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Energy access in the United Nations Economic Commission for Europe

Access to energy services in the ECE region[1]

Contents

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Summary

The United Nations Economic Commission for Europe (ECE) member States mandated the newly established Group of Experts on Renewable Energy (GERE) to carry out action-oriented, practical activities to significantly increase the uptake of renewable energy (RE), in line with the United Nations (UN) Secretary General's Sustainable Energy for All (SE4ALL) initiative.

Among the concrete activities, the Group of Experts will consider to help member States, at their request, identify those communities in the ECE region that, at present, have no access to energy, and suggest ways to ensure that these communities have access to renewable or alternative sources of energy as soon as possible.

Given the diversity of the ECE member States, energy demand and quality of supply differ greatly within the region. In this discussion paper, access to energy will be analysed in terms of access to energy services and more precisely, the electrification aspect has been considered throughout this paper.

In order to identify the communities with limited access to energy services, we should consider that there is not a single agreed-upon definition for this concept. Therefore, various methods have been adopted to measure the developments in this field based on different definitions, rendering comparisons of the information often irrelevant from one source to another.

This overview of the situation on access to energy services in the ECE region is mainly based on the Global Tracking Framework report (GTF), a multi-agency study led by the World Bank Group (WB) and the International Energy Agency (IEA), which is the database that tracks developments regarding the three objective of the SE4ALL initiative. Certain areas of the ECE region present limited physical access to electrification cases, even though this only concerns a minority of the population according to the GTF "Access to electricity" indicator.

Identifying the communities with limited access to energy services relies on the availability of data. Throughout this paper, gaps regarding data have been identified in terms of data availability, quality and reliability. Energy access data for many of the region's 56 Member countries exist but for many countries are not readily available, up-to-date, accessible or reliable. This is an obstacle for strategic energy planning in many of the ECE countries and may represent a challenge to be tackled in future activities of the GERE.

Furthermore, taking into account key RE sources that could be used in remote areas to ensure access to energy and summarised in this paper, the Group of Experts could work together with major stakeholders to ensure access to energy services through an integrated approach which promotes RE uptake and energy efficiency improvements.

I. Concept of access to energy services

1. Access to energy services, a basis for growth

In the ECE region, the energy demand and quality of supply differ greatly between the member States. Disparities remain within the ECE region, which includes developed and developing countries. For this reason tackling access to energy services issues should be approached through different angles depending on local economic, social and environmental circumstances between countries.

Access to energy is fundamental to overcome poverty, improving health, increasing productivity, enhancing competitiveness and promoting economic growth[2] eradicating extreme poverty as desired by the Millennium Development Goals (MDGs). “Although energy itself is not a basic human need, it is critical for the fulfilment of all needs. Lack of access to diverse and affordable energy services means that the basic needs of many people are not being met[3]”. So, energy is the underpinning element to ensure economic and social development.

The Brundtland report of 1987 was the first report to define the concept of Sustainable development given the three pillars of economic growth, environmental protection and social equity. The objective is to set long-term environmental strategies for achieving sustainable development, generate greater global co-operation, invite the international community to effectively deal with these concerns, and define shared perception of the environmental issues and efforts needed to overcome such challenges[4]. The World Commission on Environment and Development recognizes the importance of universal provision of energy services as a crucial input to provide basic needs and as a determinant of poverty and development.

According to certain authors, a binding minimum standard for access to energy should constitute a human right. Adrian J. Bradbrook[5] provides characteristics for what a human right on energy access should be. He believes access to energy is the basis for equal and non-discriminating access to a sufficient, regular, reliable efficient, safe, and affordable supply of (ideally and sustainable) energy thereby translating primary energy needs from the Maslow Motivation theory into energy needs. Therefore "implementation of the right should require the supply of just sufficient energy to meet to the most pressing needs for cooking, lighting and refrigeration".

Even though, the MDGs do not have a specific goal on energy, the UN-Secretary General Ban Ki-moon launched the SE4ALL initiative in 2011, which is aimed to ensure universal access to energy services, double the share of RE in the energy mix and increase significantly energy efficiency by 2030. Sustainable energy is now recognized as a ground for sustainable development. These global objectives engage countries to set national targets in line with the overall initiative. The topic of sustainable energy is also projected to be prominent in the post-2015 agenda which will include Sustainable Development Goals, taking over the lead on the MDGs. The UN-Secretary General also declared 2012 as the “International Year of Sustainable Energy for All” then announced a “Decade of

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[2] WEO 2011, p.470

[3] Adrian J. Bradbook, April 2006, p.3

[4] United Nations, 1983, “Process of preparation of the Environmental Perspective to the Year 2000 and Beyond”. General Assembly Resolution 38/161, 19 December 1983: http://www.un.org/documents/ga/res/38/a38r161.htm (16.10.2014)

[5] Adrian J. Bradbook, April 2006, p.15

Sustainable Energy for All” from 2012 to 2024. Therefore access to energy services has gained attention from the international community.

2. Key characteristics of access to energy services

Access to modern energy services is often measured by the percentage of populations served by either national or local power networks. Access to modern energy services also includes reliability or quality of service, which can be degraded either by inadequate generating capability, transmission and distribution, end-use customer service, or maintenance, since intermittent or ephemeral service over networks cannot be considered “access”. Access also includes an economic dimension related to the ability to pay the full costs of energy services. If subsidies were to be removed, then prices would rise, and the subsidies are in the form of fossil fuel subsidies, renewables subsidies, lack of a price on carbon emissions, low end-use tariffs, and so forth. Prices would also rise if the needed investments were made to improve the quality of service.

The GTF defines access to electricity as "the availability of an electricity connection at home or the use of electricity for lighting" and "access to energy for cooking is usually equated with the use of non-solid fuels (liquid fuels, gaseous fuels such as natural gas, liquefied petroleum gas and biogas, and electricity; solid fuels include traditional biomass, for example wood, charcoal, agricultural residues, and dung), processed biomass, such as pellets and briquettes, and other solid fuels such as coal and lignite) as the primary energy source for cooking[6]”.

The UN Secretary General’s Advisory Group on Energy and Climate (AGEC) defines energy access as the access “to a basic minimum threshold of modern energy services for both consumption and productive uses. This means that the objective is not only to provide a physical access to energy but modern energy services in terms of reliability, affordability, sustainability and where feasible, from low-greenhouse gas-emitting energy sources”[7].

Along these lines, a set of characteristics has been considered to measure access to modern energy such as the physical connection to the grids, the reliability of supplied power, the availability of alternative energy solutions, the access to clean energy systems including RE sources and energy efficient measures. Finally, because access to energy services is meaningless if unaffordable the cost of energy services must be affordable across all ranges of incomes.

These characteristics are in line with the approach of the World Energy Council (WEC) in delivering sustainable energy systems. The concept of the "Energy Trilemma" lies on the three following pillars: (i) energy security includes the effective management of primary use of energy, the reliability of the energy infrastructure, and the ability of energy providers to meet current and future demand ; (ii) energy equity incorporates the physical accessibility and affordability of energy supply across the population aspect; (iii) environmental sustainability comprises the achievement of energy efficiency and the development of energy supply from renewable and other low-carbon sources[8].

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[6] WB, SE4ALL, GTF

[7] UN Secretary General’s Advisory Group on Energy and Climate (AGEC), Energy for a Sustainable Future: Summary report and recommendations, United Nations, 28 April 2010, New York

[8] Wyman, 2013

Energy poverty is of main concern in other parts of the world (especially Africa and Asia). Nonetheless, access to energy can be defined in a sense that surpasses physical access through the notion of quality of energy services which concerns any energy system. Access to sustainable energy services could be interpreted as a threefold concept as follows:

- Physical access relates to the connections to energy grids and reliable power supply.
- Environmental protection is ensured through clean energy sources such as energy efficient infrastructures and appliances, and low carbon sources such as RE.
- Economic sustainability reflects the social equity aspect of affordable energy services for end-users through schemes and mechanisms that are viable on the long-term for the economy.

In this paper, access to energy will be treated on a perspective of access to energy services from the electrification standpoint because of the role RE could play in that respect.

3. Issues in the ECE region

Given the geographical, economic and social variations within the ECE region, it is well known that certain regions have limited access to energy services. Though identifying these geographically dispersed villages is not an easy task given the current datasets. The objective of this paper is to highlight the need for these communities to be located in order to find solutions. Because energy is the underlying element for development, the international community should aim to ensure total modern energy services in the ECE region, in line with the SE4ALL initiative. Understanding the gaps constitutes the first step to creating a path for development. All stakeholders should be engaged in this discussion to overcome this challenge, such as policy makers, industries, and the investing community. Such solutions could range from cooperation on a development perspective with various development cooperation programs as well as technical cooperation projects or on a commercial basis by mobilizing the private sector to collaborate together with governments and create partnerships.

4. Developments in data gathering

When addressing physical access to electricity grids, we are facing energy poverty. To assess energy poverty, a poverty line must be defined. The following three elements are necessary to compute a poverty measure. Defining and assessing energy poverty is essential, for this matter **measuring** the developments through the relevant **indicators** and drawing a **poverty line** for a certain scope[9].

A report from the Asian Development Bank (ADB) defines energy poverty as the situation where there is “lack of access to electricity and modern cooking fuel”[10]. Therefore these elements could be measured to indicate an energy poverty situation.

