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Assessing access to advanced energy services in the UNECE region.

Introduction

The "basic" access to modern energy services is defined by the IEA (IEA World Energy Outlook 2012) as a household having "reliable and affordable access to clean cooking facilities and a first electricity supply connection, with a minimum level of consumption (250 kWh per year for a rural household and 500 kWh for an urban household) that increases over time to reach the regional average". The Sustainable Energy for All Global Tracking Report postulates that "the universal access to modern energy services by 2030 will be achieved only if every person has access to modern cooking and heating solutions, as well as productive uses and community services". While these definitions are quite relevant at the global level, its use at the level of UNECE region may not be very useful due to relatively high percentage (well over 95%) of population who already have this level of access.

Most of studies addressing the access to energy issue (e.g., widely cited IEA's World Energy Outlook; http://www.worldenergyoutlook.org/resources/energydevelopment/globalstatusofmodernenergyaccess/) are focused almost exclusively (and understandingly so) on developing countries of Africa and Asia, where this problem is most acute. At the same time, while all the UNECE region countries have higher than the global average energy access rates, this problem for them could re-formulated from the perspectives of sustainable energy use and empowerment of educated consumer choice. Main *factors* that could define the access to sustainable energy services (e.g., as formulated by UNDP – access to "sustainable sources of clean, reliable and affordable energy ") in the UNECE region could be described in terms of:

- Connection to energy grids: opportunity for gaining affordable and non-discriminatory connection to electric, natural gas or district heating networks.

- Reliability of power supply: reduced frequency of blackouts and brownouts and frequency of disruptions in the central heating delivery as well as prompt restoration of access to power.
- Access to alternative energy solutions: availability of natural gas networks, electric grids, and district heating; choice of alternative providers; ability to install autonomous generation.
- Access to modern renewable energy instruments: availability of household renewable energy technologies; ability to sell excess power to the grid; access to information on renewable energy opportunities.
- Access to energy saving instruments: access to energy saving programs and financial incentives; availability of smart metering and smart grids; access to information on how to save energy.
- Affordability: affordable cost of electricity and centralized heat (including connection charges) relative to average incomes; availability of subsidized rates for disadvantaged consumer categories.

The energy services described along these six dimensions of are defined for the purposes of the current study as "advanced energy services", making them a subset of "modern energy services". The current scoping paper attempts to review available information along the lines of the "advanced access to energy service" dimensions for the UNECE region and identify most critical issues in gaining universal access to such services based on specific country examples.

The key paper objective is to recommend directions of further research leading to specific policy recommendations for the UNECE members.

Connection to Energy Grids.

Problems with reliable physical access to energy grids in the UNECE region normally exist in remote and low-populated locations (e.g., Siberia in Russia, central parts of Kazakhstan, mountain regions of the Caucasus nations), which are difficult and expensive to serve via high-voltage lines. In such cases the solutions are being found via developing local isolated grids and/or auto generation, based on fuel oil, LPG and in some instances renewable sources.

In could be concluded that the concept of "energy poverty" ("inability to cook with modern cooking fuels and the lack of a bare minimum of electric lighting to read, or for other household and productive activities after sunset" [1]) is unlikely to be applicable to the UNECE region as a whole. However, there are could be some exceptions. For instance, the recent UNDP study[2] found out that high connection rates to electricity grids in Kyrgyzstan and Tajikistan (above 95 percent in both countries) are not very meaningful (particularly in case of rural households), since the reliability and affordability remain effective access barriers. In Tajikistan, an estimated 1 million people in rural areas spend much of the winter without regular electricity supplies, while in Kyrgyzstan, 78 percent of low-income households in 2008 reported weekly (at least) interruptions in electricity service, compared to 72 percent for the country as a whole. Since rural poverty rates in Kyrgyzstan are well above national averages, these data point to special hardships for families in rural (and particularly mountainous) areas, as it was discovered by the cited UNDP study.

[1] UN Millennium Project: Energy Services for the Millennium Development Goals. 2005
[2] UNDP: Household Energy Access and Affordability in Kyrgyzstan and Tajikistan, 2011.

