Renewable Energies and Distributed Generation[1]

Challenges and Issues in Developed Countries and Developing Countries

HIGHLIGHTS

- *Renewable energy sources (RES) ensure energy security, fewer adverse climate change impacts and broader energy access.*
- *The rapid reduction in costs is making RES competitive with traditional fossil fuels.*
- *Developed economies have to face integration of RES into their energy systems, if they want to exploit the full potential of these sources of energy.*
- *Developing countries have to unleash RES potential in order to tackle energy access and energy thirst.*

POLICY AND STRATEGIC IMPLICATIONS

- *Developed economies have to prioritize market reforms in order to accommodate RES and reform their energy systems.*
- *Markets in future ought to be based on equal duties and equal rights for all producers. New technologies will allow RES producers to offer new services and to participate to balancing needs.*
- *New business models have to be promoted in order to empower consumers and municipalities, through RES and distributed generation (DG).*
- *Access to reliable and affordable energy sources is the key for empowering rural communities and informal workers.*
- *Energy access is enabled by efficient stand-alone systems and DG. In many cases, utility network-grid connection represents the residual option.*
- *Developing Countries should carefully plan the development of their energy system to leapfrog current traditional technologies*

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RET and DG: from the environmental rationale to the economic rationale

The deployment of renewable energy technologies (RET) has seen remarkable growth in recent decades. As stated in the 2015 version of the World Energy Outlook, renewables secured their position as the second-largest source of electricity in 2014, behind coal. Compared to 2013, RET accounted for 85% of the increase in total generation. Supportive policies and steep cost reductions led to the installation of a record-high 130 GW of renewables capacity in 2014. Over the last decade, 318 GW of hydropower were built, followed by wind power (304 GW) and solar PV (173 GW). Overall, actual installed capacity outnumbered by a factor of 10 the best projections carried out in the early 2000s[2].

Improved energy security, fewer adverse climate change impacts and broader energy access are widely viewed as motivations for this increase. Moreover, renewable generation is particularly flexible and modular in size: these are two key elements in developing countries, where energy demand is rapidly increasing. Flexibility and modularity guarantee the rapid deployment of RET at an adequate and financially viable level of investment.

The business case for both renewable energy and distributed generation is further strengthened by the socioeconomic benefits it can offer. Throughout the World, policy makers are increasingly interested in the potential benefits of renewable energy deployment on economic growth and job creation. Hence, RET are now perceived as having not just an environmental rationale, but also an economic one. That is why, at present, more than 164 countries have set national renewable targets[3].

In many Countries, RET generation costs are now comfortably in the cost-range of conventional thermal power plants and well below the generation cost of new nuclear power plants[4]. Moreover, given the continuous reduction in capital costs and the constant increase in the utilization factor, the Energy Information Administration predicts that by 2020, only the levelized cost of electricity from gas-fired plants will be lower than that of wind[5].

Current drawbacks, such as variability and lack of storage, are rapidly becoming future opportunities, as they attract investments and will bridge energy and digital technologies even further.

RET future looks promising, but there are important issues at stake that will be discussed in the next paragraphs. Paragraph 2 will be devoted to the main issues concerning RET and distributed generation in developed countries, namely, integration and the likely evolution of utilities' business models. Paragraph 3 will discuss the issues at stake in developing countries, namely energy access and rapid consumption growth.

Developed Countries: towards full RET integration

At present, average RET generation accounts for 22% of total generation in OECD Countries and has reached or even surpassed 30% in several EU Countries (clearly there are Countries like Sweden or Norway whose power generation has been historically relying

[2] All the data presented in the policy brief (unless specified otherwise) are taken from the 2015 version of the World Energy Outlook, International Energy Agency, Paris.

[3] Ibid.

[4] IRENA, (2015), Renewable Power Generation Costs in 2014, Abu Dhabi.

[5] Energy Information Administration (EIA), (2015), Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2015, Washington DC.

heavily on hydropower and their share of RET production has always been close to 100%).

Hence, the focus is rapidly moving from RET deployment to full market integration: this implies not just hardware solutions, but also new market rules, pricing and design.

