Financed under specific grant agreement no. 2017/388-041 from the EU IPA II Multi-Beneficiary Programme for Albania, Bosnia and Herzegovina, North Macedonia, Kosovo*, Montenegro and Serbia
*** This designation is without prejudice to positions on status, and is in line with UNSCR 1244/199 and the ICJ opinion on the Kosovo declaration of independence.**

Western Balkans Investment Framework Infrastructure Project Facility Technical Assistance 7 (IPF 7)

TA2017050 R0 IPA

WBEC-KOS-ENE-01

Assessment of the potential to deliver utility-scale dispatchable renewable power to Kosovo

Final Report

June 2021

The Western Balkans Investment Framework (WBIF) is a financing facility launched in December 2009 by the European Commission, together with the Council of Europe Development Bank (CEB), the European Bank for Reconstruction and Development (EBRD), the European Investment Bank (EIB), Bilateral Donors, and Western Balkans countries with the purpose to deliver funding for strategic investment projects in beneficiary countries. Eligible sectors include infrastructure development in the environment, energy, transport, social and digital sectors as well as private sector development. KfW and the World Bank subsequently joined the Framework. In July 2017, the KfW became a partner organisation.

Report Issue Record

Subproject Title:	Assessment of the potential to deliver utility-scale dispatchable renewable power to Kosovo
Protocol Number:	WBEC-KOS-ENE-01
Report Title:	Final Report
Issue Number:	01

Revision	1	2	3	4
Date	17.5.2021			
Detail	Final draft			
Prepared By	Marko Krejči			
Checked By	Božidar Radović			
Approved By	Martyn Osborn			

Experts that participated in drafting this report are: Marko Krejči, Božidar Radović, Alush Grosha, Valon Stavileci, and Mimoza Hyseni-Spahiu.

Table of Contents

List of Tables

List of Figures

Abbreviations

Abbreviation	Meaning
aFRR	Automatic Frequency Restoration Reserve
AK	Albania-Kosovo (control block)
ALB	Albania
ALKOGAP	Albania-Kosovo Gas Pipeline
BESS	Battery Electricity Storage Systems
CA	Connection agreement
CAPEX	Capital expense
CCGT	Combined cycle gas turbine
CF	Capacity factor
DLR	Dynamic Line Rating
DSO	Distribution system operator
DSR	Demand Side Response
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EMS	Energy Management System
EnC	Energy Community
ENTSO-E	European network of Transmission System Operators for Electricity
ERO	Energy Regulatory Office in Kosovo
EU	European Union
FA	Final authorization
FiT	Feed-in Tariff
GLEB	Guidelines for Electricity Balancing
GWh	Gigawatt hour
HPP	Hydropower plant
HUDEX	Hungarian Derivative Energy Exchange
HUPX	Hungarian Power Exchange
IBEX	Independent Bulgarian Energy Exchange
IDCF	Intra-Day Congestion Forecast
IFI	International Financing Institution
IGCC	International Grid Control Cooperation
IMF	International Monetary Fund
IPA	Instrument for Pre-accession Assistance
IPF7	Infrastructure Project Facility, Technical Assistance 7
IRENA	International Renewable Energy Agency
KEDS	Distribution system operator in Kosovo

KEK	Kosovo Energy Corporation
KESH	Public Generation Company in Albania
KfW	Kreditanstalt für Wiederaufbau, German state-owned development bank
KOSTT	Transmission system operator in Kosovo
kV	Kilovolt
kW	Kilowatt
kWh	Kilowatt-hour
LCOE	Levelized cost of energy/electricity
MA	Municipal Authority
MAFRD	Ministry of Agriculture, Forestry and Rural Development
MARI	Manually Activated Reserves Initiative
MEE	Ministry of Economy and Environment
MESP	Ministry of Environment and Spatial Planning
mFRR	Manual Frequency Restoration Reserve
MKD	North Macedonia
MNE	Montenegro
MoM	Minutes of Meeting
MVA	Megavolt amperes
MW	Megawatt
MWh	Megawatt-hours
NDC	National Dispatch Center
NRA	National Regulatory Authority
NREAP	National Renewable Energy Action Plan
NREL	National Renewable Energy Laboratory
NTC	Net Transfer Capacities
OHL	Overhead (transmission) line
OPEX	Operating expense
OST	Transmission system operator in Albania
PA	Preliminary authorization
PICASSO	Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation
PPA	Power Purchase Agreement
PSHP	Pumped storage hydropower plant
PV	Photovoltaic
RE/RES	Renewable energy / Renewable energy sources
RR	Replacement Reserves
SCADA	Supervisory Control and Data Acquisition (System)
SEEPEX	South East Europe Power Exchange

SRB	Serbia
TA	Technical Assistance
TERRE	Trans-European Restoration Reserves Exchange
ToR	Terms of Reference
TPP	Thermal power plant
TSO	Transmission system operator
TWh	Terawatt hour
TYNDP	Ten-year network development plan
WACC	The weighted average cost of capital
WB6	The 6 Western Balkan countries: Albania, Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia, Serbia
WBIF	Western Balkans Investment Framework

In this report thousands are separated with space and decimals are designated with ".". This is in accordance with the guidance of the EC[1].

[1] https://ec.europa.eu/info/sites/default/files/styleguide_english_dgt_en.pdf

Executive summary

Kosovo[2] electricity generation is dominated by lignite capacity. The total installed generation capacity is cca 1 470 MW, and almost 88% of it are the two lignite-fired thermal plants. In terms of electricity generation, the two lignite units provide cca 95% of overall Kosovo generation. The balance is provided by small hydro, wind, and solar PV plants.

Available capacity is frequently insufficient to cover the demand during peak hours, particularly during the winter. During night time there is a surplus of generation.

The power system of Kosovo is well interconnected with neighboring power systems through 400kV transmission links to Montenegro, Albania, and North Macedonia. The high voltage backbone is connecting the main generation and consumption nodes in the country. Unlike the 400kV grid, transmission network at the 110kV level is less developed and the assets are relatively old. The transmission system is regularly upgraded, old assets are gradually modernised or refurbished, so it should not be an obstacle for planned development of RE generation.

With regards to RES, some 1 185 MW of solar PV and wind capacity currently are under various stages of development in Kosovo. This is several times more than envisaged under the current Kosovo Energy Strategy (2017-2026). These projects could generate cca 2 300 GWh of electricity, which would increase Kosovo's current generation by 40%. The technical potential of RE projects in Kosovo, as assessed by the World Bank, is significantly larger (1 200 MW for wind and 3 600 MW for solar PV), thus additional wind and solar PV projects may be added to the development pipeline in the future. In addition, small hydro projects with a total capacity of 146 MW have been identified. Future development of such hydro projects however is uncertain due to environmental and social concerns and related public opposition.

Based on the ToR, the Consultant identified and performed a preliminary assessment of the technical, economic, and financial viability of utility-scale renewable power plant projects in Kosovo. The assessment was done based on publicly available data, interviews with relevant institutions, international donors, and network operators, and interviews with a few RE developers in Kosovo. The Consultant notes that RE developers, in general, were reluctant to be interviewed and only 3 of them (active in wind, hydro, and PV solar) agreed. Under such circumstances, the Consultant used best expert judgment in estimating various input assumptions regarding the projects.

Over 83% of RE projects in development in solar PV and wind are utility scale projects with over 10MW of envisaged capacity. Table below provides the basic project information.

Project name	Type	Installed capacity (MW)	Average annual electricity output (GWh)	Overall status of the project	Comments
Bajgora/Selac I, II, III	Wind	103.4	280	Under construction	FiT secured. Commissioning expected in Q4 2021.
Zatriqi/Zatric I, II	Wind	64.8	176	PA	No information on the status of EIA, nor other development activities.
Koznica	Wind	34.5	96.6	PA, CA	Commissioning expected in Q4 2022. No information on the status of EIA.
Çiçavica	Wind	116.6	296	CA	Commissioning expected in Q4 2022. No information on the status of EIA.

[2] This designation is without prejudice to positions on status, and is in line with UNSCR 1244/199 and the ICJ opinion on the Kosovo declaration of independence.