The “energy ladder” [11] is a concept that translates energy poverty by examining trends and impacts of household fuel use. The ladder ranks household fuels along a spectrum running

[9] Coudouel et al. (2002), Poverty Measurement and Analysis, in the Poverty Reduction Strategy Paper (PRSP) Sourcebook, World Bank, Washington D.C.

[10] Sovacool, B. (2013), *Energy Access and Energy Security in Asia and the Pacific*, Energy, Economics working papers, Asian Development Bank, http://www.adb.org/publications/energy-access-and-energy-security-asia-and-pacific (21.10.2014)

from simple biomass fuels (dung, crop residues, wood) through fossil fuels (kerosene and gas) to the most modern form (electricity)[12]. The energy ladder also ranks different energy fuels and sources from the most traditional kinds used in low-income countries to more modern types that are commonly used in developed countries[13]. This ladder could be used as a source of indicators to measure energy poverty.

In terms of a minimal threshold, there is no global consensus. The IEA has set a baseline for electricity consumption indicating access to electricity in a household[14]. Access to electricity involves more than a first supply connection to the household; the amount of consumption of a specified minimum level of electricity varies based on whether the household is in a rural or an urban area.[15]

Table 1: Baseline for access to electricity

Type of area	Energy consumption per household per year (kWh)
Urban	500
Rural	250

OECD/IEA, WEO 2011

In annex 2, a table with yearly electricity consumptions of daily appliances is provided. This gives indications on what kind of appliances could be powered with such energy consumption rates (250-500 kWh per year).

The AGEC suggests a multilevel approach which captures the different tiers of energy services. The AGEC's modern society needs of electricity consumption amounts to an electricity consumption of 2,000 kWh per household per year.[16] Therefore is an electricity consumption of 250-500 kWh per year per household an adequate baseline determining energy poverty for the ECE region?

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[11] See International Energy Agency, United Nations Development Programme, United Nations Industrial Development Organization (2010) ; Jones (2009) ; Legros et al (2009) ; Cook et al (2005) ; International Energy Agency (2004) ; and Barnes and Floor (1996)

[12] UNDP, UN-DESA, *World Energy Assessment*
For more information: "The 'energy ladder' is a useful framework for examining trends and impacts of household fuel use (…). The ladder ranks household fuels along a spectrum running from simple biomass fuels (dung, crop residues, wood) through fossil fuels (kerosene and gas) to the most modern form (electricity). The fuel-stove combinations that represent rungs in the ladder tend to become cleaner, more efficient, more storable, and more controllable in moving up the ladder.2 But capital costs and dependence on centralised fuel cycles also tend to increase in moving up the ladder", OTA (Office of Technology Assessment). 1992. *Fueling Development:Energy Technologies for Developing Countries.* OTA-E516

[13] Pieter van Beukering, Jos Bruggink, Roy Brouwer, Frans Berkhout, Raouf Saidi, Greening the African energy ladder, The role of national policies and international aid, (2009) http://www.ivm.vu.nl/en/Images/Scoping%20paper%20IS%20Academy%20-%20ReNeW_tcm53-93243.pdf

[14] IEA measures access to electricity on a household basis with an assumption of five persons per household.

[15] WEO 2011, p.473

[16] AGEC, Energy for a Sustainable Future: Summary report and recommendations, United Nations, 28 April 2010, New York, http://www.unido.org/fileadmin/user_media/Publications/download/AGECCsummaryreport.pdf (16.10.2014)

Table 2: Access to energy services levels

Levels	(1) Basic human needs	(2) Productive uses	(3) Modern society needs
Electricity use (kWh per person per year)	**50-100** Lighting, health, education, communication, and community services	**500-1,000** Electricity modern fuels and other energy services to improve productivity: Agriculture, water pumping, irrigation, fertilizer, mechanized tilling Commercial: agricultural processing, cottage industry Transport: fuel	**2,000** Modern energy services for many more domestic appliances, increased requirements for cooling and heating (space and water)
Solid-fuel use (koe per person per year)	**50-100** Cooking and heating	**150** Minimal use Transport: Mass transit, motorcycle, or scooter	**250-450** Minimal use Private transportation

AGEC (2010), ADB report (2013)

Many methodologies exist (cf. Annex1), from a single indicator method – for instance defining a threshold for energy poverty – to a composite assessment such as the Energy Development Index (EDI) from IEA. This assessment does not just analyse the physical access to electricity but also, what is referred to as the quality of supply[17]. However, the IEA's WEO highlights several weaknesses such as the lack of data and a common standard for minimal quality.[18]

The GTF report advocates a multi-tier analysis. It would measure different attributes of energy services such as quality of electricity supply, legality, affordability, duration and peak of availability capacities through five tiers. This approach should capture the multidimensional aspects of access to energy services.

Given the striking issues that revolve around access to energy services, the overall question remains:

How could access to energy services be approached in the ECE region from an electrification perspective?

[17] WEO – Methodology for Energy Access Analysis
[18] WEO – Methodology for Energy Access Analysis

II. Overview of the situation on access to energy services in the ECE region

1. Assessment of physical access: Global Tracking Framework Report

The GTF determines energy access based on the results of household surveys that clarify the percentage of the population with connection to electrical network and thus access to non-solid fuels. The GTF defines solid fuels as traditional biomass (wood, charcoal, agriculture and forest residues, dung, etc.), processed biomass (pellets and briquettes) and others such as coal and lignite.

The GTF statistical concept and methodology for calculating access to electricity as applied by GTF

“Data for access to electricity are collected from different sources: mostly data from nationally representative household surveys (including national censuses) were used. Survey sources include Demographic and Health Surveys and Living Standards Measurement Surveys, Multi-Indicator Cluster Surveys, the World Health Survey, other nationally developed and implemented surveys, and various government agencies (for example, ministries of energy and utilities). Given the low frequency and the regional distribution of some surveys, a number of countries have gaps in available data. To develop the historical evolution and starting point of electrification rates, a simple modeling approach was adopted to fill in the missing data points - around 1990, around 2000, and around 2010. Therefore, a country can have a continuum of zero to three data points. There are 42 countries with zero data point and the weighted regional average was used as an estimate for electrification in each of the data periods. 170 countries have between one and three data points and missing data are estimated by using a model with region, country, and time variables. The model keeps the original observation if data is available for any of the time periods. This modelling approach allowed the estimation of electrification rates for 212 countries over these three time periods (Indicated as "Estimate"). Notation "Assumption" refers to the assumption of universal access in countries classified as developed by the UN.”[19]

The nine ECE member States, where population has less than 100 percent access to electrical network as determined by the above-described methodology, are shown in Table 3. Shares of such population are shown as percentage of (i) total population, (ii) urban population, and (iii) rural population.

[19] Global Tracking Framework, SE4ALL Database

Table 3: ECE countries with less than 100 percent access of population to electrical networks (GTF 2010)

ECE member State	Total population in 2011 (mill.)	Percentage of total population (%)	Population with no access in 2011	Average electricity consumption per capita in 2011 (kWh/cap)	Assessment of electricity consumption in 2011 (MWh)	Percentage of urban population with access (%)	Percentage of rural population with access (%)
Armenia	3.0	99.8	5'900	1,755	10,404	99.9	99.7
Azerbaijan	9.2	99.4	55'000	1,705	93,840	99.7	99.7
Bosnia and Herzegovina	3.8	99.7	11'500	3,189	36,728		97.7
The former Yugoslav Republic of Macedonia	2.1	99.0	21'000	3,881	81,656	99.7	98.0
Moldova	3.6	98.6	49'800	1,470	73,265	99.3	98.0
Ukraine	45.7	99.8	91'400	3,662	334,751	99.9	99.6
Kazakhstan	16.6			5,306			97.5
Tajikistan	7.8			2,089			99.0
Turkmenistan	5.1			2,873			99.6
TOTALS							
Sub-total (1-9)	**96.8**		**234'800**		**630,643**	**or 2.27 PJ**	
Total for ECE region	**1,245.3**		**1,245,277.0**	**7,736**	**9,633,270,147**		
Percentage of ECE (%)			**0.019**		**0.007**		

**) Assuming that all population with no access to electrical networks would consume the national average amount of electricity per capita (kWh/cap).*
Source: WB, Global Tracking Mechanism (2010).

The ECE region scores high electrification rates, from 98.6 to 100 percent. Nevertheless, total access to energy services has not yet been achieved. The table also shows that the population in rural areas have lower access rates than in urban regions. This implies that the energy consumption is unequal within these countries. Therefore we can conclude that the major issue revolves around connecting remote and mountainous areas to electricity grids. For instance, Kazakhstan is the world's largest landlocked country and the ninth largest country in the world. The territory includes flatlands, steppe, taiga, rock canyons, hills, deltas, snow-capped mountains, and deserts.[20] Connecting such remote and low populated

[20] Reegle. Country Energy Profile: Kazakhstan, http://www.reegle.info/countries/kazakhstan-energy-profile/KZ (8.10.2014).

locations (e.g. Siberia in the Russian Federation, central parts of Kazakhstan, and mountainous regions of the Caucasus nations) to existing grids would not be a cost-effective solution.

