in Germany largely due to ambitious renewable energy targets. The current infrastructure can create bottleneck situations that require inconsistent wind power sources to have to disconnect from the grid on windy days in order to ensure grid stability. The Power Grid Development plan focuses on the changing regional distribution of power sources and the expansion of transmission capabilities in order to facilitate the transformation to a grid more suitable for renewables.

Direct Support: Energy Storage Target

California: 'Energy Storage' target of 1,325MW of energy storage by 2020[75]

In the summer of 2013, California's Public Utilities Commission set a target of 1.3 GW of grid level energy storage by the end of the decade. The target is set as part of the 2010 California Assembly Bill 2514 that sets the first state law for grid-scale energy storage. The target will scale up every two years. So far, project developers have applied with enough projects to collectively store almost double the energy required by the target. The increasing interest in grid storage in California is pushing lawmakers to better value energy storage along with electricity production. This will require a significant adjustment of current regulations but sets the stage for the development of more grid level storage in the future.

Direct Support: Flexible Grid Access

Net-metering Allows a two way flow of electricity and only charges consumers for their net electricity use[76]

Net metering is a policy created to encourage private investments in renewable energy. Net metering allows utility customers with distributed generation systems such as rooftop solar PV panels to be credited at the full retail rate of electricity for any electricity they are able to supply to the grid through their on-site power sources. This

http://www.encharter.org/fileadmin/user_upload/Publications/Albania_EE_2013_ENG.pdf

[74] Development And Integration of Renewable Energy: Lessons Learned From Germany (http://www.finadvice.ch/files/germany_lessonslearned_final_071014.pdf)

[75] http://www.greentechmedia.com/articles/read/californias-massive-on-paper-grid-energy-storage-market

[76] http://www.eei.org/issuesandpolicy/generation/NetMetering/Documents/Straight%20Talk%20About%20Net%20Metering.pdf

requires electric companies to buy the power from customers. Many sources of electricity are eligible for net metering such as energy storage, combined heat and power systems and micro wind turbines but solar PV is the most common by far. By being credited for the electricity to the grid at the full retail costs, customers are only being charged for their net electricity use. Turkey has enormous potential for the use of net metering. Power demand is continually increasing in Turkey. Net metering is allowed in Turkey and grid parity has been reached.

- **International Cooperation**

Data-Sharing

Clean Energy Ministerial provides a global forum to share best practices that support clean energy policies[77]

The Clean Energy Ministerial is global forum set up to promote international cooperation and data sharing to advance clean energy technology. The forum focuses on sharing lessons learned and best practices based off of areas of common interest among the participating governments and other stakeholders. The ministerial includes 23 participating governments that collectively account for 80% of global GHG emissions and 90% of global clean energy investments. The work of the ministerial focuses on high level policy dialogue at annual meetings, public private engagements, partnerships, and year-round initiatives that spread information on clean energy technologies, policies and practices in order to enhance international cooperation around RE.

Partnership

Black Sea Regulatory Initiative: focused on electricity grid regulatory developments in an expanded regional context[78]

Due to growing electricity and gas demand in the Black Sea region there has been growing interest in cross border electricity trade and in examining alternative gas supply and transit in the region. The Black Sea Regulatory Initiative was created in response to this demand in order to increase interaction and information exchange amongst regulators and other stakeholders in the area through facilitated information exchanges. The information exchanges focus on current regulatory and market developments locally, in Europe and the US. The initiative allows regulators to discuss issues of common concern and also current developments in regional and sub-regional markets. The initiative could strengthen the technical and legal environment in the region in order to promote harmonized regulatory practices and more cross border electricity trade.

[77] http://www.cleanenergyministerial.org/
[78]http://www.naruc.org/international/Documents/Schwartz_NARUC%20Black%20Sea%20Regulatory%20Initiative_Eng.pdf

3. Structural Matrix of Supportive Measures

Figure 6 provides a menu of supportive policy measures, best practices and lessons learned for addressing RE technical challenges. The examples of supportive measures are categorizes by type of policy instrument and represent a collection of best practice policies identified by the IEA and World Bank, as well as through the authors' research. The list of polices are not meant to be exhaustive, but rather to provide a preliminary assessment for discussion of specific opportunities within the structural dimension of RE that may assist with accelerating uptake. A brief description and resource for more information is provided for each measure.