Kamenica I, II	Wind	69.6	184	PA, CA	Commissioning expected in 2024. No information on the status of EIA.
Mareci	Wind	31.2	80	PA	No information on the status of EIA. Applied to KOSTT for connection agreement in 2019. No reported activities since.
Budakova I	Wind	11	31.1	Under construction	Commissioning expected in 2022. FiT Secured. Environmental consent issued in 2017.
Budakova II	Wind	35	98.9	PA, CA	Commissioning expected in 2023. No information on the status of EIA.
Kitka (addition)	Wind	33	92.4	CA	Commissioning expected in 2022. No information on the status of EIA.
Total Wind		**499.1**	**1 335.2**	**-**	
Kosova A ash dump	Solar	100	162	Planned	(Pre)Feasibility study completed. No information on other activities and milestones. Preliminary environmental evaluation performed.
Kamenica III	Solar	30	41	CA	No information on the status of EIA. The start of construction is planned for 2021, while it is expected to be commissioned by the end of 2024.
SEGE	Solar	136	190	CA	No information on the status of EIA. Commissioning is expected in H1 2022.
Terstenik	Solar	96	134	CA	No information on the status of EIA or other milestones.
Sferke	Solar	96	134	CA	No information on the status of EIA or other milestones.
Katkos Junik	Solar	105	146	Planned	Received connection offer from KOSTT. No information on the status of EIA or other milestones.
Total Solar		**563**	**806.7**	**-**	

Table 1.1: List of identified planned RES projects larger than 10 MW with their basic information

Out of the projects listed above, Selaci I, II, III, and Budakova I are in construction. Others are at various stages of development, including key milestones achieved such as Preliminary authorization issued by ERO (PA) or Connection Agreement made with KOSTT (CA). However, more detailed information on the status of their development is not available. The note “planned” in the above table indicates that the project is being planned, however, no official authorization steps have been completed yet.

In addition to the projects listed above, new RE project initiatives and developments keep emerging. But based on contacts with developers, the Consultant understands that future development of RE projects (besides the ones having secured the FiT) currently is uncertain. A previous FiT support scheme was recently cancelled and developers are waiting for the terms of a proposed new support scheme to be announced to reassess the feasibility of their undertakings under this new regime. In principle, the Consultant considers that all of the identified projects can be successfully developed with an adequate new support scheme.

Considering Kosovo’s RE technical potential of 1 200 MW for wind and 3 600 MW for solar PV, the limitations to future RE development and deployment do not lie in the lack of suitable locations and projects but (i) principally in the financial feasibility and bankability of these projects for the developers and (ii) in the limitations of Kosovo’s power system to connect and manage the intermittent generation of significant additional RES. Financial feasibility and related risks can largely be addressed with the appropriate support scheme. However, considering that KOSTT employs a “deep connection costs” methodology, the financial feasibility of RE projects could be challenged when significant grid upgrades become necessary to accommodate the connection of new RE capacity. On the other hand, also due to the deep connection cost methodology, the TSO is comfortable with issuing connection conditions to RE generation candidate projects, knowing that all costs of the grid connection infrastructure and grid reinforcement for new RE generation facilities (except those grid reinforcements already identified in the TYNDP) will be borne by the RES investors. The issue of Kosovo power system being able to cope with significant additional RE capacity can be alleviated with market integration with neighboring countries, particularly Albania. However, investment in additional reserve and back-up capacity may still be needed.

Project LCOE calculations were performed with the combination of available information and expert estimates regarding the missing data. LCOE of wind projects is estimated in the range of 56-73 €/MWh and 53-57 €/MWh for solar PV. In both cases, a discount rate of 8% was applied. The range of calculated LCOE for identified projects for various discount rates is provided in the figure below.

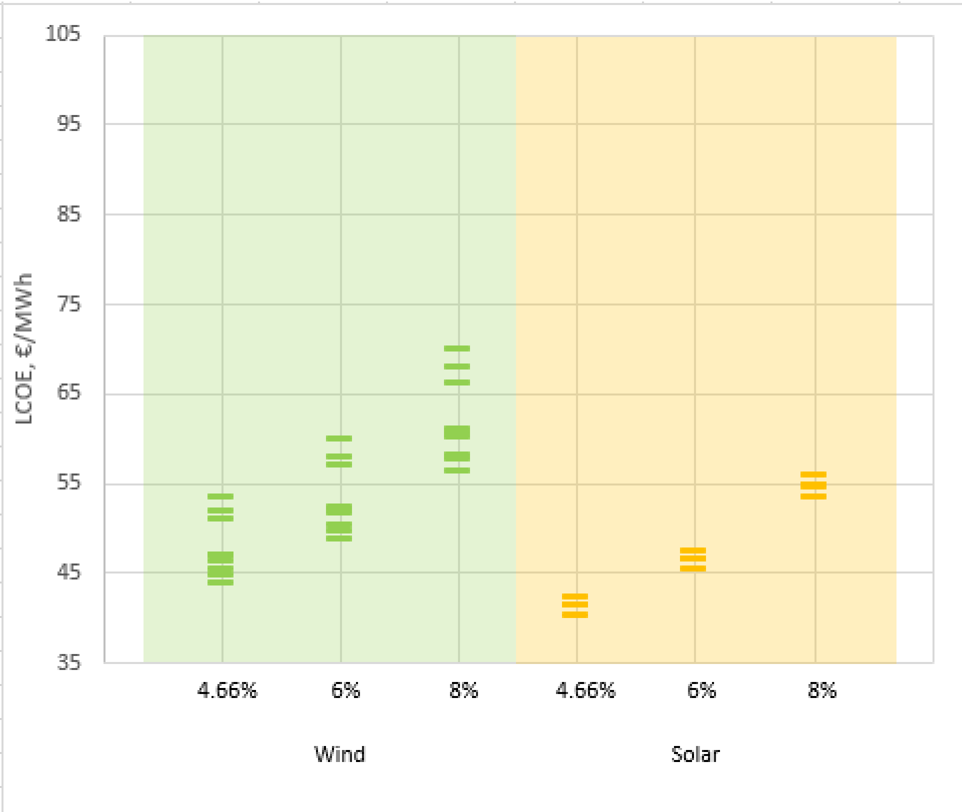

Figure: LCOE sensitivity of identified RES projects depending on the discount rate

The estimated LCOE of identified solar PV projects is comparable to the expected medium-term electricity prices in the region. Only the lower end of wind power's estimated LCOE range is comparable to the expected medium-term electricity prices in the region. Calculation of LCOE does not include additional costs of RE generation such as balancing and back-up capacity costs. Under the current market design in Kosovo, RE generators are responsible only for 25% of their balancing costs. From the elecricity system perspective, additional cost of RE generation that needs to be accounted for is the remaining 75% of the balancing cost and the cost of back-up capacity.

It should be noted that Kosovo offers a "regulated generator" mechanism, that can act as an RES support scheme. The mechanism guarantees to qualified RE generators the offtake of their entire generation at real time market prices of the substituted imported electricity. Nevertheless, at this moment the investors do not seem to be prepared to invest under these terms or to take the full market risk and invest on purely commercial grounds. Design of the new support scheme should, among other issues, take into account liquidity and bankability of projects. As the useful life of RE assets is generally longer than loan repayment periods, new projects may face liquidity issues during the loan repayment period or require excessive equity capitalisation if prices in the early years do not allow them to generate sufficient cash flows to cover debt service. In addition when assessing RES projects' bankability, financing institutions will generally consider conservative RE generation estimates (P90) rather than the expected generation estimates (P50).

Detailed financial economic modelling of the projects could not be performed as reliable and detailed data on identified RE projects was not available. In general and if the cost of balancing and reserve capacity is not taken into account, solar PV projects are competitive at current market prices, while wind electricity projects can also be competitive on an LCOE basis at current market prices.

In terms of environmental acceptability, the Consultant could not obtain detailed information on the status of respective project EIA's, or on any specific environmental and social issues that may be affecting particular projects' development. However, from the estimated location of the projects, it appears none of the identified utility scale projects is within any of the declared national parks. Based on the available information and the overall environmental impact of solar PV and wind projects, the Consultant does not expect that the identified projects would face any significant issues in developing their respective EIA's.

In terms of project maturity, the Consultant notes that 114.4 MW of wind projects currently are under construction. Another 289 MW of wind projects and 358 MW of solar PV projects have signed Connection agreements with KOSTT (although not all of these have applied to ERO for preliminary authorization). Finally projects with total capacity of 301 MW (96 MW wind and 205 MW solar PV) are in earlier stages of development. As noted above and according to Consultant's understanding, projects besides the ones in construction have not completed the EIA procedure and have not yet obtained environmental consents.