Another aspect that could be addressed within the physical access context is related to (1) relative ease of connecting to the grids of newly built houses or business facilities and (2) ability to receive needed amount of power (electricity, gas, etc.). While the physical grids are present in a close neighborhood of a new home or business it might be prohibitively expensive to receive a proper connection for a needed power capacity. Same if not worse "connection" problems exist for natural gas or district heating networks.

Reliability of power supply

As stated in the previous section, most UNECE region countries do not have serious problems with providing basic access to electricity grids; however, the reliability of such access varies depending on
a country and a region within a country.

Main parameters of a single power outage event include the magnitude (e.g., number of households without power); frequency (number of events per year) and duration (number of hours before power is restored). While the blackout magnitude appears to be most severe in North America and EU sub-regions, the frequency and duration of blackouts is greater in the EECCA (Eastern Europe, Caucasus and Central Asian) subregion.

Main factors causing blackouts and brownouts include:[3]

1. **Decreased availability of transmission lines.** For example, the restructuring of the electricity industry in the U.S., starting with FERC Order 888, allowed open access to transmission capacity, resulting in additional use of transmission resources for long distance transfers. This might have decreased availability of the lines and in this way increased blackout risk.
2. **Insufficient system-wide management** of the electricity network. A lack of a systems approach to risk mitigation leads to increased power outage risks. This includes an outdated design of "last-mile" networks.
3. **Poor alignment of protective systems design**. The design of protection systems in electrical power networks is poorly aligned with the main objective of the system: delivering energy to customers. It is mainly designed to minimise equipment damage, which may often result in sub-optimal performance with respect to reliability of supply.
4. **The liberalisation of the electricity market.** The two decades of reforms in many UNECE countries resulted in the separation of power generation and transmission and distribution (T&D) business. This process has created an additional interface which can adversely impact communication and coordination activities between operators on both sides.
5. **Increased share of renewable energy (particularly, based on wind and solar technologies)**. The undersupply from intermittent renewable sources may lead to a power scarcity resulting in a power blackout; an oversupply can also lead to grid instabilities as they alter the frequency within the networks.

Clearly, different factors have varying level of importance in different UNECE members. The increased share of intermittent renewables could cause most serious concerns in EU, where it reaches substantial shares of the overall generation (e.g., Germany, Spain). At the

[3] CRO Forum Emerging Risk Initiative: Power Blackout Risks Risk Management Options Emerging Risk Initiative – Position Paper. 2011; and Leonardo Energy: Increasing frequency of black-outs in the U.S. 2013

same time, the fragility of “last mile” networks seems to be a common cause for larger system failures in both North America and EECCA regions.

Major approaches to deal with poor reliability are derived from the major contributing factors and direct causes of blackouts/brownouts and could be summarizes as follows:

- Building in required redundancy in major grids, so that consumers could switch to an alternative power delivery route in case of the main transmission line failure
- Constant modelling, monitoring and maintenance of the grid condition, to avoid unexpected disruptions
- Ensuring on-site backups (e.g., fuel oil generators) in most vulnerable areas
- Building smart-grids to handle variable loads and transmission constraints
- Promoting auto-generation (including renewables) in the isolated locations with poor grid access.

Access to alternative energy solutions

This dimension of the “access to advanced energy services” is defined here as opportunity for consumers to choose between different “traditional” energy sources, such as electricity, natural gas from the grid, LPG, fuel oil, and district heating (access to renewable energy sources is addressed separately).

It should be noted that these alternative energy carriers have widely different technical and economic parameters. For instance, electricity is the most versatile and could be used for all possible applications, including cooking, heating, cooling and powering electric devices. At the same time, the use of electricity for heating, especially in countries with cooler climate could be prohibitively expensive, which makes the district heating alternative quite attractive in the areas with higher population densities in such UNECE countries as Denmark, Russia, Ukraine and Belarus.

Another important advantage of the access to different energy carriers is an opportunity to use alternative providers. While the “last mile” grid connections are normally controlled by regulated local monopolies (e.g., local natural gas or electricity distribution companies) the energy carrier (e.g., electricity or gas) could be supplied by alternative providers (e.g., power generation companies).
Given that different UNECE members have widely different approaches to energy markets, from most liberal to highly monopolistic, it could be recommended that more rigorous analysis is done on how the width of consumer choice affects the quality of received energy services. It could be also suggested to examine the economic/market causes and consequences of wide-spread introduction of auto generation/distributed generation.