Structural Supportive Measures

Policy Instrument	Objective	Example
Regulations & Standards	Direct Support: Increase Demand	Denmark: Danish Energy Agreement 2012: Denmark 50% wind energy for electricity by 2020 (100% RE electricity 2050)
		Israel: National level solar hot water mandate
		Azerbaijan: State Agency of Alternative and Renewable Energy Sources
	Indirect Support:Restrictions on Non-Renewable Power Sources	France: Natural Gas Fracking Ban
Price Instruments	Increase Supply	Germany Lessons-Learned: FIT policy introduces unintended challenges
		Netherlands (SDE+): Scheme designed so that level of subsidy keeps up with the market price of energy
		Russia: Renewable Energy Source Development Measure
	Increase Demand	United Kingdom: Home Energy Renewable Energy Loan Program
Quantity Instruments	Renewable Portfolio Standard/Renewable Energy Credit	Maryland: The 2013 Maryland Offshore Wind Act (Offshore Renewable Energy Credits)
Government Procurement	Increase Demand: Leading by Example	United States: 'Green Power Purchasing' policies aimed to green federal buildings
International Cooperation	Climate Financing	Kazakhstan: Renewable Energy Investment Forum
	Partnership	Norway-Sweden: Joint Swedish-Norwegian Electricity Certificate System

Figure 6. Matrix of structural supportive measures, best practices and lessons-learned.

- **Regulations and Standards**

Direct Support: Increase Demand

Denmark Danish Energy Agreement 2012: Denmark 50% wind energy for electricity by 2020 (100% RE electricity 2050[79])

Denmark has an ambitious target to complete a full conversion to renewable energy by 2050. The country aims to have wind supply 50% of electricity by 2020. The targets have been set based on the country's large wind resources and shallow offshore areas suitable for offshores wind. Denmark has been highly involved in developing the country's wind resource potential since the 1970s. Many local universities with top experts in the field collaborate closely with the wind industry. In order to help meet the goal of 50% wind power in Danish electricity consumption, massive investments in wind renewables will be made. The country plans to implement 1,800 MW of new onshore wind power and 1,500 MW of new offshore wind power. Two large wind farm projects are planned in the Baltic Sea and in the North Sea at 600 MW and 400 MW respectively. The policy is a strong example of direct support to renewable demand.

Direct Support: Increase Demand

Israel: National level solar hot water mandate[80]

Ninety percent of Israeli homes have a solar hot water heater. During a fuel shortage in the 1950s, limits were placed on times when water could be heated. As a response, most home owners installed hot water heaters that were eventually mandated on every new home. Since the 1980s, most buildings have been required to have solar hot water heaters with only certain medical, industrial and high-rise buildings being exempt for the mandate. Israel is the only country with national level requirements to include hot water heaters on new buildings. The policy follows the public momentum by mandating what was already being done in order to ensure demand.

Direct Support: Increase Demand

Azerbaijan: State Agency of Alternative and Renewable Energy Sources[81]

Following a presidential decree in 2009, the Azerbaijan State Agency of Alternative and Renewable Energy sources was created to be the principle regulatory institution for renewable energy in the state. The agency assesses sustainable energy potential, shapes policies, and collaborates and enforces procedures such as giving special permissions for entities to construct power plants. Azerbaijan potentially has enough renewable energy resources to become a leader in renewable output among European countries. The Azerbaijan government plans to utilize these resources through a target to increase the national share of renewable energy sources to 9.7%, three times the current amount. In order to meet these targets, the State Agency of Alternative and Renewable Energy Sources plans on creating a new legislative framework for renewable growth including a number of tax grants and supports for renewable energy producers while also working towards an accurate analysis of renewable power resources in the area.

[79] http://www.ens.dk/sites/ens.dk/files/dokumenter/publikationer/downloads/accelerating_green_energy_towards_2020.pdf

[80] http://www.estif.org/policies/solar_ordinances/

[81] http://www.renewableenergyworld.com/rea/news/article/2013/08/azerbaijan-aims-to-boost-output-of-renewable-energy

Indirect Support: Restrictions on non-renewable power sources

France: Natural Gas Fracking Ban[82]

In 2011, the French parliament voted to ban hydraulic fracturing for natural gas and oil. The ban was based off of the questionable environmental impacts of fracking. The ban on fracking will most likely play out as an indirect support for renewables as the government plans to continue supporting their development. The country also plans to increase renewable energy from the current 13% up to 23% by 2020 with plans currently in place to open bidding for solar energy projects and two offshore wind farms. France continues to poise itself towards the development of renewables while avoiding fossil fuels in part to meet emission reduction targets.