The Consultant assessed the pattern of current solar PV, wind and hydro generation in Kosovo based on average actual output from these sources in 2020 in Kosovo. The assessment indicates that solar and wind generation may complement each other in terms of seasonality and that hydropower, although nominally "run of river", seems to provide a degree of intraday dispatchability. In addition, output patterns present interesting similarities with actual demand patterns. Based on such assessment, a model could could be developed to assess the magnitude of energy storage and/or back-up capacity that would be required for the desired target contribution of particular RE sources.

From the system planning and system operation point of view, with increasing penetration of RE generation, electrical power systems need additional dispatchable back-up and reserve capacity. Back-up capacity is needed to provide energy to the system at times when RE sources are not generating or are not generating enough to meet the demand. Reserve capacity is needed to balance RE output and provide electricity when RE output is not in line with day-ahead planning. Frequently the same units can serve both as backup and reserve capacity. Such units can be gas-fired power plants and reservoir (or pumped storage) hydro.

The requirements for back-up and reserve can be somewhat decreased with careful planning and combining various complementary RE sources, for example, solar PV plants' output somewhat matches the daily demand peaks. Reserve requirements can also be reduced if considering RE sources over a larger area. For example, a decrease of generation in one solar plant due to the cloud can be offset with the generation of the other PV plant.

The energy and installed capacity requirements for backup sources are significantly higher than for reserve sources. In cases when actual RE generation is in excess of system demand, energy storages are beneficial for the system. The current structure of Kosovo's energy generation does not have significant capacity for either backup or reserve capacity and therefore new dispatchable generation capacity and/or energy storage will need to be considered to facilitate the integration of additional RE capacity in Kosovo's electricity system.

There are several energy storage projects in Kosovo, none of them of a scale sufficient to provide weekly or even longer-term electricity storage. The only energy storage project with high round trip electrical efficiency is the PSHP Drini/Vermica. Its envisaged storage capacity is 2 GWh, installed power is 250 MW and the expected investment is 460 mln €. This translates into a specific cost of energy storage capacity of 230 €/kWh. Although high, it is lower than the cost of battery storage, which is estimated in the range of 330 €/kWh. The Consultant notes that there are several regional PSHP projects with an estimated cost of storage at the level below 10 €/kWh of storage capacity.

In-depth analysis is required to estimate the required capacity of energy storage to provide for system reserve in Kosovo for a given structure of its electricity system and the targeted installed capacity of renewables. If energy storage is also to serve the purpose of providing backup capacity for renewables, its required capacity would need to be significantly higher, depending on the targeted structure of the Kosovo electricity generation system.

1. Introduction and background

This assignment has been initiated by the EU office in Kosovo. The task was to identify and assess possible utility-scale renewable generation projects in Kosovo and to assess the necessary energy transport infrastructure required to facilitate identified projects. For practical purposes, only projects with an envisaged capacity of 10 MW or above were considered to meet the ToR's "utility-scale" category. Given the intermittent nature of renewable energy (RE) sources, the consultant was to consider energy storage projects that would complement RE sources and facilitate the supply of dispatchable electricity.

1.1 Key energy commitments of Kosovo

Kosovo is a signatory of the **Energy Community Treaty** since 2005. The Energy Community Treaty and its mechanisms are used as a pre-accession tool for contracting parties aiming to expand the benefits of the regional market before joining the European Union. Kosovo is not yet a signatory party of the United Nations Framework Convention on Climate Change and Kyoto Protocol, nevertheless, by signing the Energy Community Treaty Kosovo undertook responsibilities to respond toward implementation of the Convention and the Protocol. In this regard, Kosovo as a signatory Party to the Energy Community Treaty is obliged to harmonize its national legislation in compliance with the EU energy *acquis communitaire* adopted by the Ministerial Council of the Energy Community.

As a contracting party of the Energy Community, Kosovo transposed EU directives related to the third energy package and completed the unbundling of the system operator, and in February 2019 certified KOSTT as a transmission system operator. The development of the day-ahead and intraday market coupling between Kosovo-Albania is under the implementation stage, whereas the Albanian Power Exchange is established with KOSTT being a shareholder. Kosovo also committed to reaching a 25% share of RE in final gross energy consumption by 2020, compared with 18.9% in 2009. This commitment is based on the national mandatory overall target for the share of energy from RES in gross final energy consumption in the year 2020 as determined in the Ministerial Council of the Energy Community Decision D/2012/04/MC-EnC.

However, Kosovo in its National Renewable Energy Action Plan (2013) aimed for a higher target of 29% of expected gross final energy consumption by 2020 (known as voluntary target). To reach the 2020 RE target, the ERO adopted an administrative support scheme based on Feed-in Tariffs for different RE technologies.The EnC Secretariat confirmed that Kosovo, according to the submitted National Renewable Energy Action Plan and as well as all three Progress Reports on implementation of the Renewables Directive, registered a 24,9% share of energy from renewable sources in 2018, putting it on the trajectory to reach its 25% target in 2020 (appraisal of Kosovo 2019 or 2020 achievements is not available). This result was achieved in part due to a revision of biomass consumption.

The EU Directive (2018/2001) requires EU member states by 2030 to achieve 32% of their final consumption of energy based on renewable energy sources. The targets for 2030 are yet not published by the EnC, therefore Kosovo still does not have a target for RES. According to ERO, for the coming 2030 targets, Kosovo aims to attract new investments in RE technology based on competitive procedures, a process that is under development by Kosovo institutions.

The "Clean energy for all Europeans" package, in particular, the new Directive (EU) 2019/944 on common rules for the internal market for electricity and the Regulation (EU) 2019/943 on the internal electricity market, is currently still not adopted as *acquis communitaire* by the Energy Community and consequently not yet transposed to Kosovo law. Once the Energy Community adopts the EU legislation as *acquis communitaire* for the Energy Community's purposes, then it will require the contracting parties to transpose and implement the latest requirements.

2. Overview of the current electricity sector in Kosovo

The electricity markets in the Western Balkans are experiencing a period of complex transition, characterized by the coexistence of liberalization, dependency on aging polluting generation assets, and decarbonization agendas. Electricity sector reforms have advanced over the last years.

At a time when the European Union (EU) strives to achieve net-zero greenhouse gas emissions by 2050, coal still represents 97% of electricity generation in Kosovo. Kosovo has around 1.8 million inhabitants. Its electricity generation is almost entirely dependent on two state-owned aging lignite plants: Kosova A (five units with 800[3] MW installed) and Kosova B (two units with 678 MW[4] installed). Both are highly polluting. This adds significantly to Kosovo's heavy air pollution and environmental problems, especially during the winter period in the capital of Kosovo, Prishtina. Kosovo has very large lignite resources, amongst the largest in Europe totaling 12.5 billion tonnes. A new 500 MW lignite power plant project (around 450 MW net and estimated cost of EUR 1 billion) – Kosova e Re – was under development for many years. Recently, the promoter made public the withdrawal of its proposal.

Kosovo has no oil or gas extraction and no gas import infrastructure, although it is interested in connecting to the Trans-Adriatic Pipeline via Albania (ALKOGAP) and to North Macedonia's gas network. Kosovo does not have many hydro power resources as opposed to other Balkan countries. However, the developments in recent years have included the construction of several small hydropower plants. Several hydropower projects face strong public opposition due to concerns over their environmental impact. In 2019, total hydropower generation in Kosovo accounted for only 3.7 % of Kosovo's demand.

Overall Kosovo is a net importer of electricity. Most electricity imports are for covering peak demand.

The existing Kosovo Energy Strategy goes until 2026, and the review is expected to occur in meantime due to the legal obligation of the review of the energy strategy every three years from the adoption date. As a member of the Energy Community, Kosovo aims to achieve the 2030 RE targets once in force. The 2020 obligatory RE targets are assumed achieved since Kosovo registered a 24.9% share of energy from renewable sources in 2018[5] [1].

Kosovo abolished the administrative feed-in tariff support scheme in December 2020. RES developers that received FiT support scheme have a PPA for 12 years which grants them guaranteed purchase of generated electricity by the Market Operator as the off-taker of RES energy. A set of projects admitted to the support scheme and which have obtained the feed-in tariff are under construction, whilst other projects are at the preparation phase. KOSTT has entered into several connection agreements for large projects, in different parts of Kosovo, and mainly for solar PV and wind power technology.

A new concept for a market-based support scheme to RE is under development by Kosovo institutions to replace the feed-in tariff support scheme. The scheme is expected to help attract new investments in RE technology needed to reach future 2030 targets. According to the EROs consultative report of May, 16th 2019 on the "mechanism of support for RES targets (20MW solar PV)"[6] [2] it is stated that the feed-in tariffs as dominating measure in many European and regional countries until 2016, is expected to be substituted with new models which align the price of energy from RES with the market price. According to the consultative

---

[3] Out of that, only 610 MW is technically available, and only 400 MW is operationally available.