Energy consumption trends – The figure 1 shows the energy consumption rate for the households sector per capita according the WEC's energy efficiency indicator. The electricity use of households per capita is the ratio between the electricity consumption of households and the number of inhabitants[21].

$$\mathbf{elefcrespop} = \frac{\mathbf{elefcres}}{\mathbf{pop}}$$

With:
elefcrespop: electricity use of households per capita(kWh/cap)
elccfres: electricity consumption of households (MWh)
pop: number of inhabitants (million)

The GTF provides the electricity consumption per capita per year but the results differ greatly with the WEC's data because the later accounts for the average household electricity consumption per capita. Given the fact that the definition of access to energy in the GTF report is focused on access to electrification in homes, this indicator could be useful. However, data is unavailable in fifteen ECE member States. There is one country in the region where the average electricity consumption of households per capita is below 500 kWh per year. In this case, basic human needs for electricity use are barely being met. Given this table, ten countries have an average household electricity consumption between 500 kWh and 1,000 kWh per capita in year 2011. These countries do not meet the AGEC's baseline for productive uses of electricity. Therefore, there is a considerable potential to strengthen the quality of the energy services to reach modern society needs in the ECE region in terms of energy paucity and quality of supply.

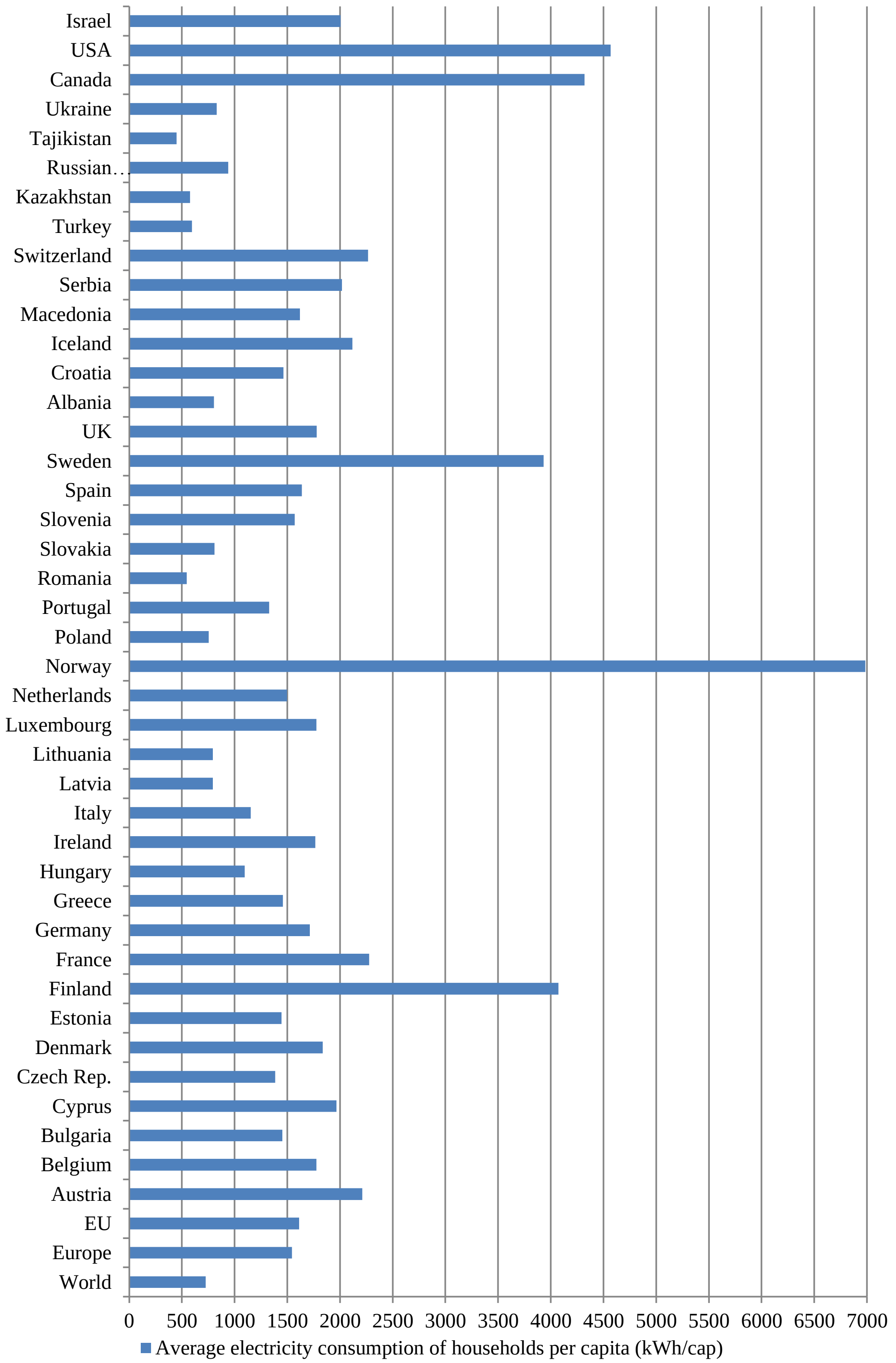
Quality of data – Extensive information on the topic of access to energy services is provided by different organizations and reports regarding the binary characteristics of access to energy (in terms of availability of electricity connections and the reliance on non-solid fuels for cooking and lighting). There is the IEA's World Energy Outlook, the WB Development Indicators or energy series, the GTF report etc. However, the ECE region does not always appear in these various databases. For instance the IEA's World Energy Outlook for year 2013 does not provides data for the ECE region as it is focused on Africa, developing Asia and the Middle East[22]. Also, the WEC's data on the household electricity consumption per capita data does not account for fifteen ECE member States. Therefore, the availability of data is restrained for the ECE region. The GTF adopted a modeling approach to fill in the data gaps in order to obtain estimates. Because it provides analysis on a household basis, it does not account for the full range of energy services needed for earning a living or for community services.[23] According to a Poor People's Energy Outlook (PPEO) report, such measures fail to recognize the use of energy for productive ends or community services, neglects the role of mechanical power and intermediate technologies, and does not consider how energy is used and ultimately how people benefit from energy.

[21] WEC, Energy efficiency indicators, http://www.worldenergy.org/data/efficiency-indicators/ (24.10.2014)
[22] IEA, World Energy Outlook, 2013
[23] PPEO 2014, p. 52

Furthermore, the GTF database does not assess the quality of energy services, which is a major component to measure effective access to energy services. The absence of a single definition for access to energy services lead to either an over-counting situation or an under-counting situation. The PPEO report suggests, on the one hand, that the electrification rates are not meaningful unless affordability of the energy services (rather maintenance of the energy systems or electricity pricing) and the reliability of the energy systems are taken into account. A potential connection leads to an under counting situation when connections to energy services are supplied beyond the grid. The GTF report advocates the adoption of a multi-tier methodology that would encapsulate different stages of developments in the energy systems (cf. annex 1). In the absence of a single agreed-upon definition of the concept of access to energy services, various indicators could provide certain indications on the quality of energy systems but they are dispersed through different databases.

Therefore in the ECE region, data represents an issue in terms of availability, timeliness and reliability thereby quality. Filling the gaps may be done through survey as the GTF has conducted for year 2011 addressed to stakeholders such as governmental entities, main energy companies, associations.

Fig. 1: Average electricity consumption of households per capita, 2011



WEC, Energy Efficiency Indicator, Enerdata (http://www.wec-indicators.enerdata.eu/secteur.php)

2. Measuring quality of energy services

Access to electricity grid is meaningless if it is unaffordable for the population or unreliable. Access to energy services implies the availability of a physical access but also the availability of reliable, affordable, safe energy services. Therefore the quality of the energy supplied also characterizes the concept of access to energy services. The GTF does not track this aspect of access to energy services, though it advocates for a methodology that would encapsulate such dimensions. However, the indicators below provide some information on the quality of the services provided.

Affordability – End-use prices should be affordable in a sense that electricity pricing should take into account life-cycle costs, including return on investment, and both the resources and requirements of the buyer. Ensuring affordability is ensuring that investments are made throughout the value chain – from primary energy development to final consumers – and that all involved have fair access to energy markets. Affordable pricing should allow end-users to have the ability to pay for supply costs.

Reliability of power supply – This relates to electric blackouts, brownouts and disruptions in the central heating delivery as well as prompt restoration of access to power[24]. In the ECE region, the reliability of such access varies depending on local circumstances. The fragility of networks could be a common cause for system failures in the ECE region. For instance a UNDP study found that reliability and affordability of energy access services in certain member States constitute main barriers to access to energy services. In rural mountainous areas, households rely on coal and electricity for heating; therefore such areas are vulnerable to interruptions of electricity supply.[25]

The WB assesses the value lost due to electrical outages and the average number of power outages that establishments experience during a typical month.

Table 4: Member States with the most power outages in the ECE region

Member State/Indicator 2013	Number of power outages in firms in typical month	Value lost due to electrical outages (% of sales)
Tajikistan	6.2	9.3
Uzbekistan	5.7	6.5
Albania	4.2	5.4

WB, Enterprise Surveys (http://www.enterprisesurveys.org/), World Development Indicators

These indicators show that in certain ECE member States, regular power outages result in non-negligible losses for the private sector, up to 9 percent value lost. Therefore improving the reliability of energy services could strengthen the quality of supply and boost the private sector's economic performance.