- **Price Instruments**

Increase Supply

Germany: Lessons-learned from FIT policy[83]

Germany's feed-in-tariffs (FITs) became the policy choice of Germany to increase the share of renewable energy production. FITs are incentives through subsidies that guarantee long term (~20yrs) fixed tariffs per unit of renewable energy power produced. The tariff prices are usually set by the government and are separated from the market price. The price can be adjusted in order to reflect technology cost declines for renewable energy systems. As opposed to a quota system that sets the target amount of renewables and lets the market determine the price, the FIT system sets the price of renewables and allows the market to determine the appropriate amount of renewables. Consequentially, the FIT system in Germany produced an uncontrolled growth of renewables due to the overly generous incentives of the FIT system. The level of growth was unsustainable in the long term but the FIT policy helped create the highest production of non-hydro renewable electricity in Europe.

Increase Supply

Netherlands (SDE) Scheme designed so that level of subsidy keeps up with the market price of energy[84]

The Netherlands have developed a support scheme for renewables, the Stiumlering Duurzame Energieproductie (SDE+). The SDE provides a per unit of energy subsidy to cover the extra costs of producing renewable energy. The scheme acts as a FIT subsidy and is technology neutral within renewable projects. Multiple project types including renewable electricity, gas and heat projects are eligible. The incentives are aimed at private companies that would benefit from the SDE+ compensating the difference of renewables price compared to fossil fuels over a period of 5, 12 or 15 years.

Increase Supply

Russia: Renewable Energy Source Development Measure[85]

[82] http://www.nytimes.com/2013/10/12/business/international/france-upholds-fracking-ban.html?_r=0
[83] http://cleantechnica.com/2014/08/07/germany-solar-feed-in-tariffs-seia/
[84] http://english.rvo.nl/sites/default/files/2013/11/English_brochure_SDE+_2013_(kleur_version)_0.pdf
[85] http://www.renewableenergyworld.com/rea/news/article/2013/05/new-russian-renewable-energy-source-development-measures-to-overcome-obstacles

Russia has state policy guidelines for promoting renewable energy in the power sector. The guidelines aim for a share of 4.5% renewables in 2020 excluding hydropower over 25MW. When the policy was passed in 2009, less than 1% of Russia's electricity was produced from renewable sources. The policy aims at creating feed in tariffs for renewable energy, mandating that wholesale electricity buyers purchase a certain percentage of energy from renewables while also improving the overall legal framework for the increased generation of renewables.

Increase Demand

UK: Home Energy Renewable Energy Grants[86]

The New Green Deal is a government policy in the UK that allows grants for energy efficient improvements to the home. The original Green Deal offered loans that could be repaid through energy bills with the goal that the savings from the energy enhancements will be enough to offset the loan payments, saving money on the bills. The original system was criticised for being too complicated. The new Green Deal started this year with as much as £120m set aside for the initial grants. Homeowners could receive a return of up to £7,600 based on the measures implemented. There are 45 different energy efficiency improvements covered by the green deal that include energy efficiency measures as well as local renewable energy generation such as through solar panels or heat pumps.

- **Quantity Instruments**

Renewable Portfolio Standards/Renewable Energy Credits

Maryland: Offshore Renewable Energy Credit[87]

Since May 2004, Maryland has had a renewable energy portfolio standard that requires electricity suppliers to use renewable energy sources to generate a minimum portion of their retail sales. The renewable requirements will increase gradually while separating different forms of renewables into two different tiers. The Maryland Offshore Wind Energy Act of 2013 will build off of the renewable energy portfolio standard by requiring a certain percentage of the renewable energy be provided by offshore wind turbines starting in 2017. This introduction of the "offshore renewable energy credits" or ORECs will be tradable credits used by utilities to help comply with the legislation. The ORECs will be a financial incentive for offshore wind generators. The credits are expected to encourage the development of at least 200 MW of offshore wind energy near Maryland.