Given the high level of investment and the dramatic fall in costs, it is now mainstream to consider some forms of renewable energy to be competitive today with conventional energy (fossil fuels and nuclear) in many places, even in the absence of policy support. The economic performance of RET is less of an issue than it was ten years ago.

The case for technical and economic integration

It has become clear that, after a first wave of RET penetration, current market design and current backbone infrastructure are no longer able to accommodate more RET and need to be changed, particularly in the electricity sector. Electrification of the energy system, coupled with new generation and consumption technologies are driving a system transformation. Once, conventional technologies fitted centralized, inflexible, and commodity-like systems; now, system designers have to think in terms of flexibility, modularity, multiple levels of service and reliability, and a balance of centralized and decentralized, with energy becoming more service-like and less commodity-like.

Without the needed policy clarifications, the removal of non-economic barriers (in particular, all those regulations that forbid the full exploitation of RET potential) and the successful implementation of new business models, the IEA projects a lower rate of RET penetration.

Market reforms to unleash RET potential

RET and power markets

The overall objective of the market reform is to minimize inefficiencies and operational constraints deriving by the different treatment and rules that at present are applied to RET producers and all other electricity generators.

Future market design will be based on equal duties and equal rights for all. In particular, this implies that RET producers will face the same responsibilities and incur the same costs whenever generating imbalances and voltage intermittences. At the same time, newly designed markets will allow new services and will incentivize new technologies so that RET will fully participate to balancing activities, for instance by allowing load aggregation, by promoting storage technologies and specific voltage or balancing services.

New market designs will drive away from standard day-ahead and intraday balancing and dispatching markets, towards more real-time pricing and delivery, with specific short-term capacity markets.

These new markets will allow RET producers to be active in all the segments of the value chain, not by just producing electricity but also by offering balancing and all other ancillary services required for a safe and efficient electricity network.

Financial instruments for innovation

Among the expected reforms, there is the introduction of more structured financial instruments that will provide higher liquidity and will allow for more specific and targeted hedging products for RET producers.

The changing role of stakeholders

The abovementioned reforms, as well as other reforms that are about to be implemented in many developed Countries (e.g. the “revised” EU Target Model), will pave the way for new services, new business opportunities and new

actors. To this respect, as the 2020 policy framework has shown, specific quantitative targets are perceived by all relevant stakeholders as key to foster investments (Barba Navaretti et al., 2016, Galeotti et al., 2016).

Distribution System Operator (DSO)

Distributed variable RET, coupled with demand-side management by small-scale consumers can contribute to increase the overall efficiency of the energy system.

Hence, new policies will enable DSOs to offer services with economic value to local electricity markets. For instance, these services include the provision of voltage support and other ancillary services such as tertiary reserves, improvement of voltage quality and reduced losses, deferring upgrades of the network, and improving power system resilience.

Third party energy services

RET and ICT technologies are expected to enable new service providers and new energy contracts. For instance, third party energy services (TPES) will allow consumer to have RET technologies without bear an upfront investment costs. TPES will install, own, and operate distributed generation on behalf of residents or building owners, bundling renewable investments with energy efficiency improvements, high-efficiency end-use equipment, and/ or local energy storage for a true “energy services” business.

As energy supply is expected to become more capital-equipment based at a local level, rather than commodity-based at a centralized level, both traditional utilities as well as new TPES will likely begin to offer customers per-kilowatt capacity-based pricing plans (perhaps with kilowatt-hour caps or time-of-day restrictions), beyond traditional per-kWh pricing — similarly to the transition of mobile phone plans from per-minute billing to fixed billing plans (inclusive of smartphones and other ICT devices).

Mobility services

The increasing electrification of our energy consumption will likely enable electric mobility. This will allow not just new forms of co-ownership but it will integrate these vehicles with household-based renewable energy systems. In turn, this might enable other types of energy services, e.g. companies selling large blocks of energy storage and controllable charging (demand-response) to utilities, and contract with thousands of vehicle owners for intermediated charging control.

The penetration of self-driving cars will likely enable new business models. Automakers, utilities, distributors as well as local governments will partner to offer new forms of public transportation, substituting classic above-the-ground transport lines with taxi-like services.