[4] Out of that, only 520 MW is operationally available.

[5] Annual Implementation Report 2020, Energy Community Secretariat, Page 83

[6] http://www.ero-ks.org/2019/Tarifat/RAPORT_konsultativ_per_Energjine_solare_02_05_2019.pdf

report, the policies of Kosovo aim at supporting renewables and at the same time allowing the market to determine the reasonable level of that support, ie. the prices for RE technology generation.

2.1 Demand

Figure 2.1 below shows the historic energy balance of Kosovo. Kosovo is a net importer of electricity, although in recent years its exports are increasing as well. According to ERO annual reports, due to the inflexibility of its coal units, Kosovo is generally a net importer of electricity during winter and a net exporter during summer. On the intraday level, Kosovo frequently exports electricity during the night (because of surpluses due to low load) and imports electricity during peak hours in a day. As prices of electricity are typically higher during peak hours and lower during nighttime, the economics of this situation is unfavorable for Kosovo.

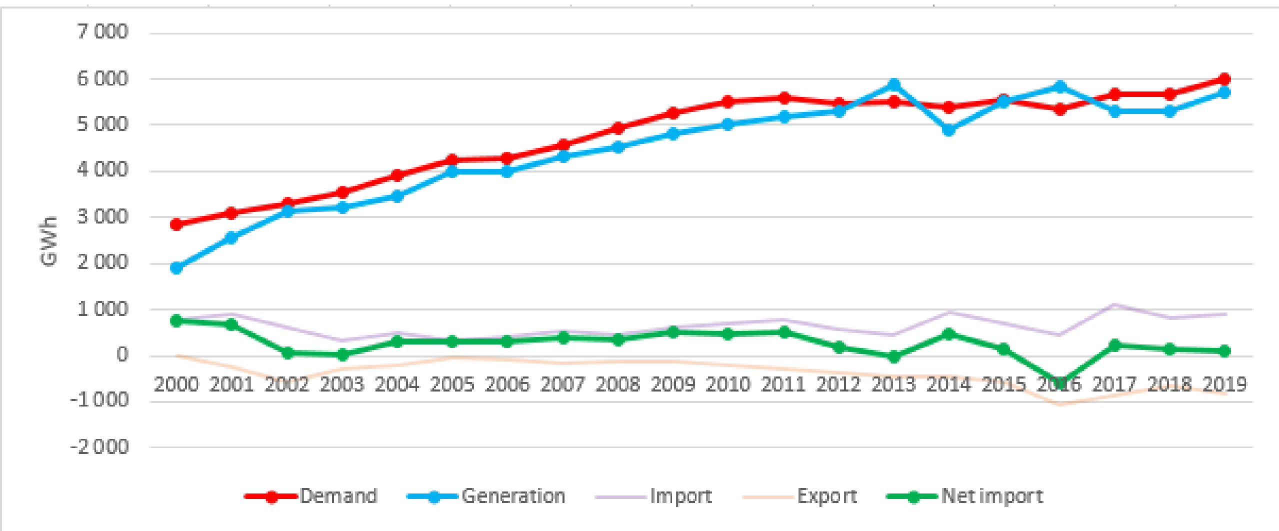

Figure 2.1**:** Historic energy balance for Kosovo

Source: Energy Strategy 2017-2028 & ERO, Annual Report 2016-2019 [3] [4] [5] [6] [7]

Note that the actual electricity demand in some years was larger but was not served as power outages were implemented. The volume of unserved demand has been decreasing over the recent years and the problem mainly occurs in the winter months.

Table 2.1 shows monthly unserved consumption (due to curtailment of demand) for the period 2017-2019, while **Figure 2.2** presents the annual unserved demand from 2009 to 2019.

Reductions, GWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Total**
2017	6.4	9.8	1.9	2.1	1.8	0	0	0	0	0	0	0.7	**22.6**
2018	3.4	0.3	8.4	0	0	0	0	0	0	0	4.2	0	**16.2**
2019	0	0	0	0	0	0	0	0	0	0	0	0	**0**

Table 2.1: Load shedding by months, 2017-2019

Source: ERO, Annual Reports 2017-2019 [5] [6] [7]

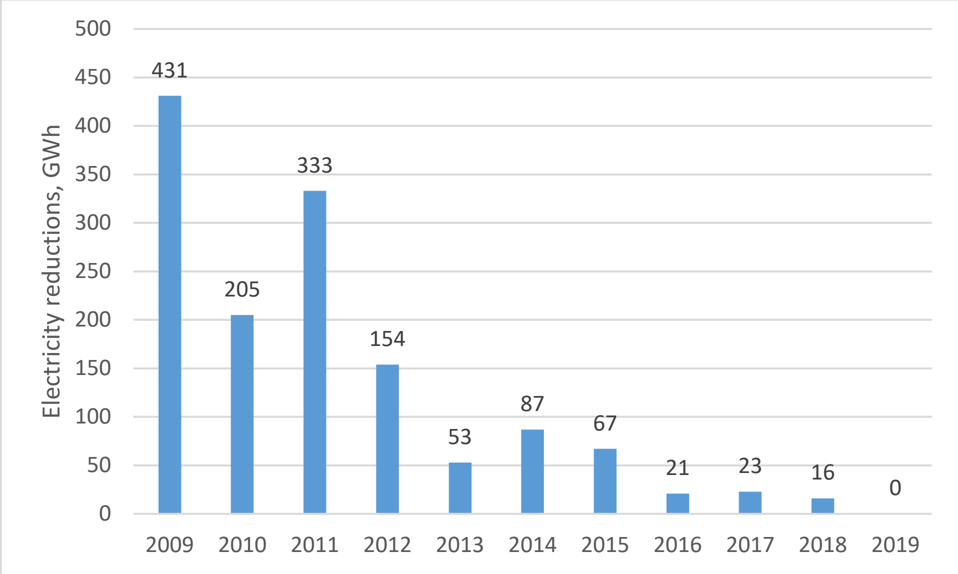

Figure 2.2**:** Load shedding through years 2009-2019

Source: ERO, Annual Report 2019 [7]

The structure of gross electricity consumption is provided in **Figure 2.3**. The Consultant notes a high level of technical and particularly non-technical losses in the distribution system.

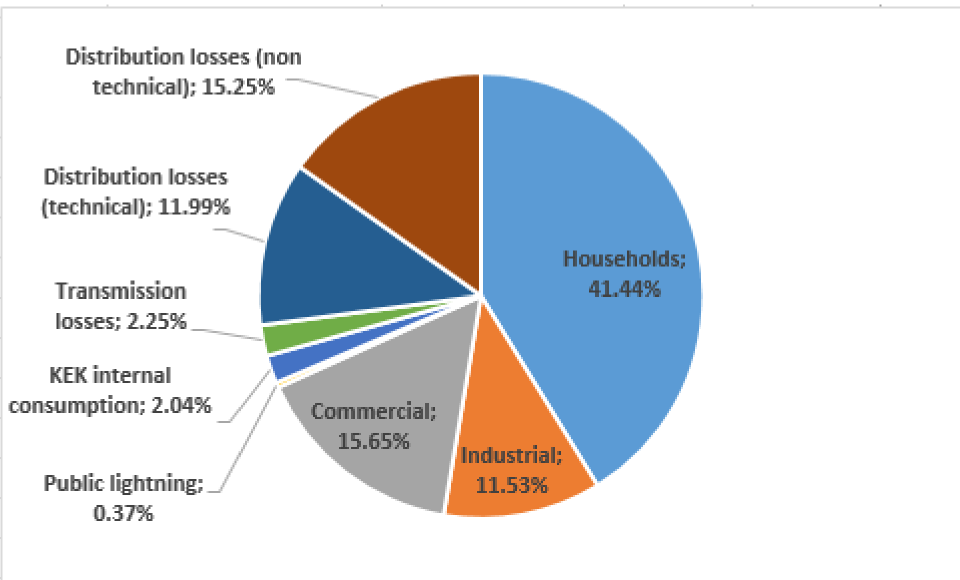

Figure 2.3**:** Gross electricity consumption in Kosovo, 2016

Source: World Bank, Evaluation of Power Supply Options for Kosovo, 2018 [8]

Peak load in the Kosovo network is increasing at an average rate of 2.8% annually and has reached 1 260 MW in 2018. The system load duration curve is provided in **Figure 2.4**.