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[24] UNECE, Committee on Sustainable Energy, Informal document No.8, Twenty-second session, Geneva, 21-22 November 2013, Assessing access to advanced energy services in the UNECE region, http://www.unece.org/fileadmin/DAM/energy/se/pdfs/comm22/InfDocs/ID.8_AssessingAccessAdvEnerServUNECE.pdf (16.10.2014)

[25] UNDP: Household Energy Access and Affordability in Kyrgyzstan and Tajikistan, 2011 (http://europeandcis.undp.org/uploads/public1/files/vulnerability/Senior%20Economist%20Web%20site/Brief_Report_PSIAs.pdf)

Alternative energy sources – This concerns the availability of electric grids, the choice of alternative providers and the ability to install autonomous generation[26]. The availability of alternative energy solutions could improve the reliability of energy services by ensuring back-up power. This could be important in the case of long power outages (e.g. for reconstruction purposes). Providing alternative energy sources offers more choices for the consumers and increases competiveness among the energy sources and companies thereby opening the energy market. This has been done in the European Union (EU). The Third Energy Package of 2007 (currently in force) aimed to open the electricity and gas market. In result the competition increased due the unbundling of ownership within the European electricity market. Also in the United States (United States of America), the Energy policy Act of 1992 opens the access for all electricity suppliers to the United States power grid leaving implementation of deregulation up the States level. Therefore diversifying energy supply could improve the reliability of energy services and affordability for end-use consumers. But, in certain countries alternative energy sources (as opposed to conventional sources) are limited. Therefore, improving the reliability of energy systems through providing alternative energy sources could be a possibility.

Ease of connectivity to new electricity grids – If getting electricity connections poses a challenge then the quality of energy services is affected. Firms consider that electricity is one of the biggest constraints to their businesses therefore electricity matters for businesses.[27] Prolonged delays to gain access to electrification would translate a fragile energy system and could discourage investments in a country. Measuring the ease of getting electricity as the International Finance Corporation (IFC) has done in its Doing Business project provides indications on the ease of getting an electricity connection. 189 Countries are ranked among which 51 are ECE member States. The IFC tracks the procedures, times and costs required for a business to obtain a permanent electricity connection for a newly constructed warehouse. The most recent round of data collection for the project was completed in June 2012.[28] The IFC ranking is provided for the member States in annex 3.

Within the region, certain countries' results show lengthy periods, extensive procedure and very high costs to obtain a new connection to electricity. The World Development Indicator from the WB, assesses the numbers of registered new businesses per country. Many reasons could explain lower numbers of newly created companies. For instances, the differences of sizes of a country could render comparisons irrelevant. However, it is safe to say that the easier it is to get a permanent connection to electrified networks, the better the conditions are to open a new business. Therefore there is a link between getting electricity and the corporate world.

Nevertheless, these indicators are national averages. So these results do not indicate what the situation is in remote areas and could only show overall performances.

[26] UNECE, Committee on Sustainable Energy, Informal document No.8, Twenty-second session, Geneva, 21-22 November 2013, Assessing access to advanced energy services in the UNECE region, http://www.unece.org/fileadmin/DAM/energy/se/pdfs/comm22/InfDocs/ID.8_AssessingAccessAdvEnerServUNECE.pdf (16.10.2014)

[27] The international Bank for Reconstruction and Development / WB, *Getting Electricity, A pilot indicator set from the Doing Business Project*, 2010, http://www.doingbusiness.org/~/media/FPDKM/Doing%20Business/Documents/Special-Reports/Getting-Electricity-Pilot-Indicator-Project.pdf

[28] More information available on: http://www.doingbusiness.org/methodology (14.10.2014)

III. Integrated approach to providing access to affordable clean energy services in the ECE region

Improving access to energy could be done through clean and efficient solutions in line with the SE4ALL Initiative.

1. Energy efficient solutions

a. A tool to reduce energy demands

Electrification needs will grow as population increases. According to the IEA projections in 2010, 1.2 billion people will still lack access to electrification in 2030 if no additional policies are taken. To ensure universal access to energy services, an additional 250 GW should be generated according to the IEA[29].

The overall level of primary energy supply and its composition can be substantially modified by still considerable opportunities for more efficient use of energy [30]". Therefore, while RE sources could offer solutions for isolated communities with limited access to electrified networks, implementing energy efficient measures is a prior step that could reduce significantly the amount of electricity otherwise needed, thereby decreasing energy costs.

According to the UN Foundation, energy efficiency could strengthen access to energy services by[31]:

- **Extending the Grid:** this would require developing generation efficiency and end-use applications to reduce systems demand and free-up power for new connections. In other words, energy efficiency could help expand access by effectively enabling countries to supply power to more people through the existing energy infrastructure[32].
- **Improving energy services**: by improving the reliability, the availability of power supply by ensuring affordable services through modernized distribution systems and efficient appliances.
- **Enabling remote applications** by integrating highly efficient end-use appliances and equipment as part of RE systems to lower overall system cost and enable more energy service.

Furthermore, technology developments in the field of smart grids play a key role as they could enable end-users to reduce energy consumption through demand response mechanisms. The end-users could then better understand its electricity needs and adjust its consumption by maximizing efficiency. Such technology constitutes a step forward to improving the quality of energy services.

b. Various mechanisms

Many policies and mechanism have been implemented in the ECE region to encourage the development of activities that will increase energy efficiency. Raising awareness and

[29] OECD/IEA 2010, *Energy poverty – How to make modern energy access universal*? p.19 (http://www.iea.org/publications/worldenergyoutlook/resources/energydevelopment/universalenergyaccess/)
[30] WEF, Energy Transition: Past and Future, 2013, p. 43
[31] Hopkins M., UN Foundation, *Enabling Energy Access Through Energy Efficiency Presentation*, https://cleanenergysolutions.org/webfm_send/986 (7.10.2014)
[32] OECD/IEA 2014, *Capturing the multiple benefits of Energy Efficiency*

setting technological frameworks have been developed by different organizations. A few examples of mechanisms developed in the region are provided below.

The voluntary approach with energy efficiency standards and labels play an active role in setting baselines for improvement. For instance, the ISO5001 is an energy management standard[33], which provides a framework for any organizations – rather public or private, small or large – to manage energy. This standard spreads information on strategies to improve energy performance, including energy efficiency, use and consumption while reducing costs. It explains the requirements of an energy management system for an organization to develop and implement an energy policy, establish objectives, targets, and action plans, which take into account legal requirements and information related to significant energy use. An energy management system enables an organization to achieve its policy commitments, take action as needed to improve its energy performance and demonstrate the conformity of the system to the requirements of this International Standard.[34]

The Russian Federation harmonized the national legislation with this energy management standard. It is designed to improve the energy management for companies, provide access to the information needed to achieve the targets set for energy efficiency, support the procurement of energy efficient products and services. It also supports national and corporate energy efficiency projects[35].

In addition, the Energy Star Label (2001) encourages the increase of energy efficiency measures through uniform labeling. It identifies power-saving equipment such as computers, monitors, printers, copiers, so it provides information to the public on how to purchase energy-efficient equipment[36]. These standards and labels appear as successful mechanisms to raise awareness.

International cooperation is also necessary to share information on a global scale. For instance a collaborative approach has been adopted by the Energy Management Working Group of the Clean Energy Ministerial composed of eleven participating countries and other international organizations such as the IEA, the Institute for Industrial Productivity, the ISO, the Global Cool Cities Alliance, the International District Heating Association, DELTA, Fortum, Helsingin Energia, and Euroheat & Power. The aim for these stakeholders is to identify and evaluate energy management systems activities, opportunities, strategies, and best practises. In result the working group is increasing awareness by providing assistance to countries and releasing case studies[37].

In Kazakhstan, the economy accounts for 72 percent of total national energy consumption[38]. The ministry of Industry and New technologies of the Republic of Kazakhstan (MINT) is

[33] ISO, Win the energy challenge with ISO5001, http://www.iso.org/iso/iso_50001_energy.pdf

[34] ISO5001 – Energy Management, http://www.iso.org/iso/home/standards/management-standards/iso50001.htm

[35] For more information: Since 2013, Russia plans to put in place a national version of the standard ISO50001 Energy management, Russian Ministry Energy News, http://minenergo.gov.ru/press/min_news/11073.html

[36]DENA, Projects, Energy Star, http://www.dena.de/en/projects/energy-services/energy-star.html?tx_dscoverview%5Bliste%5D=1&tx_dscoverview%5Bpluginid%5D=7

[37] For more information : Clean Energy Ministerial, Fact Sheet: Global Superior Energy Performance Partnership,
http://www.cleanenergyministerial.org/Portals/2/pdfs/factsheets/FS_GSEP_April2013.pdf

[38] DENA, Energy Advice Centre in Kazakhstan, http://www.dena.de/en/projects/international/energy-advice-centre-in-kazakhstan.html

cooperating with the German Energy Agency (DENA) with the creation of an Energy Advice Centre in order to increase energy efficiency in Kazakhstan. It was established in 2012 in Astana. In result, DENA provided recommendations and measures for the Kazakh industrial sector. This collaboration introduces markets services for Kazakhs in the energy efficiency market, energy audits and efficiency measures for industries. This kind of collaboration constitutes a model for projects using the expertise of an organization and applying in areas that could benefit from such knowledge.

Such types of initiative increasing energy efficiency could be developed in order to ensure total access to energy services in line with the SE4ALL initiative.