Overall, while the distributed generation could not replace the centralized grids it could compel the local grid monopolies (along with alternative grid-based suppliers) to become more effective and customer-friendly. It could be argued that in a near future each customer would be able to choose its energy service solution in a most optimal and cost-effective fashion (similar to choosing a phone or internet connection). A list of options should include:

- Traditional hard-wired local grid provider for all energy services
- Alternative supplier via a local grid company
- Self-generation (distributed generation).

Access to modern renewable energy instruments

It should be noted that while in North America and EU the use of renewables is based on modern technologies, in remote parts of Russia, Central Asia and Caucasus the use of traditional biomass (fuel wood, peat, and animal manure) is still practiced for cooking and heating on a regular basis. Clearly, such a practice is commonly seen as a sign of backwardness and is likely be completely replaced by modern energy solutions.

The following characteristics of the access to modern RE instruments could be identified:

1. Ability of consumers to purchase "green" power from the grid (e.g., energy produced from such renewable sources as wind, solar, biomass, etc.) or as liquid/solid fuel (wood pellets, biodiesel, etc.)
2. Ability of consumers to self-generate energy for their own need (e.g., roof-installed solar panels, biomass digesters, heat pumps, etc.)
3. Ability of consumers to sell excess RE energy back to the grid and
4. Availability of governmental RE economic support mechanisms in terms of subsidies, carbon taxes, carbon offset schemes, etc.
5. Availability of informational and technological support (e.g., equipment and installers of solar panels, etc.).

There are strong differences in the RE uptake in case of different UNECE members. While the centralized support is quite important for large RE generation projects it does not seem to affect final energy consumer choice. Households in EU and US purchase "green power" not because it is cheaper than conventional (the "green" surcharge is about 15% on top of regular tariff), but because the "educated" consumer understands the global environmental challenges and wants personally to contribute to their solutions. Economic stimuli are more important in purchasing and installing end-user renewable generation, including small wind, solar heating and PV, biodigesters and heat pumps. In addition to saving money on fuel cost owners of such auto-generation in some jurisdictions receive tax credits, rebates and even can sell access power back to the grid (e.g., in Germany).

While the "big" RE generation in the EU is presently under strain due to the cancellation of government subsidies, consumer-based auto-generation is getting momentum in US and Canada, most EU states, and even in some Caucasus and Central Asia jurisdictions. It appears that all the five characteristics of the access to modern renewable energy services are equally important for the share of RE sources to increase on both the small- and large scales.
While different government support mechanisms for large-scale RE generation have been studied in great detail (e.g., http://www.iea.org/policiesandmeasures/renewableenergy/) much less attention have been dedicated to consumer access to RE in various forms. It could be suggested that this topic is further analyzed across UNECE members and specific recommendations on improving such an access could be made.

Access to modern energy efficiency instruments

Similar to the fast growth in renewable energy use the drive to increase end-use energy efficiency (EE) during the last decade has been primarily related to an urgent need for controlling GHG emissions. Both households and businesses use a wide variety of instruments to save energy while improving the quality of energy services. These instruments include:

(1) Introduction of demand-side management (DSM) programs at the regional and individual consumer levels;

(2) Wide availability of energy efficient devices and appliances, which are appropriately labeled and certified ;
(3) Introduction of smart metering and smart grids
(4) Increased availability of energy efficient building technologies
(5) Increased availability of information on how to save energy.

As in the case of renewable energy, UNECE members differ greatly in the access to EE instruments, including those provided by utilities. The access to EE instruments have very clear economic dimension as it allows consumers to save money while helping the environment. Energy efficient devices ranging from LED lighting to energy-efficient HVACs to low emission vehicles are in most cases more functional allowing consumers a wider choice of options (e.g., LED lighting is much more versatile in comparison with traditional ICLs or more efficient CFLs).

In some UNECE jurisdictions (e.g., North America) the national energy efficiency strategies are actually focused on improving consumer access to EE instruments, while other (e.g., Russia, Kazakhstan) rely more on mandatory measures (e.g., requirement to reduce energy use by 3-5% per year for public institutions). In North America a very large emphasis is made on the informational component of the access to modern energy efficiency instruments. Several large voluntary certification and labeling schemes are in place including Energy STAR, LEEDs, etc. Such schemes have proven to be very effective when they are sufficiently publicized, i.e., when consumers could make educated choices based on labels and certificates attached to consumers products, housing, transportation options, etc.