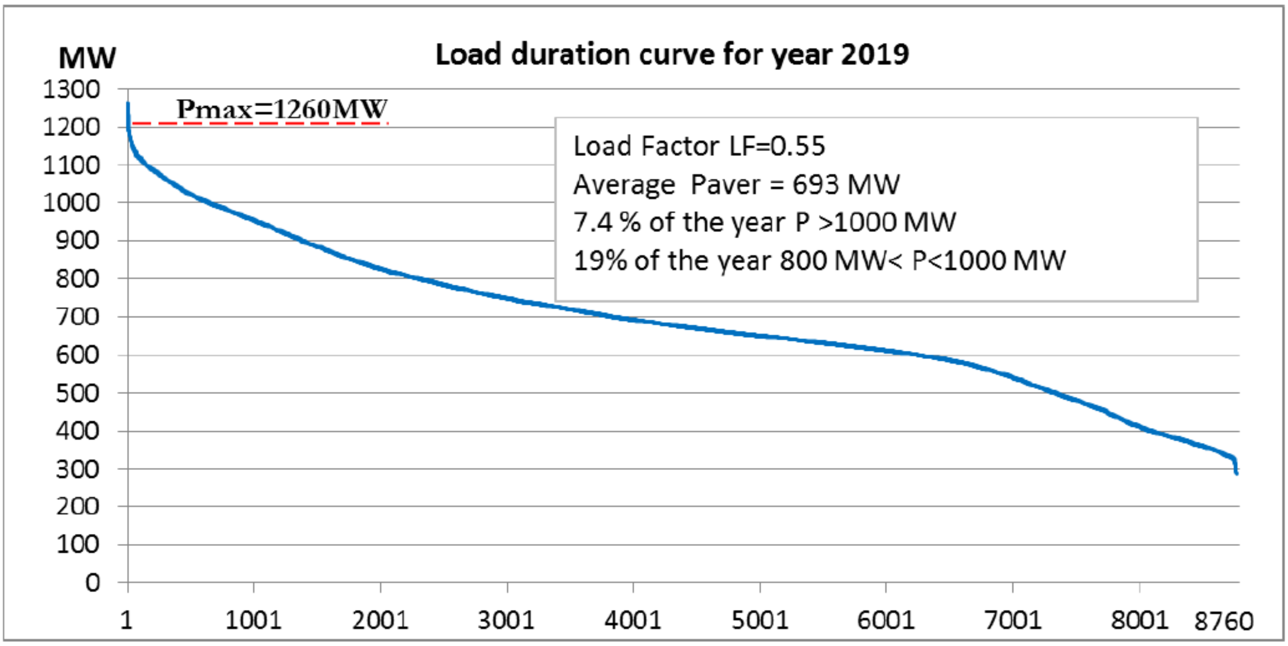

Figure 2.4**:** Load duration curve, 2019

Source: KOSTT Transmission Development Plan 2021-2030 [9]

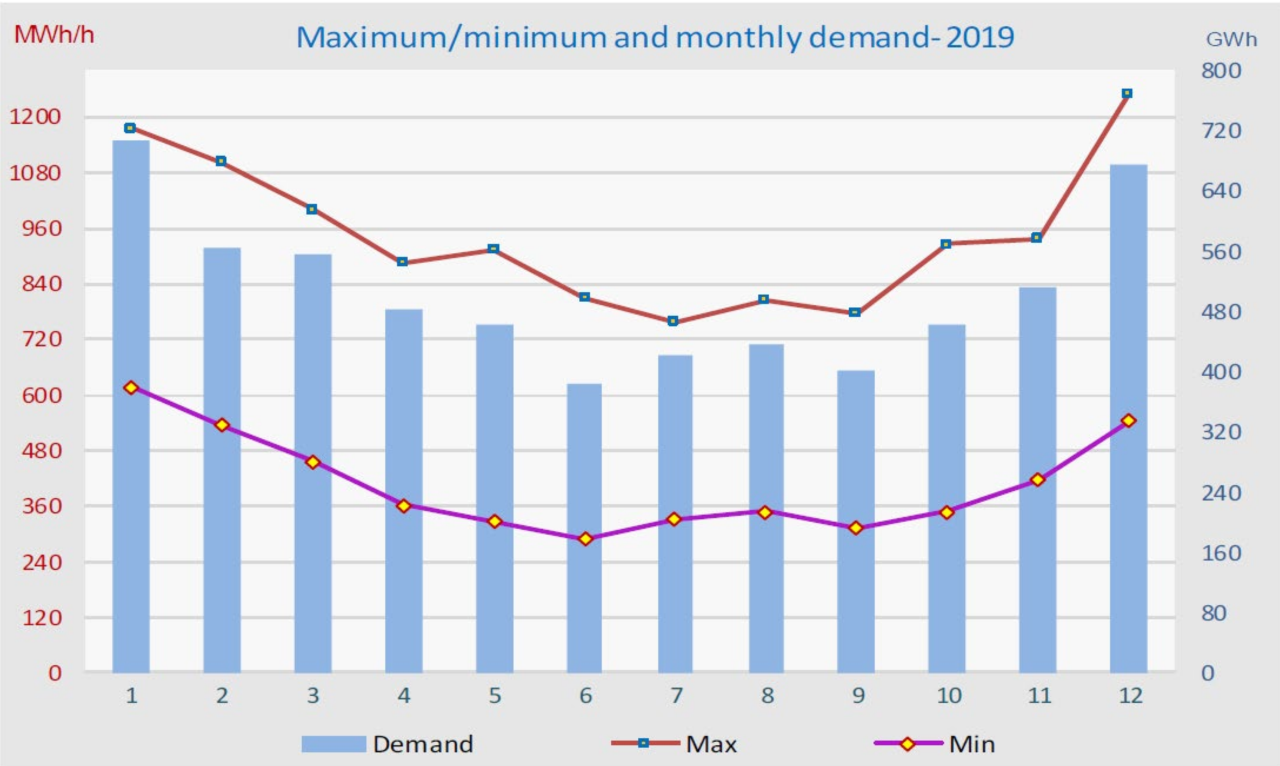

Figure 2.5. The Figure also provides the monthly average demand in 2019. The Consultant notes significant seasonality of system load and energy demand. Energy consumption in the winter months is up to 80% larger than in the summer months. The daily maximum load in winter months can be up to 100% larger than the daily minimum load in winter months. Also, daily maximum loads in winter months can be up to 60% larger than maximum loads in summer days. This indicates that the Kosovo electricity supply should cope with both significant seasonal and intraday load variations. These variations are common in most electricity systems, however, in Kosovo, they may be somewhat more pronounced, at least partially, due to electricity being used for space heating.