Utilities

Utilities can profit from this changing market landscape, by leveraging on their historical relation with their customers and with the possibility to offer various on-the-bill financing for end-user investments as well as introducing more tailored pricing schemes, based on customized needs of time of use, capacity requirements, reliability and degree of curtailment allowed etc. Moreover, utilities can benefit from new technologies by purchasing and actively selling services at wholesale and transmission level. For instance, emerging grid-based energy storage technologies will enable the sale and purchase of storage services for utilities, end-users, or renewable generators, either through existing ancillary services markets or through bilateral contracts.

Communities and cooperatives

The attractiveness of RET and ICT technologies, their modularity as well as new sources of financing, such as crowd funding and community lending should foster and promote energy investments by local communities and cooperatives.

Utilities and other energy service provider might start considering partnership with communities and cooperatives to reflect new social models for energy services and to overcome NYMBY effects and other forms of preclusion to new investments and deployment of new technologies.

Cities and local governments

RET, DG and smart grids should be perceived as opportunities also by cities, in particular large cities that are more likely to innovate (Puga, 2015). New building planning and regulation, as well as, new forms of local cooperation might enhance investments in RET and, consequently, tackle local pollution.

For instance, cities might find ways to borrow funds from investors and lend these funds directly to local property owners for additions of renewable energy and for energy efficiency improvements. Repayments might take the form of increased property taxes. Alternatively, municipalities can promote RET and other environmentally friendly investments with specific tax credits.

Developing Countries: energy access and rapid growth

RET deployment in developing Countries has accelerated in the past five years. In 2014, almost half of global investment in RET took place in developing Countries: an astonishing 130 billion USD[6]. Still, more than 1.6 billion people do not have access to electricity and rely almost exclusively on wood, agricultural residues and animal dung to meet their energy needs. In most of the developing countries, even those who have access to electricity suffer from frequent outages and curtailments.

Overall, developing Countries are facing two enormous and intertwined challenges:

- Energy access (particularly in rural areas);
- Growing energy needs.

As for the first challenge, thanks to flexibility and modularity, RET and DG are often the most viable solutions for bringing modern energy services to rural areas and to slums.

As for rapid growth, there is mounting evidence that big wind and PV projects are more easily and rapidly deployed, providing electricity in less than a year since the early stage of a project. Moreover, their payback period is now shorter than that of big fossil fuel plants, showing that developing countries are less willing to invest in assets that might become stranded.

For both issues, the crucial aspect will be the access to finance and the management of customers' payments.

Energy Access for social and economic development

On the one hand, energy access is not just about rural electrification, but it is also about a more reliable and affordable energy system in big cities and slums. In particular, access to modern energy services is crucial to modernize the informal sector and the rural population. Modern energy services are considered a key to institutionalize informal economies, which today account for more than 50% of GDP in several African and other developing Countries (Facchini, et al, 2016).

[6] All the subsequent data are taken from the 2015 version of the Renewable Energy Medium Market Report, International Energy Agency, Paris.

Empowering the informal sector means, for the Public Sector, the possibility to increase tax revenues and improve the overall monitoring of all the economic activities carried out in a given Country; for the private sector, it means providing access to structured finance, to regional and global markets as well as to widen political rights. The institutionalization of the informal economy brings about several benefits, but most of them are perceived as long term.

Specific financing for energy and electricity represents the game-changer, as easy access to reliable energy has immediate positive consequences. Hence, informal players might be willing to become formal in order to get access to energy and electricity.

There are three broad options for granting access to energy:

- Utility network grid-connection (via grid extension);
- Stand-alone systems;
- Distributed-grid (DG) systems, often known as mini-grid systems.

Utility network

The first option replicates the development of energy system in developed countries: a national or regional utility company is charged with the provision of access to electricity. As discussed below in the paragraph on energy demand growth, these companies often struggle to keep up with growing electricity demand within the areas already forming part of their grid network, usually urban, with the consequence that extension of the grid to rural and even peri-urban populations is not considered a priority. Those clients have high service costs and a low ability to meet cost-recovery tariffs in the short run.