2. Ensuring access to energy services through renewable energies

In rural areas, the challenge is to find cost-effective electrification solutions. Grid extension using traditional fossil fuels and large-scale hydropower is a standard investment model for governments which could attract large-scale private investment[39] but may not always be adequate for low-populated rural areas. Standard household electricity prices would be largely increased. However, because RE sources come from unlimited and accessible sources they could be more cost-effective solutions.[40] A brief overview of the RE sources that could be used in remote areas is provided below based on the IEA's definitions.

Wind energy – This is a kinetic energy of wind exploited for electricity generation in wind turbines and land-based wind refers to energy generated by wind turbines deployed in the mainland.[41]
Solar PV – According to the IEA such systems convert solar energy into electricity, but this technology faces the challenge that power output is limited to times when the sun is shining. There are now a number of cost-effective options that deal with this issue such as demand response, flexible generation, grid infrastructure, storage)[42]. The advantage with solar PV is that they are stand-alone technologies which can be easily installed in an isolated region.
Biomass – The IEA defines biomass as any organic matter from plants or animals available on a renewable basis; it includes wood and agricultural crops, herbaceous and woody energy crops, municipal organic wastes as well as manure. It defines bioenergy as the energy derived from the conversion of biomass where it may be used directly as fuel, or processed into liquids and gases. It is the single largest RE source today. It could provide basic energy for cooking and space heating. But, depending on its use, the IEA states that it could have severe health and environmental impacts[43]. Biomass is a major source of energy in rural areas, but it is being used in inefficient and unhealthy manners[44]. It must be processed through advanced biomass cook stoves, clean fuels and additional off-grid biomass electricity supply in developing countries.
Hydropower – According to the IEA hydropower derives energy from turbines being spun by flesh flowing water. This can be from rivers or from man-made installations, where water flows from a high-level reservoir down through a tunnel and away from a dam. It is a

[39] Emma Wilson, IIED, p.9
[40]OECD/IEA 2010, Energy poverty – How to make modern energy access universal? p.19
[41] IEA website, Topic: Renewables, http://www.iea.org/topics/renewables/subtopics/wind/ (16.10.2014)
[42] IEA website, Topic: Renewables, http://www.iea.org/topics/renewables/subtopics/solar/ (16.10.2014)
[43] IEA website, Topic: Renewables, http://www.iea.org/topics/renewables/subtopics/bioenergy/ (16.10.2014)
[44] United Nations Economic Commission for Europe, Sustainable Energy Division, Global Pro Poor Public Private Partnership (5P) Development, August 2012, p.16

mature and cost-competitive RE source and plays an important role in the current electricity's mix[45]. Small hydropower could be a suitable solution in remote areas as opposed to large hydro.

Off-grid and mini grid solution – RE sources offer isolated off-grid and mini-grid technologies. The IEA defines mini-grids as village- and district- level networks with loads up to 500 kW RE sources.[46] These stand-alone solutions are advantageous especially given the decreasing prices of such technologies. According to off-grid developers, stand-alone RE systems can even compete with kerosene in certain cases on a life-cycle basis.[47] Therefore, renewable energy technologies offer decentralised solutions such as Solar Home Systems, wind systems, biogas digesters, biogas gasifiers, micro-hydro power plants, etc.[48] According to the IEA, solar PV could provide basic services, such as lighting and drinking water but mini-hydro and biomass technologies are more appropriate for greater energy load demand[49]. Wind-power could provide a significant amount of power through cost competitive mini-wind systems.

Installing RE sources should been in accordance with local specificities such as climate and the environment, but also the socio-cultural context.[50] A brief overview on the overall RE potential is provided in table 7 for the member States with limited access to electrification according to the GTF database. This table offers a compilation of information and estimates. It appears that there is significant potential to provide electricity from off-grid and mini-grid RE sources such as wind, solar system and small hydro. Biomass is also an untapped source of energy in certain areas.

The annex 4, on Indicative qualitative assessment of renewable energy potential by renewable energy type and ECE member State, provides indications on renewable energy potential by RE type. It offers a general overview of possibilities in terms of renewables for each ECE member State.

Once again, most of the databases provide information on a national scale, but access to energy services mainly concerns remote areas within a country. A further study could be led to offer a more comprehensive set of information for each country with limited access to energy services in order to understand the gaps, needs, potential energy sources and provide appropriate recommendations according to local circumstances.

These clean technologies are low carbon emitting technologies and are in line with the SE4LL's overall target of climate change mitigation. However, the challenge for the uptake of RE is that certain sources such as solar PV and wind power cannot run continuously, as opposed to geothermal, hydropower or conventional energy sources. The intermittency of RE sources jeopardizes its reliability. To remediate to this, constant electricity, power storage is being developed to ensure energy supply in accordance with the energy demand. This would not only benefit the uptake of RE in general but also conventional energy

[45] IEA website, Topic: Renewables, http://www.iea.org/topics/renewables/subtopics/hydropower/ (16.10.2014)
[46]Alliance for Rural Electrification, Why renewable energy sources for rural electrification? http://www.ruralelec.org/17.0.html?&L=%2F (13.10.2014)
[47] Energy: diesel generators were not included in this analysis, though they compete with renewable options in markets (Wilson E., 2014)
[48] Alliance for Rural Electrification, Why renewable energy sources for rural electrification? http://www.ruralelec.org/17.0.html?&L=%2F (13.10.2014)
[49] OECD/IEA 2010, Energy poverty – How to make modern energy access universal? p.23
[50] Wilson et al., 2013

sources that run exclusively at times of peak load.[51] Therefore research and development in this area is encouraged. Such developments would then strengthen the possibility to install such technologies in rural areas.

[51] WEF, The Challenge of Intermittency, Energy Transitions: Past and Future, Energy vision 2013

Table 7: Indicative assessments of renewable energy potential for wind, solar, biomass and hydropower

Member State < 100% electrification access	Wind energy	Solar energy	Biomass energy	Hydropower
Armenia	Strong mountain valley winds Up to 20 m/s	Annual radiation average: 1,720 kWh/m2 per year	Potential for biomass power: there are areas of land covered by forest and land for agricultural industry including farming for plants and animals	Estimated economical feasible hydropower: 3.6 billion kWh/year
Azerbaijan	Estimated potential: 3 GW wind power capacity is undeveloped	High due to the favourable climatic conditions	Area of forests: 14.400 km2 which represents 3.2% of the overall territory. Potential for methane production from landfills	Estimated potential: 240 MWh per year
Bosnia and Herzegovina	Estimated potential: 900 MW is exploitable Velocity: 10 m/s at a height of 10 m on 150 days in the year	High potential: 74.65 pWh per annum Irradiation figures: 1,240 kWh/m2 per year in the north 1,600 kWh/m2 per year in the south	Estimated potential for biomass: 14% of the total energy supply	Estimated potential: 8.000 MW Average precipitation in the country: 1250 mm/m2. Small hydro is regarded as the most promising source of RE
The former Yugoslav Republic of Macedonia	15 potential locations for wind plants with foreseen capacity of 25 MW to 33 MW Average wind speed: 6.5 – 8.5 m/s at 80 m in mountainous regions Average of 7 m/s in the south-eastern regions	North: 3.4 kwh/m2 South: 4.2 k-Wh/m2	Estimated 180,000 m3 of wood waste are produced annually which is entirely unused. Potential also to utilize biogas from animal manure for energy generation, as well as growing crops for production of biofuel. Potential for wood pellet use in the residential heating sector over firewood	Estimated potential for small hydro-power plants: 1088 GWh per year in 400 sites throughout the country.
Moldova	Estimated potential: 1,000 MW Favourable zones		Potential for fuel wood and agricultural forestry waste is	Estimated overall hydro potential: 3 TWh per year (with 1.9 TWh

	are present Up to 7 m/s at 50 m above ground		estimated to be 820,000 TOE Estimated biogas potential: 3.7 million m3	per year from large hydro and 1.1 TWh per year from small hydro)
Ukraine	Regions of great wind potential: Black Sea and Azov Sea, Carpathian, Transcarpathian, Lower Carpathian, Donbass terrain and Dnepropetrovsk Region	Annual radiation average: 1,200 kWh/m2 Largest potential: in the South, Crimea	Estimated total potential for biomass in 2003: 86,300 GWh per year	Estimated total potential for hydropower: 20 billion KWh of per year (with 2,500 million KWh per year from small hydro)
Kazakhstan	High potential velocity: 4-5 m/s	1,300-1,800 kWh/m2 per year	Estimated potential for biomass (high): 10 million hectares of forests which is 4% of the whole country Energy potential from timber waste: 200 thousand TOE.	High potential (3rd highest in CIS countries) Estimated potential: 170 billion kWh per year ; economically feasible estimates: 27 billion kWh per year, with 7-8 billion kWh per year effectively used Three major districts: Irtysh River basin, South Easter zone and the Southern zone
Tajikistan	Largely unsearched Estimated potential: areas with wind speed of 5-6 m/s Such as: Fedchenko, Aznob, Sarez Lake in Gorno Badakshan area	Potential: favourable Could satisfy 10%-20% of national energy demand Estimated potential: 25 billion kWh/year	Potential electricity production from biomass: 2 billion Kwh per year	Economically feasible hydropower potential: 264 billion kWh per year Small hydro could represent a viable economic and technological option for remote areas.