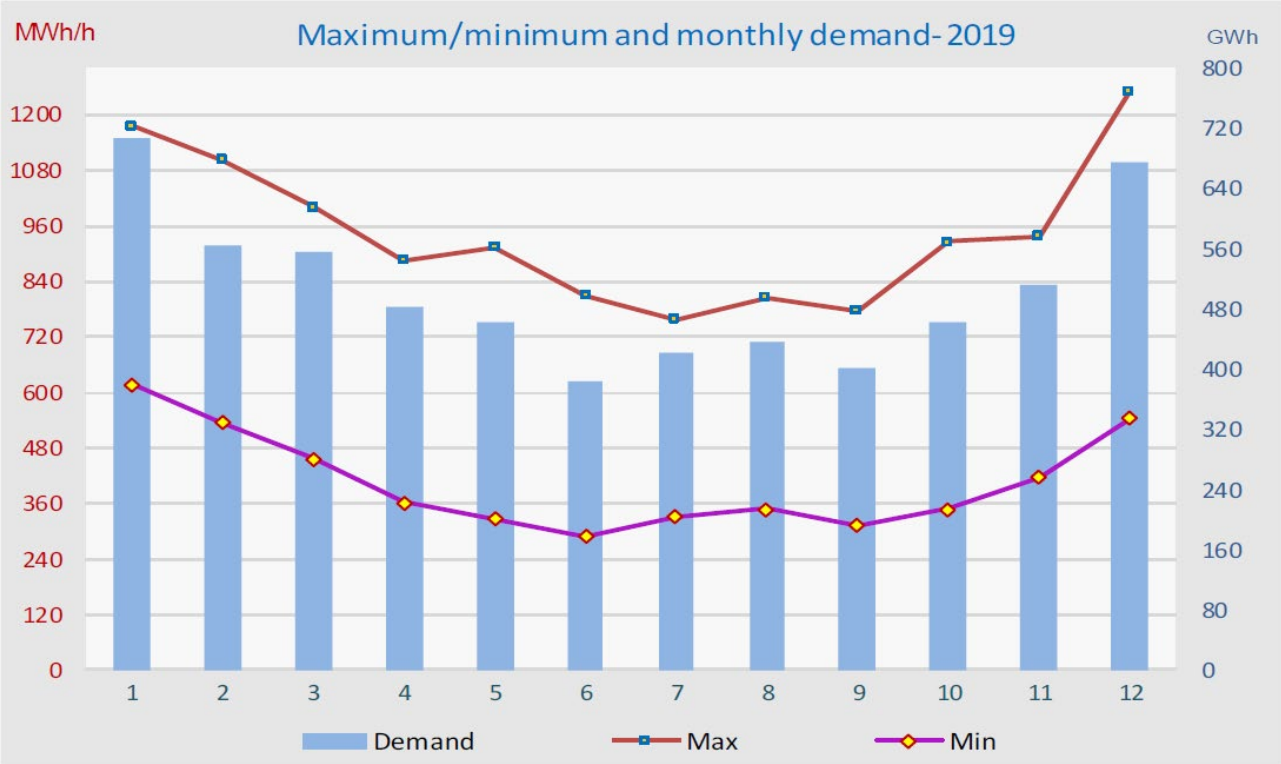

Figure 2.5**:** Monthly average demand and maximum/minimum daily loads 2019

Source: ERO, Annual Report 2019 [7]

The daily load profile on a typical day is provided in **Figure 2.6** below. Electricity consumption during the night is lower. As it can be seen from the figure below, the highest summer system load is reached around 11h and only slightly decreases throughout the rest of the day. Summer load starts to decrease after 21h. In winter there are two peaks, the first one reached at 11th hour, and the second, higher one, reached around 18h.

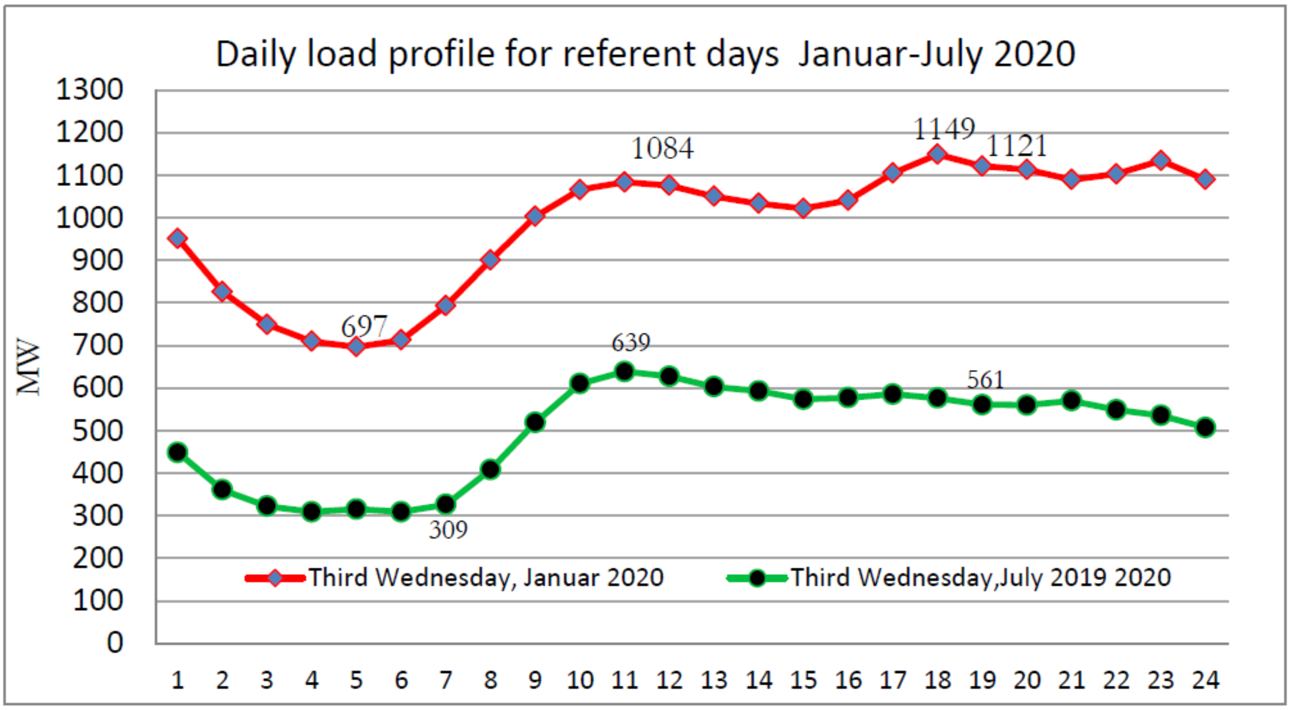

Figure 2.6**:** Daily load profile on typical days, 2020

Source: KOSTT Transmission Development Plan 2021-2030 [9]

2.2 Supply

2.2.1 Generation

Kosovo's electricity supply is mostly sourced from two lignite plants, Kosova A and Kosova B. In 2020, coal-fired power plants represented 87.8% of the overall installed generation capacity. The remaining 12.2% consisted of renewables, mostly HPP Ujmani, HPP Lumbardhi Cascade (Lumbardhi 1&2, EGU Belaja, EGU Decani), and Wind Park Kitka. Small wind farms, solar, and hydropower plants have a total of 79.46 MW installed capacity.

In terms of electricity generation by technology, in 2019[7] coal provided 94.5% and hydro 3.7%. Wind and solar together produced 1.8% of all electricity in Kosovo.

Information on the installed capacity on transmission and distribution grid, electricity generation, and shares depending on the technology (source) are provided in **Table 2.2** and **Figure 2.7** below.

Plant	Type	Installed capacity[8], MW	Generation[9], GWh	Start of operation
Kosova A[10]	Thermal (Coal)	610	2 078.29	1970-1975
Kosova B	Thermal (Coal)	678	3 325.47	1983-1984
Ujmani	Hydro	35	82.89	1983
Lumbardhi cascade	Hydro	32.17	72.66	(1957) 2005, 2015, 2015[11]
Small HPPs	Hydro	68.11	57.37	2010-2017
Wind Power/Wind Generators	Wind	1.35	0.11	2010
Kitka	Wind	32.4	90.54	2018
Small PVs	Solar	10	10.48	2015-2019
Total		**1 467.03**	**5 717.81**	

Table 2.2: List of power plants in Kosovo with their installed capacities, electricity generation in 2019, and the start of operation

Source: Installed capacities of generation in Kosovo 2020 (KOSTT website) & ERO, Annual Report 2019 [10] [7]

Note that the available capacity in Kosova A and B are smaller than nominally installed.

[7] Note that the 2020 generation data were not available during this assignment.

[8] KOSTT website, data on installed capacity for year 2020. [10]

[9] ERO Annual Report 2019 [7], data on generation for year 2019. Note that generation data for 2019 does not include the capacities installed in 2020 (and in certain cases in 2019).

[10] Capacity of 610 MW stands for units A3, A4 and A5, which are still in function.

[11] Start of operation: Lumbardhi 1 - 1957 (2005), EGU Belaja - 2015, EGU Decani - 2015.