Affordability

The affordability dimension of the "access to advanced energy services" concept is tightly linked with all other dimensions. In fact, most the aforementioned characteristics of the "access" could be delivered to a local consumer at a certain price at most metropolitan areas across the UNECE region. This price tag, however, will vary greatly from one country to another. At the same time, the aspect of energy service affordability does not correlate with average income per capita and is equally important in countries with quite different energy systems and wealth levels such as USA and Russia. Even in EU, the share of consumers having difficulty paying electricity bills varies across countries from 5% to 69%.
The UNECE region-wide studies of energy affordability are quite scarce. Most research is done either for North America or EU. For instance one of the EU studies has discovered wide ranging levels of basic electric power affordability (e.g., from just over 1% in Lithuania to close to 4% in Bulgaria). Also, the same time, according to a recent World Bank study[4], across the EECCA region, the highest shares of income spent on energy services are found in Hungary, Bulgaria and Serbia, and the lowest – in Tajikistan and Ukraine.

The principle improvements in the advanced energy service affordability could be achieved by better tailoring the type of service to the needs of individual consumers. For instance, the recent World Bank study shows that low income families tend to allocate higher shares of their energy budgets to electricity relative to other groups because they tend to have less access to alternative sources such as district heating or gas, especially in rural areas.

[4] World Bank: BALANCING ACT -- Cutting Energy Subsidies While Protecting Affordability, 2013.

Another clear answer to attaining affordable services is continuous deregulation of competitive sectors of the energy system. Such a deregulation could help to keep energy costs at manageable levels. Also, the recent World Bank study recommends that countries where tariffs are still subsidized (e.g, in most of the EECCA sub-region) need to define a path to increasing tariffs and the policy responses necessary to cushion the impacts of such increases.

Conclusions and recommendations

The brief analysis presented above is focused on identifying and describing key dimensions defining the "access to advanced energy services" in the UNECE member countries. Such type of access is different to the access to "basic" or "modern" services that is widely addressed in developing agencies' reports and programs and focused primarily on poorest countries of Africa, Asia and Latin America.

A large majority of population in the UNECE region has relatively good access to basic and modern energy services. At the same time, the global need for low-carbon "green" development compels the UNECE members to introduce a range of policies and measures facilitating universal access to "advanced energy services", which could be defined as "customized, affordable, and reliable access to retail energy markets supplemented by widely available self-generation, renewable energy and energy efficiency solutions".

In order to find appropriate solutions for attaining the universal and equitable access to advanced energy services this subject should be analyzed in greater details. Below we suggest main directions of further analysis with respect to different access "dimensions":

1) Connection to energy grids

A large majority of UNECE consumers have potential physical access to electricity grids. However, grid connection charges for new customers and duration of this process varies widely, with most of EECCA countries having unduly lengthy and expensive connection process (for both consumers and generators). An in-depth analysis of the factors that lead to this situation could be recommended. A range of factors that could be analyzed include technological; managerial; and economic. This analysis could also include a comparative assessment on how the connection process is related to the structure of energy markets and presence of alternative energy service providers. The streamlining of grid connection process (including all types of grids: electric, natural gas and district heating) is very essential not only for new residential consumers, but also to business since this parameter is one of those defining the IFC "doing business" national rankings.

2) Reliability of power supply

With growing demand on energy grids from new consumers and alternative generators the issue of reliability becomes the critical one for most of the UNECE members. While the importance of different fundamental contributing factors and immediate causes of blackouts and brownouts is likely to differ from one UNECE member to another there are likely to be several universal trends and solutions to this challenge. A further study of the power supply reliability should address such key topics as:

- Relationship between power outages and investment in grid infrastructure
- Cost/benefit assessment of continuous modeling/monitoring/maintenance of grids and a frequency of grid failures
- Approaches to consumer involvement in maintaining the "last mile" grid integrity
- Impact of distributed and intermittent generation on the grid reliability

- Options for improving reliability of power supply in remote and/or mountainous areas
- Options for including power supply reliability in estimating the cost of energy supply in different locations,
- Relative costs of improving grid reliability vs. maintaining back-up generation, etc.