Turkmenistan	Highest estimated potential: areas near the Caspian Sea with the large desert zone. 40% of the territory holds wind energy potential Estimated potential: 10 to 500 GW could be developed	High solar potential		Hydropower potential: in Murgab and Amu-Daria river basins. Small hydropower potential: in the southern part of the Republic on the Murgab and Tejen rivers and Karakumy canal.

Country energy profiles, Clean Energy Information Portal, Reegle (http://www.reegle.info/countries)

3. Collaborative partnerships strengthening the access to energy services

a. Engaging various stakeholders through collaboration

RE solutions have the advantage of having low running cost but require significant investments for upfront installation costs. According to the IEA, mini-grid appears as the most promising solution to approach rural electrification. But subsidized delivery mechanism must be in place for maintenance and repair to ensure access to all households regardless of their incomes. It is estimated that USD 65-86 billion per year of additional investment would be required to ensure universal access to energy services.[52] Therefore there is a need to attract the financing community into the debate.

With the rise of impact investors and social entrepreneurs seeking to contribute to development projects aimed at improving the physical access to energy services through sustainable energy systems, there are innovative opportunities to serve the public interest while expecting financial return.[53] Besides, more and more public funds are available for energy access. However, energy poverty does not necessarily represent a main issue for the ECE region as it considered as rather developed, and available funds are generally dedicated to other regions in the world such as Africa and Asia.[54]

Development projects present risks, which is why the financial community tends to be reluctant to invest into such projects. For instance, the private sector shies away when faced with political and economic instabilities. Incentivizing private investment could be a pathway towards enhancing the quality of energy services in line with the SE4ALL initiative. Mobilizing financial resources could be done through collaborations between national governments with the private sector which would reduce associated investment risks and at the same time respond to the public's interest. According to an ESCAP report, "public-private partnerships are one of the best mechanisms to supplement and overcome Government budgetary constraints for widening access to energy services, especially to the poor, as they can allocate project-risks between the public and private sector"[55]. Therefore one way forward would be to involve all stakeholders to collaborate together and open a dialogue within the international community in order to unlock collaborative relations.

[52] Pauchauri et al. 2013
[53] Savacool, 2013 ; Sireau, 2011
[54] Wilson et al. 2014
[55] United Nations publication, ESCAP 2013, *Partnerships for Universal Access to Modern Energy Services*, A global Assessment Report on Public-Private Renewable Energy Partnerships, ESCAP/UNECA/ECLAC/DESA/UNECE/ESCWA

b. Examples of partnerships improving access to energy services

Certain examples of initiatives show that through cooperation and collaboration, improvement in access to energy services in remote areas could be made and have been made within the ECE region.

For instance, a hydropower project was initiated in Tajikistan in 2002, supported by a collaborative partnership between the government of Tajikistan, the WB and the Aga Khan Fund for Economic Development. A hydropower infrastructure and transmission lines were rehabilitated to increase electricity supply capacity. In order to ensure the affordability of electricity, a subsidy was provided upon delivery of energy services. In result, the annual power generation has increased from 135,000 MWh per year in 2002 to 163,215 MWh in 2010 and the total installed capacity increased from 33 to 43,5 MW. The duration of electricity supply per day during the winter increased from 3 hours to 22-24 hours per day. About 27 percent of the populations located in isolated areas now have access to electricity supply 8-16 hours per day. Losses in the transmission and distribution network have decreased and the use of diesel generators and firewood as energy supplies has been reduced in Tajikistan. Finally this project has had an impact on the Energy Company, which showed positive results for year 2009. An estimated 220,000 people have benefited from getting access to electrification all day including public services such as schools, hospitals, and businesses[56].

In addition, the construction of a solar power plant has been conducted in a remote area in the Altai Mountains in Siberia (the Russian Federation) where there were no sources of electricity generation rendering the region dependent on Bijjskogo electricity lines. 45 MW of solar capacity is planned to be installed by Hevel Solar LLC Company. In September 2014, a 5-MW power plant was installed in Kosh-Agach which will power about 1,000 local households. This project is the result of a partnership between Hevel and the local government which intend to build autonomous hybrid diesel-solar power plants of up to 200 kW capacity each, with the first 100 kW already being commissioned[57].

These projects constitutes examples of how different stakeholders could collaborate together to launch initiatives and play an effective role in increasing access to affordable, reliable and clean energy. This shows how important the impact of rural electrification to economic and social development through sustainable energy systems.

Also, the EU and the Russian Federation launched an energy partnership in 2002 with the creation of the EU-Russia Energy Technology Centre enabled the Russian Federation to cooperate with European companies. This Centre serves a platform to open energy dialogue between companies in the field of energy (for hydrocarbons, coal, electricity, RE and energy efficiency). The main objectives of this cooperation are to exchange information on legal frameworks; share experiences, knowledge and cooperation on projects related to energy efficiency, energy savings, RE sources, gas flaring reduction and implement joint

[56] For more information : WB, Tajikistan: Providing Reliable Electricity in the Pamir Mountains, http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:23143909~menuPK:141310~pagePK:34370~piPK:34424~theSitePK:4607,00.html (14.10.2014)

[57] For more information : Militsa Mancheva, Russia's Hevel cuts ribbon on 5-MW PV plant in Siberia, 8 September 2014, https://renewables.seenews.com/news/russia-s-hevel-cuts-ribbon-on-5-mw-pv-plant-in-siberia-437646 (14.10.2014) ; "Hevel" begin designing the first in the Altai Mountains of solar power in 2012, 1 February 2012, RIA Novosti, http://www.enginrussia.ru/news/2012/02/01/Xevel_nachnet_proektirovanie_pervoj_v_Gornom_Altae/ (14.10.2014)

projects in these sectors[58]. The Center provides a platform for dialogue and sharing on ideas, information on technologies, trainings. It also provides a project facilitation mechanism that will help identify priority projects requiring financing and assist through the different steps of the project (from the attraction of investments to providing technical assistance for the introduction of advanced energy technologies in the Russian Federation). This project contributes to the long-term EU energy strategy in ensuring a stable, secure, diverse, cost-effective and environmentally-friendly supply of energy to the EU[59].

Conclusions: How could the ECE support those communities with limited access to energy services?

"What you measure is what you get. That is why it is crucial to get measurement right and to collect the right data" according to Kandeh Yumkella, Secretary General's Special Representative for Sustainable Energy for All and CEO of the SE4ALL Initiative. Monitoring and measuring developments made in energy systems are essential to take the appropriate measures that would improve access to energy services.

Throughout this paper, it has been found that identifying the communities with limited access to energy services relies on the availability of data. Therefore, the ECE could support those communities with limited access to energy services by ensuring data availability and reliability in order to identify the communities with limited access to energy services. The following gaps regarding data have been identified:

- **Availability** – Data for each ECE member State is not always provided throughout the different existing databases. The GTF provides assumptions; it has collected data from different sources and used a modelling approach to fill in the gaps.
- **Quality** – The absence of an agreed-upon definition of access to energy services compromises the quality of data. Results are inconsistent from one source to another because they are based on different definitions and indicators. The binary definition of access to energy, which is used by the GTF to track development related to SE4ALL initiative, does not seem appropriate especially for the diverse region of the ECE. The GTF Report advocates for the adoption of a multi-tier methodology that would measure all the dimensions characterizing access to energy services. Furthermore, data is provided on a national scale. Though to identify the areas with limited access to energy services, regional data would be required. Such data could only provide an overview of the situation.
- **Reliability** – The GTF data is from year 2010. This translates the difficulty of accessing timely data. The older the data gets, the more its accuracy becomes compromised.

For this reason, the ECE could engage in several activities to support those communities with limited access to energy service. The ECE could be a platform to engage all the stakeholders including the policy-makers, the financial community, the industries, the

[58] EU-Russia, Energy dialogue, The first ten years, 2000-2010Report of the Thematic Group on Energy Efficiency second half 2008 – second half 2010, http://ec.europa.eu/energy/publications/doc/2011_eu-russia_energy_relations.pdf (14.10.2014)

[59] EU-Russia Energy Technology Centre, Project description, http://www.erec.org/projects/finalised-projects/energy-technology-centre-russia.html (14.10.2014)

private sector, civil societies and associations in the discussion. The ECE could engage into the following actions:

- Cooperation with specific organizations specialized in data gathering could be a solution for the ECE
- Conduct surveys directed to the all stakeholders such as governmental entities, main energy companies, the private sector, energy associations and societies in order to analyse the local context of member States in order to gather accurate data on access to energy services.
- Generate interest and support governments by promoting renewable energy solutions for communities with limited access to energy sources tailored to local specificities of member States.
- Develop international cooperation and open dialogue by the discussion with the group of experts to share experiences, ideas, technology information, capacity building.
- Unlock collaborative approaches between local, regional, international stakeholders from public to private sector.

The WEC provides five country profiles enabling policy makers to focus on the most pressing issues given the characteristics of their country in reaching a low-carbon economy. Such profiling could be a model to be replicated in the ECE region as a potential methodology for providing measuring according to country profiles.