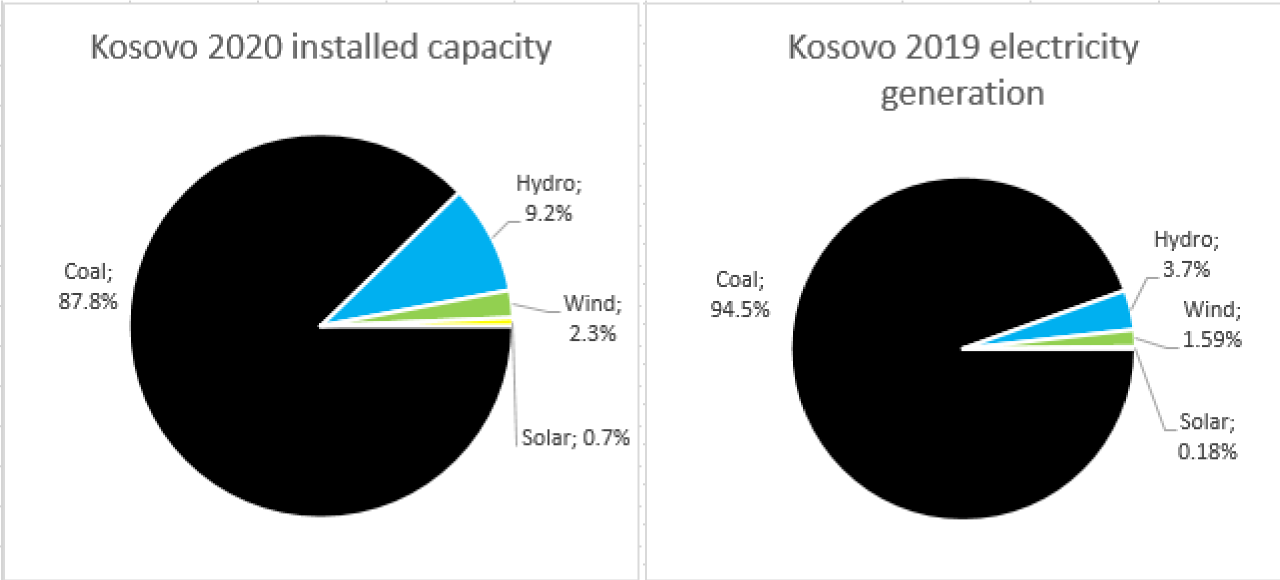

Figure 2.7**:** Structure of Kosovo installed capacity for 2020 (left) and electricity generation for 2019 (right) by technology (source)

Source: Installed capacities of generation in Kosovo 2020 (KOSTT website) & ERO, Annual Report 2019 [10] [7]

Note that Table 2.2 and Figure 2.7 do not include the generation capacity put into operation in 2021, nor the generation of any new capacity put into operation in 2020 nor 2021. Information on those units is provided in **Table 2.3** below**.**

Plant	Type	Installed capacity, MW	Start of operation date
Lumbardhi II	Hydro	6.20	01.01.2020
Brodosan	Hydro	0.31	03.02.2020
Albaniku 2	Hydro	3.55	06.02.2020
Binca	Hydro	1.00	25.02.2020
Brod I	Hydro	2.48	22.02.2021
Restelica III	Hydro	2.35	22.02.2021
Albaniku 4	Hydro	1.12	04.03.2021
Total		**17.01**	

Table 2.3: List of additional capacities added during 2020 & 2021 with their start of operation date

Source: Register of Applications for construction of new generating capacities from RES, 2021 [11]

Kosovo's energy generation is almost exclusively dependent on lignite Kosova A and B units. The capacity of those units is not sufficient to cover the demand during winter peak hours.

2.2.2 Imports

As illustrated in **Figure 2.1** above, Kosovo is a net importer of electricity. A significant part of Kosovo's imports is peak electricity. Imports are larger during winter. Kosovo's exports of electricity are typically excess generation from inflexible lignite units that occur during low domestic load, typically during the night and in summer. **Figure 2.8**, shows that Kosovo mainly exports energy during low consumption hours (01:00 - 08:00), whereas it imports electricity during daytime hours.

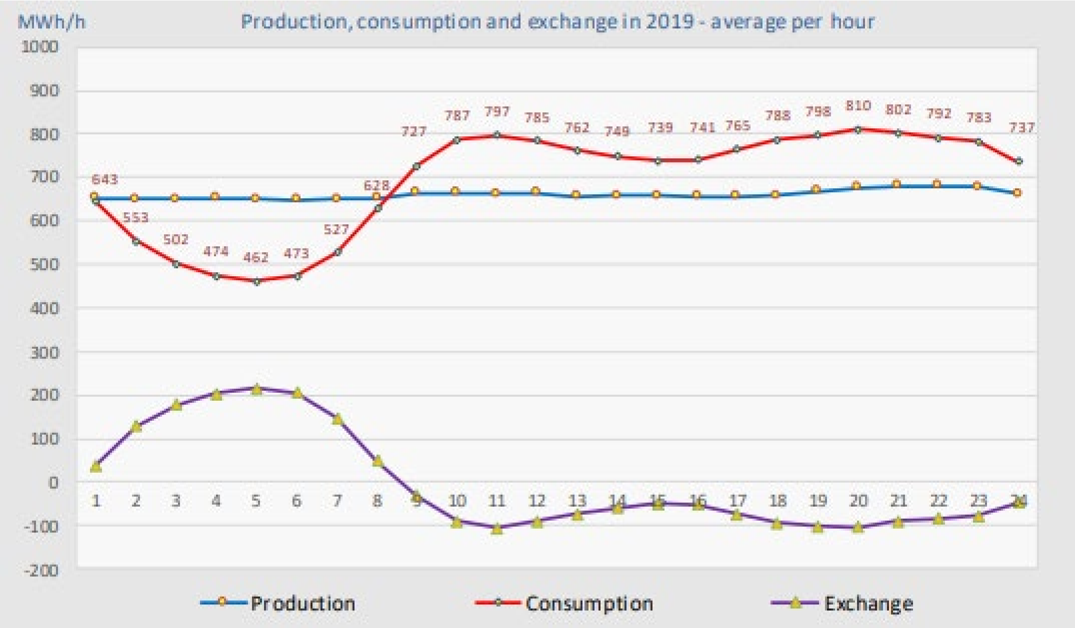

Figure 2.8**:** Hourly average production consumption and exchange of electricity in 2019

Source: ERO, Annual Report 2019 [7]

Historic average prices of Kosovo imported electricity are provided in **Figure 2.9**.

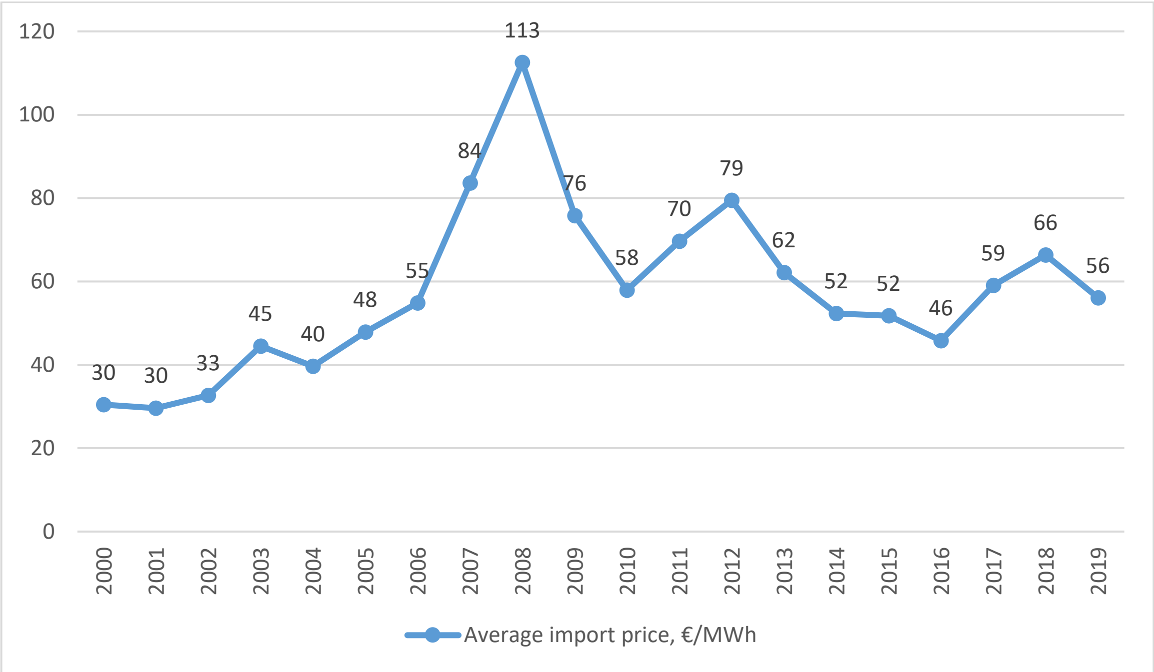

Figure 2.9**:** Historic Kosovo average electricity import prices

Source: ERO, Annual Report 2019 [7]

Figure 2.10 and **Figure 2.11** provided below compare reported Kosovo electricity import prices to the prices of peak and baseload electricity observed on regional exchanges in the past 6 years.