3) Access to alternative energy solutions

A wider consumer choice between different traditional energy sources leads to increased energy efficiency and could also result in improved affordability. For instance, a recent World Bank study have found that EU jurisdictions with access to multiple energy sources (e.g., district heating, electricity, LPG, etc.) have better overall affordability that those with just electric grid connection.[5] An in-depth analysis of linkages between a quality of service and a range of consumer energy service choice (including a choice between auto-generation and energy from the grid as well as the choice between alternative commercial suppliers) could give UNECE members a foundation for advancing energy market reforms. A list of topics that could be covered by such an analysis includes:

- Co-relation between affordability/reliability and a number of alternative energy sources available to consumers
- Mechanisms and options for establishing competitive retail market for electricity, natural gas and heat providers
- Costs and benefits of auto-generation in different economic circumstances (e.g., which level of energy price could trigger a switch auto-generation)
- Modifying traditional economic model of utilities in conditions of wider consumer choice and open access to energy grids
- Technological solutions for open energy markets.

4) Access to modern renewable energy instruments

Energy from renewable sources is projected to demonstrate the fastest growth among other energy sources reaching 14% of the global supply by 2040 (EIA reference case scenario)[6] . For this scenario to materialize the centralized government support policies (e.g., feed-in tariffs) need to be complimented by measures that provide greater access to renewables to individual consumers, including businesses and households. An educated consumer choice in favor of energy generated from renewable sources could give the RE industry competitive edge over fossil fuel-based generation. While most of the RE studies are focused on measures to support large RE generation, it could be recommended that more attention is given to a consumer angle, seeking answers to the following questions:

- What type of tools/information could convince consumers to choose RE energy supplier?
- In what conditions could the renewable self-generation become an alternative to traditional energy sources?
- What is more cost-effective for a national economy give subsidies to large RE generators or rebates/incentives to consumers to purchase renewable energy?

5) *Access to energy saving instruments*

Facilitating energy efficiency policies and reaching measurable energy savings is the prime objective of such ongoing UNECE initiatives as EE21 and GEE21. As it could be seen

[5] World Bank: BALANCING ACT -- Cutting Energy Subsidies While Protecting Affordability, 2013.
[6] http://www.eia.gov/forecasts/ieo/more_highlights.cfm

from international experience, one of the key factors of reaching sustainable progress in making national economics more energy efficient is giving final consumers (businesses and households) a wide range of instruments, including technology and knowledge on how to save energy. Some UNECE countries have gone long ways in developing and implementing such instruments, while other are still making first steps in this direction. An in-depth analysis of best practices of empowering consumers to make educated energy saving choices could make a great difference in advancing UNECE energy efficiency objectives. Such an analysis could cover the following issues:

- What is an optimal balance between mandatory top-down energy efficiency standards and voluntary initiatives based on free consumer choice?
- Are the higher energy tariffs always lead to greater savings?
- How to make energy utilities co-finance end use energy efficiency?
- What is the role of the financial sector in making economy more energy efficient?
- How the “smart gird” and “smart meters” could help consumers to save energy?

6) Affordability

The relative wealth of UNECE members (e.g., measure by GPD/capita) ranges widely. However, single instances of “energy poverty” could be found in most of the UNECE countries. A drive to raise regulated tariffs in the EECCA region has already made electricity in relative terms (e.g., the ration of average tariff divided by GDP/cap) more expensive in poorer countries than in more wealthy ones. For instance residents of Moscow (Russia) pay for electricity about the same price (between 12 and 13 US cents/kWt-h), while the income per capita in Moscow (in $USD) is lower by 3-4 times.
The affordability is commonly contrasted with efficiency: the argument is that cheap energy does not incentivize to save. It could be recommended that this and other affordability-related issues are analyzed in a greater detail. A potential list of topics for analysis includes:

- Is there a connection between affordability and quality of advanced energy service?
- How to make energy affordable for all without universally subsidized tariffs?
- Would affordability suffer in competitive retail energy markets?
- How “smart grids” could help to reduce energy poverty?
- What are the linkages between a higher share of renewable energy and average affordability?