There are three key areas for infrastructure development: finance, capacity building and policy reform.[60] Finally, socio-cultural context and environment must be taken in account while developing policies and projects.[61]

[60] Scott and Seth, 2012
[61] Wilson et al., 2013

Table 8: ECE profiles based on the World Energy Trilemma, WEC [62]

Profile	Illustrative members	Key strengths	Core challenges
High performers in RE implementation	Switzerland, Denmark, Iceland, Norway	Overall high performance	Ensuring achievement of climate targets
Fossil-fuelled	Canada, United States	Affordability and security of energy	Energy and emission intensity challenges and mitigation of impact on the environment
Highly industrialized	EU, Kazakhstan, Poland	Energy security and strong GDP growth	Impact of rapid industrial growth, energy security and environmental sustainability
Hydro-powered	France, Norway, Russian Federation, Sweden, Tajikistan, Kyrgyzstan	Strong use of renewables leads to low emissions and higher electrification rates	Improving physical energy access and affordability
Gaps in energy access	Armenia, Kyrgyzstan, Moldova, Montenegro, Tajikistan, Turkey	Lower GDP and country risks ratings may hinder possible investment	Ensure access to modern energy services

[62] Wyman, 2013

Annexes

Annex 1 – Existing methodologies to track energy access developments, GTF report

Single indicator	**Energy Poverty Line** (Barnes, Khander and Samad 2011): Demand-based approach to define an energy poverty line at the threshold point at which households consume a bare minimum level of energy needed to sustain life. The objective is to define a threshold point at which households consume a bare minimum of energy
Dashboard of indicators	**Energy indicators for sustainable development (IAEA 2005):** Set of 30 indicators of sustainable development aiming to measure the current and future effects on energy use human health, human society, air, soil and water to determine whether current energy use is sustainable and if not how to change it. **Energy access situation in developing countries (UNDP/WHO 2009):** measures percentage of population in developing countries with access (or lack of) too three key areas of energy supply; electricity, modern household fuels, and mechanical power (data limited to 3 countries); plus measures access to improved cookstoves and analyses overall fuel use. The objective is to estimate the penetration rate of modern energy. **Ecosystem Health Indicators (PPEO 2012):** Set of 17 indicators across three elements of an energy access ecosystem – financing, policy and capacity. The objective is to evaluate the energy-access ecosystems.
Composite index	**Energy development Index (IEA 2004 – amended 2010 and 2012):** Tracks progress in a country's transition to the use of modern fuels. The objective is to estimate the penetration rate of modern energy and levels of energy consumption across households and community indicators, compiling a country-level index. It is intended to help understanding of the role that energy can play in human development . **Multidimensional Energy Poverty Index (Nussbaumer and others 2011):** Measure of deprivation of access to a range of modern energy services affecting individuals. The objective is to measure lack of access to energy services by ownership of appliances. **Total energy access (PPEO):** categorizes five essential energy access services with quantitative minimum standards. The objective is to set minimum standards for five energy services.
Multi-tier approach	**Energy supply Index (PPEO 2010):** Categorizes three key areas of energy supply with qualitative levels of supply. The objective is to create a multidimensional measure of the quality of energy supply. **Incremental levels of access to energy services (AGECC 2010):** Multilevel access to energy services: (i) basic human needs, (ii) productive uses, and (iii) modern society needs. The objective is to estimate the level of access to energy services through energy usage (kWh/per capita). **Minimum levels and priorities of access to energy services (EnDev 2011):** Defines minimum levels for three key energy services – (i) lighting, (ii) cooking, and (iii) communication and information, based on quantitative and qualitative indicators. The objective is to measure minimum access to basic energy needs in terms of quantity, quality, and affordability. **Multi-tier standards for cookstoves (GACC/PCIA 2012):** multi-tier standards for household cookstoves (levels not finalized). The objective is to establish standards for cookstoves in terms of efficiency, safety, and emissions.

Source: GTF Report, 2011

Annex 2 – Table of electricity consumption of daily appliances

Load / Application	**Rated Power (W)**	**Average daily working hours (h)**
Energy saving lights	9-30	5
21” Color TV	70	5
B/W TV	20	5
Cassette recorder	40	2
Washing machine	150	2
Refrigerator	120	10
1/5 HP Water Pump	165	0,5
Radio set	10	1
Dust cleaner	750	1
2 Pair conditioner	2000	5 (Jun-Sept)
Electric fan	50	2 (Jun-Sept)
Moveable Electric Heater	1000	3
Bubble Jet Printer	20	1
Desk computer	400	5
Monitor	200	5
Fax machine	100	30min
Microwave stove	1000	10min

Source: China Village Power Project Development Guidebook

Annex 3 – Getting Electricity indicator for ECE member States, 2012

ECE Member State	Getting Electricity Ranking/189	Procedures (number)	Time (days)	Cost (% of income per capita)
Albania	158	6	177	543.3
Andorra	n.a	n.a	n.a	n.a
Armenia	109	5	242	98.9
Austria	28	5	23	101.7
Azerbaijan	181	9	241	570.8
Belarus	168	7	161	431.7
Belgium	90	6	88	92.5
Bosnia and Herzegovina	164	8	125	492.5
Bulgaria	135	6	130	320.0
Canada	145	7	142	131.8
Croatia	60	5	70	319.8
Cyprus	108	5	247	96.8
Czech Republic	146	6	279	179.0
Denmark	18	4	38	118.4
Estonia	56	4	111	188.0
Finland	22	5	42	29.6
France	42	5	79	43.3
Georgia	54	4	71	515.0
Germany	3	3	17	46.9
Greece	61	6	62	66.7
Hungary	112	5	252	116.4
Iceland	1	4	22	14.4
Ireland	100	5	205	89.4
Israel	103	6	132	13.8
Italy	89	5	124	215.9
Kazakhstan	87	6	88	65.3
Kyrgyzstan	180	7	159	2,256.4
Latvia	83	5	108	326.1
Liechtenstein	n.a	n.a	n.a	n.a
Lithuania	75	6	148	48.1
Luxembourg	66	5	120	57.7
Malta	115	5	136	463.2
Moldova	165	7	140	542.1
Monaco	n.a	n.a	n.a	n.a
Montenegro	69	5	71	487.6
Netherlands	70	5	143	35.8
Norway	58	6	62	49.7
Poland	137	6	161	205.2
Portugal	36	5	64	53.6
Romania	174	7	223	534.0
Russian Federation	117	5	162	293.8
San Marino	10	3	45	57.1
Serbia	85	4	131	505.6
Slovakia	65	5	158	10.6
Slovenia	32	5	38	120.3

Spain	62	5	85	234.4
Sweden	9	3	52	36.6
Switzerland	8	3	39	59.6
Tajikistan	186	9	185	1,077.4
The former Yugoslav Republic of Macedonia	76	5	107	258.6
Turkey	49	4	70	475.3
Turkmenistan	n.a	n.a	n.a	n.a
Ukraine	172	10	277	178.0
United Kingdom of Great Britain and Northern Ireland	74	5	126	91.9
United States of America	13	4	60	15.6
Uzbekistan	173	9	108	1,159

IFC, Doing business project, Getting Electricity (http://www.doingbusiness.org/data/exploretopics/getting-electricity)

Annex 4 – Indicative qualitative assessment of renewable energy potential by RE type and ECE member State (GIZ, Baseline Conditions on Renewable Energies in the ECE region)

	Country	RES Potential					
		Wind	Solar	Hydro	Biomass	Geothermal	Ocean
	Northern America						
1	Canada	High	Medium	High	High	High	High
2	United States of America	High	High	High	High	High	High
	European Union						
1	Austria	Medium	High	High	High	Medium	n.a.
2	Belgium	High	Low	Medium	Medium	Medium to Low	Medium
3	Bulgaria	High	High	High	High	High	Low
4	Croatia	High	High	High	Medium	Medium	Unknown
5	Cyprus	Medium	High	Low	Low	Unknown	Low
6	Czech Republic	High	Medium	High	High	High	n.a.
7	Denmark	High	Medium to Low	Low	High	Unknown	High
8	Estonia	High	Medium to Low	Medium	High	Low	Unknown
9	Finland	High	Medium to Low	High	High	Low	High
10	France	High	High	High	High	High	High
11	Germany	High	Medium	High	High	High	Medium
12	Greece	High	High	High	Medium	High	Low
13	Hungary	Medium	Medium	Low	High	High	n.a.
14	Ireland	High	Medium to Low	Low	Medium to Low	Medium to Low	High
15	Italy	Medium	High	High	High	High	Low
16	Latvia	High	Low	High	Medium	Low	Unknown
17	Lithuania	High	Medium to Low	Medium to Low	High	High	Unknown
18	Luxembourg	Medium to Low	Medium to Low	Low	Medium to Low	Low	Unknown
19	Malta	Medium to Low	High	n.a.	Low	Unknown	Low
20	Netherlands	High	Medium	Low	Medium	Medium	Medium
21	Poland	High	Medium	Medium to Low	High	Low	Unknown
22	Portugal	High	High	High	Medium	High	High
23	Romania	High	High	High	High	High	Low
24	Slovak Republic	High to Medium	Medium to Low	High	Medium	High	n.a.
25	Slovenia	High to Medium	Medium	High	High	Medium	Unknown
26	Spain	High	High	High	High	Medium	High
27	Sweden	High	Medium to Low	High	High	High	High
28	United Kingdom	High	Medium	High	High	High	High
	European Free Trade Association						
1	Iceland	High	Medium to Low	High	Unknown	High	Unknown
2	Lichtenstein	Country data not provided / available.	Country data not provided / available.	Country data not provided / available.	Country data not provided / available.	Country data not provided / available.	Country data not provided / available.
3	Norway	High	Low	High	High	Unknown	High
4	Switzerland	Medium	Medium	High	Medium	Unknown	n.a.
	Western Balkans						
1	Albania	High	High	High	Medium	Low	Unknown
2	Bosnia and Herzegovina	High	High	High	High	Medium to Low	Low
3	Montenegro	Medium	High	High	Medium	Unknown	Unknown
4	Serbia	High	Medium	High	High	Medium	n.a.
5	FYR of Macedonia	High	Medium	High	Medium	High	n.a.
	Eastern Partnership						
1	Armenia	Medium	High	High	Low	Medium to Low	n.a.
2	Azerbaijan	High	Medium	High	Medium	Medium	Unknown
3	Belarus	Medium	Medium	Medium	High	Low	n.a.
4	Georgia	High to Medium	Medium	High	Unknown	Medium	Unknown
5	Republic of Moldova	High	Medium	High	Medium	Low	n.a.
6	Ukraine	High	Medium	High	High	High	Unknown
	Central Asia						
1	Kazakhstan	High	Medium	High	High	High	Unknown
2	Kyrgyzstan	High	High	High	Medium	Unknown	n.a.
3	Tajikistan	Medium	High	High	Low	Unknown	n.a.
4	Turkmenistan	High	High	High	High	Unknown	Unknown
5	Uzbekistan	High	High	High	High	Unknown	Unknown
	Others						
1	Andorra	Country data not provided / available.	Country data not provided / available.	Country data not provided / available.	Country data not provided / available.	Country data not provided / available.	Country data not provided / available.
2	Israel	High	High	Unknown	Medium	Medium to Low	Unknown
3	Monaco	Country data not provided / available.	Country data not provided / available.	Country data not provided / available.	Country data not provided / available.	Country data not provided / available.	Country data not provided / available.
4	Russian Federation	High	Medium	High	High	High	Unknown
5	San Marino	Country data not provided / available.	Country data not provided / available.	Country data not provided / available.	Country data not provided / available.	Country data not provided / available.	Country data not provided / available.
6	Turkey	High	High	High	High	High	Low