Stand-alone systems

Stand-alone systems are small-sized generators that normally supply a single household. Due to high running costs and to adverse environmental impacts of fossil fuel generators, the most common type of small-scale stand-alone system involves the use of a RET, such as wind generator or PV array, to maintain an adequate level of charge in an electrical storage battery. The battery in turn can provide electricity on demand for electrical applications such as lights, radios, refrigeration, telecommunications, etc.

Stand-alone system are expensive, therefore not many households in developing countries can afford them. That is why there is the increasing need to develop community-based projects.

Distributed-grid and community engagement

In developing countries, DG systems are community-based projects. DG systems are decentralized power plants, effectively larger stand-alone systems, which supply power to isolated groups of householders, communities or even larger groupings. They involve a local grid-network for the supply of power. Whenever the national or regional grid is relatively faraway, it is more cost-effective to implement such DG systems.

The decision to extend the grid and connect new customers will ultimately be based on the cost to the utility. DG systems often have high capital costs for equipment and initial set-up of the distribution system. For community systems, this can be covered, at least in part, by a low interest loan or grant. The financing structure and the payment strategy are crucial and they both need to be well developed before the implementation.

Billing and tariff collection can be problematic, not because people are not willing to pay or do not pay, but rather because the costs of reading meters and money collection can be higher than revenues raised from those communities, which normally consume very little, unless sound strategies are put into

practice. ICT technologies (remote reading and the possibility to remotely disable the consumer in case of insolvency) and community involvement in tariff reforms (payment at a local shop and transfer via mobile system payments) provide efficient solutions to revenue collection.

In the table below, we summarize the main economic and management issues, from the point of view of the community, concerning the options.

	PROS	CONS
Grid connection	Financial risk on the utility Management and technical capacity on the utility	No stake in power supply O&M jobs outside the community Expensive tariff collection No load management
Decentralized systems (stand-alone and DG)	Community and cooperative management of the power supply Local labour and skill transfer Flexible tariffs and local mangement	Financial risk on the community Management and technical training required for local communities

Energy growth for a more inclusive World

For all non-OECD countries, primary energy demand has grown from 4.9 Gtoe in 2000 to 7.9 in 2013. By 2025, it is expected to be twice as it was in the year 2000. As for electricity, in the same period non-OECD demand has grown by almost 100%, reaching 10,576 TWh, and it is expected to grow by 3% per year until 2040.

Therefore, rapid deployment of generating capacity is essential to meet this fast-growing demand. At the same time, it is important not to add too much generating capacity, given financial constraints faced by developing countries.

Within this context, RET represent an increasingly cost-effective form of generation to meet these aims, due to a combination of: sustained technology progress, expansion into newer markets with better resources and improved financing conditions, i.e. well-designed long-term power purchase agreements.

As a result, some very low contract prices for wind and PV have been awarded over the past few years (e.g. 49 USD per MWh in Brazil for an onshore wind farm; 65 USD per MWh for a big size PV in South Africa), supporting deployment over the medium term with reduced incentive.

In light of these trends, some regions, such as sub-Saharan Africa (SSA), where fossil fuel generation costs are high and electricity access remains low, have the potential to cost-effectively leapfrog to cleaner power systems based on much higher levels of renewables.

Given the long-term horizon of energy investments and the uncertainty for many developing countries to secure safe and continuous access to fossil fuels, the perceived risk of investing in conventional thermal power plants is increasing. Moreover, traditional fuels require huge investment to profit from scale economies. Huge investment translates into very high capital costs and under-utilized power plants, at least in the short and medium run. Moreover, these power plants require the development of transmission lines to expand the customer-base. Governments who have limited amount of capital and who want to meet energy needs as they appear question this rigidity and lack of modularity.

Moreover, private investors prefer to secure smaller portion of demand, which is already there, rather than to strand assets in wait of future demand.

These conditions are providing easier financing for modular projects based on RES, than on big projects based on traditional thermal generation.

In the end, as suggested by the VAM policy paper, diffused clean power generation is rapidly bypassing income barriers to become available in less developed countries.

Further readings

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