- **Government Procurement**

Increase Demand: Leading by Example

United States: Green Power Purchasing[88]

Section 203 of the federal Energy Policy Act of 2005 requires that, to the extent economically feasible and technically practicable, the federal government consume a minimum of 10% of electricity from RE resources in fiscal year 2015, 15% in fiscal

[86] http://www.bbc.com/news/business-27759217
[87] http://theenergycollective.com/jessejenkins/196881/offshore-wind-energy-development-new-maryland-legislation
[88] http://www.epa.gov/greenpower/documents/purchasing_guide_for_web.pdf

years 2015 and 2017, 17.5% in fiscal years 2018 and 2019 and 20% in fiscal year 2020 and thereafter. Federal agencies may meet these targets through installing agency-funded RE on –site at federal facilities, contracting for energy that includes the installation of a RE project on sit or off-site, purchasing electricity and corresponding RE credits.

- **International Cooperation**

Climate Financing

Kazakhstan: Renewable Energy Investment Forum Partnership[89]

In 2012, Kazakhstan and the US signed a Joint Action plan cooperation and energy development between the two countries. As part of the partnership, the two governments will support joint training and capacity building projects. The projects will focus on energy management systems and energy audits while also further researching Kazakhstan's geothermal resources. Through the partnership, both countries will focus on expanding cooperation to improve regional energy exchanges, promote competition and strengthen the reliability of the electricity transmission systems.

Partnerships

Norway-Sweden: Joint Swedish- Norwegian Electricity Certificate System[90]

In 2012, Norway and Sweden established a common market for electricity certificates in order to increase to cost effectiveness of generating renewable energy. The linked markets will increase overall functioning of the market while creating better competition and more stabilised prices. Both countries combined have a goal of creating 26.4 terawatt hours of new electricity from renewable sources by 2020. Electricity producers will have access to an electricity certificate market that will promote new electricity production from renewables and allow cross border trading in order to achieve goals. The market will be technology neutral therefore increasing the competition between different renewable technologies to drive the prices down. The market is more cost effective than previous schemes and achieves more renewables development at a lower cost than subsidies.

[89] http://www.jamestown.org/programs/edm/single/?tx_ttnews%5Btt_news%5D=40059&cHash=7926dcc75e445edef6f1ff0f4e1566e0#.VFt2FfnF90w

[90] http://ec.europa.eu/competition/state_aid/modernisation/centeno-lopez_en.pdf

4. Social Matrix of Supportive Measures

Figure 7 provides a menu of supportive policy measures and best practices for addressing RE social challenges. The examples of supportive measures are categorizes by type of policy instrument and represent a collection of best practice policies identified by the IEA and World Bank, as well as through the authors' research.. The list of polices are not meant to be exhaustive, but rather to provide a preliminary assessment for discussion of specific opportunities within the social dimension of RE that may assist with accelerating uptake. A brief description and resource for more information is provided for each measure

	Policy Instrument	Objective	Example
Social Supportive Measures	R&D Support	Social Awareness	Hungary: Energy and Climate Awareness Raising Action Plan
			10Action: Actions to Increase Energy Awareness and improve the Sustainable Behaviour of European Citizens
		Education	United States: Energy Literacy Framework
		Job Training	Danish Wind Power Academy: Dedicated efforts for wind energy job training
	International Collaboration	Partnership: Training	EEC The European Energy Center: Works with universities, institutions, and organizations to showcase energy training courses and certificates

Figure 7. Matrix of social supportive measures and best practices.

- **R&D Support**

<u>*Social Awareness*</u>

Hungary: Energy and Climate Awareness Raising Action Plan[91]

In 2011, the Hungarian Parliament approved the National Energy Strategy 2030. The resolution aims to raise public awareness on energy and climate in Hungary in order to mobilize consumers as actors to the national energy strategy. The target results of the resolution are to lower consumer energy demands while increasing the share of domestic renewable sources. The plan also helps to prepare the public for any future increases in the cost of energy or climate change effects. Part of the population of Hungary is unfamiliar with the impacts of the amount of energy consumed and its effect on the environment. The messages are focused on transitioning to a low carbon society with a special focus on Hungarian households.