Source: IRENA Renewable Energy Country Profiles (www.irena.org, July 2014).

Legend:
- High
- High to Medium
- Medium
- Medium to Low
- Low
- Unknow n
- n.a. – Not applicable (e.g. no access to the ocean)
- Country data not provided / available.

Annex 5 – IRENA Country Profiles

Europe and Eurasia	http://www.irena.org/REmaps/EuropeandEurasia.aspx
Albania	http://www.irena.org/REmaps/countryprofiles/Europe/Albania.pdf
Armenia	http://www.irena.org/REmaps/countryprofiles/Europe/armenia.pdf
Austria	http://www.irena.org/REmaps/countryprofiles/Europe/austria.pdf
Azerbaijan	http://www.irena.org/REmaps/countryprofiles/Europe/Azerbaijan.pdf
Belarus	http://www.irena.org/REmaps/countryprofiles/Europe/Belarus.pdf
Belgium	http://www.irena.org/REmaps/countryprofiles/Europe/belgium.pdf
Bosnia and Herzegovina	http://www.irena.org/REmaps/countryprofiles/Europe/BosniaAndHerzegovina.pdf
Bulgaria	http://www.irena.org/REmaps/countryprofiles/Europe/bulgaria.pdf
Croatia	http://www.irena.org/REmaps/countryprofiles/Europe/croatia.pdf
Cyprus	http://www.irena.org/REmaps/countryprofiles/Europe/cyprus.pdf
Czech Republic	http://www.irena.org/REmaps/countryprofiles/Europe/CzechRepublic.pdf
Denmark	http://www.irena.org/REmaps/countryprofiles/Europe/denmark.pdf
Estonia	http://www.irena.org/REmaps/countryprofiles/Europe/estonia.pdf
Finland	http://www.irena.org/REmaps/countryprofiles/Europe/finland.pdf
France	http://www.irena.org/REmaps/countryprofiles/Europe/france.pdf
Georgia	http://www.irena.org/REmaps/countryprofiles/Europe/georgia.pdf
Germany	http://www.irena.org/REmaps/countryprofiles/Europe/germany.pdf
Greece	http://www.irena.org/REmaps/countryprofiles/Europe/greece.pdf
Hungary	http://www.irena.org/REmaps/countryprofiles/Europe/hungary.pdf
Iceland	http://www.irena.org/REmaps/countryprofiles/Europe/iceland.pdf
Ireland	http://www.irena.org/REmaps/countryprofiles/Europe/ireland.pdf
Italy	http://www.irena.org/REmaps/countryprofiles/Europe/italy.pdf
Latvia	http://www.irena.org/REmaps/countryprofiles/Europe/latvia.pdf
Lithuania	http://www.irena.org/REmaps/countryprofiles/Europe/Lithuania.pdf
Luxembourg	http://www.irena.org/REmaps/countryprofiles/Europe/luxembourg.pdf
Malta	http://www.irena.org/REmaps/countryprofiles/Europe/malta.pdf
Moldova	http://www.irena.org/REmaps/countryprofiles/Europe/moldova.pdf
Montenegro	http://www.irena.org/REmaps/countryprofiles/Europe/montenegro.pdf
Netherlands	http://www.irena.org/REmaps/countryprofiles/Europe/netherlands.pdf
Norway	http://www.irena.org/REmaps/countryprofiles/Europe/norway.pdf
Poland	http://www.irena.org/REmaps/countryprofiles/Europe/poland.pdf
Portugal	http://www.irena.org/REmaps/countryprofiles/Europe/portugal.pdf
Romania	http://www.irena.org/REmaps/countryprofiles/Europe/romania.pdf
Russian Federation	http://www.irena.org/REmaps/countryprofiles/Europe/RussianFederation.pdf
Serbia	http://www.irena.org/REmaps/countryprofiles/Europe/serbia.pdf
Slovakia	http://www.irena.org/REmaps/countryprofiles/Europe/slovakia.pdf
Slovenia	http://www.irena.org/REmaps/countryprofiles/Europe/slovenia.pdf
Spain	http://www.irena.org/REmaps/countryprofiles/Europe/spain.pdf
Switzerland	http://www.irena.org/REmaps/countryprofiles/Europe/switzerland.pdf

The former Yugoslav Republic of Macedonia	http://www.irena.org/REmaps/countryprofiles/Europe/FYRMacedonia.pdf
Turkey	http://www.irena.org/REmaps/countryprofiles/Europe/Turkey.pdf
Ukraine	http://www.irena.org/REmaps/countryprofiles/Europe/ukraine.pdf
United Kingdom	http://www.irena.org/REmaps/countryprofiles/Europe/UnitedKingdom.pdf
Asia	http://www.irena.org/REmaps/asia.aspx
Kazakhstan	http://www.irena.org/REmaps/countryprofiles/asia/Kazakhstan.pdf
Kyrgyzstan	http://www.irena.org/REmaps/countryprofiles/asia/kyrgyzstan.pdf
Tajikistan	http://www.irena.org/REmaps/countryprofiles/asia/tajikistan.pdf
Turkmenistan	http://www.irena.org/REmaps/countryprofiles/asia/turkmenistan.pdf
Uzbekistan	http://www.irena.org/REmaps/countryprofiles/asia/uzbekistan.pdf
Middle East	http://www.irena.org/REmaps/middleeastmap.aspx
Israel	http://www.irena.org/REmaps/countryprofiles/middle/Israel.pdf
Americas	http://www.irena.org/REmaps/americasmap.aspx
Canada	http://www.irena.org/REmaps/CountryProfiles/Latin%20America/Canada.pdf#zoom=75
United States	http://www.irena.org/REmaps/CountryProfiles/Latin%20America/UnitedStates.pdf#zoom=75
Non-available	Andorra, Liechtenstein, Monaco, San Marino.

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WEC, Energy Efficiency Indicator, Enerdata (http://www.wec-indicators.enerdata.eu/secteur.php)

Acronyms and abbreviations

AGEC – Advisory Group on Energy and Climate of the UN-Secretary General
CIS – Commonwealth of Independent States
DENA – German Energy Agency
DESA – United Nations Department of Economic and Social Affairs
ECLAC – United Nations Economic Commission for Latin America
EDB – European Development Bank
EDI – Energy Development Index
ESCAP – United Nations Economic and Social Commission for Asia and the Pacific
ESCWA – United Nations Economic and Social Commission for Western Asia
EU – European Union
GNI – Gross National Income
GTF – Global Tracking Framework
h - Hours
IEA – International Energy Agency
IFC – International Financial Corporation
ISO – International Organization for Standardization
kW - Kilowatt
kWh – Kilowatt hour
m2 – Square meters
m3 – Cubic meter
MDG – Millennium Development Goal
MW - Megawatt
MWh – Megawatt hour
PJ – Petajoule

PV – Photovoltaic
PPEO – Poor People's Energy Outlook
RE – Renewable Energy
SE4ALL – Sustainable Energy for All
TOE – Tons of oil equivalents
TWh – Terawatt per hour
United Kingdom - United Kingdom of Great Britain and Northern Ireland
UN – United Nations
UNDP – United Nations Development Programme
UNECA – United Nations Economic Commission for Africa
ECE – United Nations Economic Commission for Europe
United States – United States of America
W - Watt
WB – World Bank Group
WEC – World Energy Council
WEF – World Economic Forum
WEO – World Energy Outlook