<u>*Social Awareness*</u>

10Action: Actions to Increase Energy Awareness and Improve the Sustainable Behaviour of European Citizens[92]

10Action is a European project that aims to raise public awareness on energy issues while encouraging the responsible use of energy. The project also aims to increase the development of renewable and energy efficient technologies. 10Action has various target groups such as children, adolescents, university students, professional businesses and also the general public. The project will have various levels of activities and action plan for each target group. Projects for children include school competitions and websites to familiarize the children with energy consumption. Adolescents will have school competitions focusing on more complicated aspects such as solar designs and the use of recycled materials. University students will have seminars and conferences. Professionals will also have conferences and seminars but the focus will surround technologies that can presently deliver energy saving results. The general public initiatives will have more of a focus on residential solar. The expectation of the project is that each target group will become more educated on the energy issues that they will be most able to have an effect on.

<u>*Education*</u>

United States – Energy Literacy Framework[93]

The Energy Literacy Framework is an initiative run by the US Office of Energy Efficiency and Renewable Energy in order to provide an interdisciplinary approach to teaching about energy. The initiative focuses on informing the public on the nature and role of energy in the world in order to help others better understand energy and be able to better solve energy issues. The goal is to help educated people become energy-literate. An energy literate person is considered someone who can 1) trace energy flows and understand energy systems, 2) understand where energy comes from and how much is needed for different purposes, 3) judge the credibility of information about energy, 4) communicate about energy and finally 5) make informed energy use decisions. The

[91]http://www.iea.org/media/workshops/2013/decisions/10NationalEnergyStrategyandInfluencingBehaviourHenriettaCsato.pdf

[92] http://www.upm.es/observatorio/vi/index.jsp?pageac=actividad.jsp&id_actividad=108683

[93] http://energy.gov/eere/education/energy-literacy-essential-principles-and-fundamental-concepts-energy-education

energy literacy framework's cornerstone source of information is a document titled "Energy Literacy: Essential Principles and Fundamental Concepts for teaching energy". The document is available online or in a hardcopy form and is focused on assisting educators in developing energy literate people.

Job Training

Denmark- Danish Wind Power Academy[94]

The Danish Wind Power Academy (DWPA) is an industry-training organisation that provides customized courses to owners and operators of wind farms, as well as training and services to utilities and wind energy manufacturers. The DWPA is particularly recognized by the investment community for their efficient and operation target trainings in the industry.

- **International Collaboration**

Partnership: Training

The European Energy Centre: Works with universities, institutions, and organizations to showcase energy training courses and certificates[95]

The European Energy Centre is an example of international collaboration in the field of renewable energy. The goal of the centre is to promote knowledge-sharing and best practices in regards to renewable energy and energy efficiency with collaboration through the United Nations Environment Programme and international universities. The Centre hosts professional training courses, provides qualifications, conferences, publications, global partnerships, membership programmes and an internationally recognised masters certificate.

[94] http://www.danishwpa.com/

[95] http://www.euenergycentre.org/

IV. The Role of ECE

In light of the challenges set forth above, it will be important for ECE member States, through its GERE, to address the most relevant obstacles with targeted activities. Collectively, it is recommended that the GERE create a best practice task force to define the most relevant challenges and effective policy measures within the technical, structural, and social RE dimensions. In addition, within each RE dimension, the following comments for consideration are provided:

- Regarding the technical dimension, promoting active engagement of member States in the international data collection process is important for filling data gaps and improving the quality of existing RE databases. Since clarification on how to gage the sustainability of a RE technology is critical for RE policy targets, it will likewise be important for member States, through both the GERE and the Expert Group on Resource Classification, to work towards establishing universal RE terminology and enhance the gathering and dissemination of information on renewable energy resource potential.
- The inadequate information at the RE project level presents an opportunity for collaboration with technical committees, private sector, and academia to assist in further investigating and improving RE technology capacity factors in the ECE region.
- Collaboration with renewable energy technology standard setting organizations such as the ISO and IEC would assist with establishing appropriate normative instruments (including standards as needed) to streamline know-how of optimal RE terminology, project design, and RE power integration.
- Regarding structural and social dimension challenges, it is important to cooperate with organizations assessing the economic value of RE policy design and stakeholders responsible for workshops and programs on effective activities that boost RE awareness, acceptance, and education.