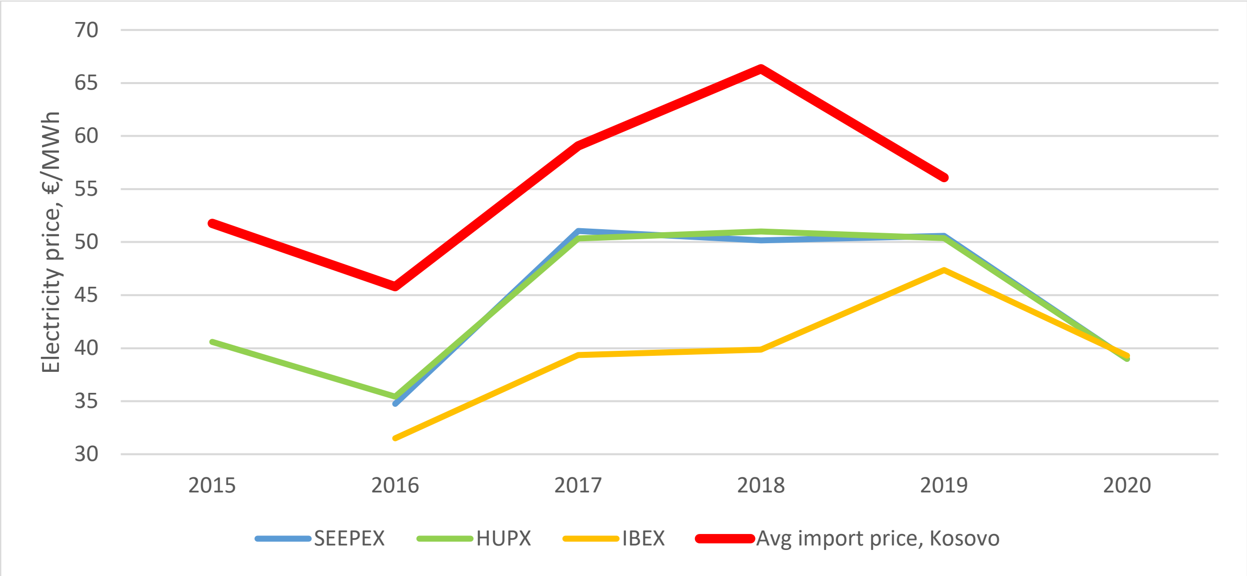

Figure 2.10**:** Comparison of Kosovo average electricity import price to base electricity prices on regional exchanges in last 5 years

Source: ERO, Annual Report 2019; SEEPEX, HUPX, and IBEX websites (Annual and Monthly reports) [7] [12] [13] [14]

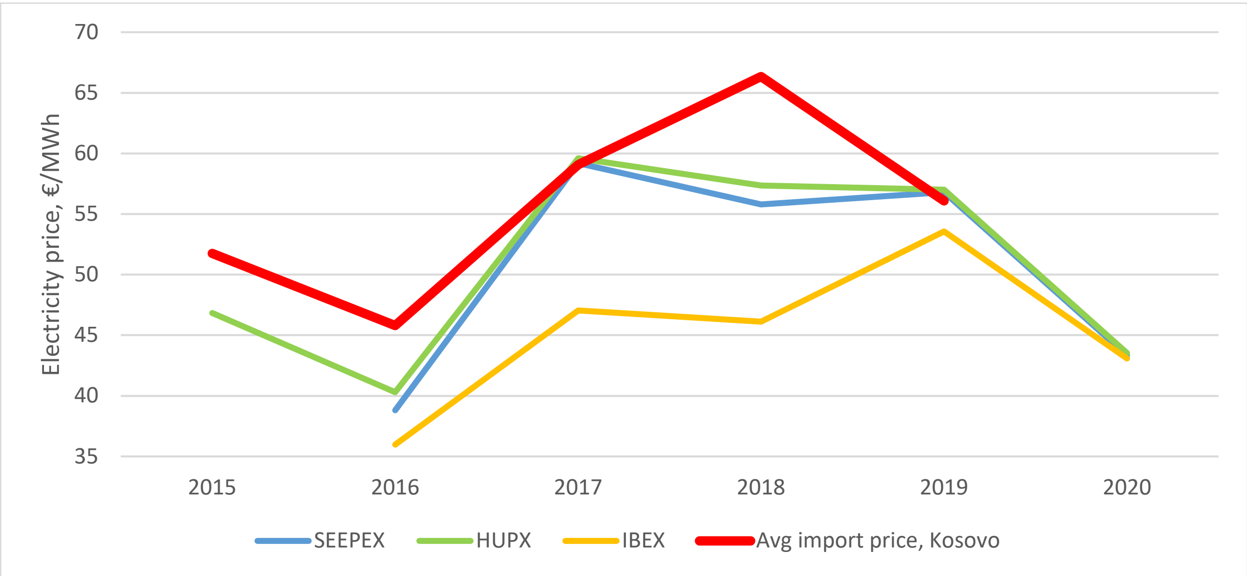

Figure 2.11**:** Comparison of Kosovo average electricity import price to peak electricity prices on regional exchanges in last 5 years

Source: ERO, Annual Report 2019; SEEPEX, HUPX, and IBEX websites (Annual and Monthly reports) [7] [12] [13] [14]

Hungarian Power Exchange (HUPX) is the most liquid regional electricity exchange with annual traded volume in 2020 exceeding 25 TWh [13]. It appears that in 2019 and 2020 the prices on Serbia-based South East European Power Exchange (SEEPEX) and Independent Bulgarian Energy Exchange (IBEX) have converged to HUPX prices.

In recent years Kosovo reported import prices are mostly consistent with HUPX peak electricity prices. That is in line with the observations made in Section **2.1**.

2.3 RE Development plans

Kosovo 2017-2026 Energy Strategy [3] sets a goal of 400-470 MW of installed capacity in RE sources.

- Solar PVs are estimated to contribute 26.5 to 75 MW by 2026, depending on the scenario. Up to now, 10 MW or 38-13% of the estimate is achieved[12].
- Biomass is estimated to contribute 11 MW by 2026. Up to now 1.2 MW or 11% of that goal is achieved.
- Wind power is estimated to contribute 130 to 150 MW by 2026, depending on the scenario. Up to now, 33.75 MW or 26-23% of that goal is achieved.
- New HPPs are estimated to contribute with 160 MW by 2026. Up to now 6.2 MW or 4% of that goal is achieved[13].

Based on the Law on Energy[14] [15] , the Energy Strategy, as the main policy document, should be revised every three years by the Government and sent to the Parliament for approval. The Consultant understands a revision of the Energy Strategy is currently at an early drafting stage. According to Kosovo authorities interviewed during this assignment, it is expected that, due to environmental and social concerns and local community opposition, the goals for small hydro will be revised downwards, i.e. no new small HPP projects are expected to be accepted in the support scheme. The goals for solar PV, and possibly wind, are expected to be revised upwards.

[12] Taking into account information available as of writing of this report.

[13] Total capacity of HPPs in Kosovo, installed at the time of adoption of the 2017-2026 Energy Strategy was 129,1 MW (according to information on KOSTT website [10]). As the Strategy declares "new capacity" the Consultant considers only the capacity added from 2017 onwards.

[14] Law on Energy No. 05/L – 081, Article 6.5

3. Overview of RE projects

3.1 RE framework and support scheme

The use of RE sources for energy production in Kosovo is expected to significantly contribute to the three objectives of national energy policy: overall economic development, increased security of supply, and protection of the environment.[15] [16]

The Law on energy[16] [15] creates a framework for RE support and utilization. To meet the RE targets, the ministry responsible for the energy sector adopts special regulation to determine the RE capacity that is to be supported. Following the Law on energy regulator[17] [17], ERO adopts procedures for RE project acceptance in the support scheme and the procedure for authorization, including the rights and obligations of RE producers, the rights and obligations related to selling of the produced electricity to the designated off-taker, provisions for financing the support scheme and integration of RE into the electricity system of Kosovo.

Starting in 2011 (Decision V_359_2011) [18] and including amendments in 2014 (Decision V_673_2014) [19], 2016 (Decision V_810_2016) [20] and 2019 (Decision V_1204_2019) [21] Kosovo had a feed-in tariff for RE sources in place. Quota and feed-in tariffs are shown in **Table 3.1** below.

Technology	ERO decision 2016		ERO decision 2019		Duration of the Power purchase agreement (years)
	Quota (MW)	FiT (€/MWh)	Quota (MW)	FiT (€/MWh)	
Small HPPs	240	67.47	240	67.47	10
Wind	150	85.00	150	85.00	12
Solar (PV)	10	136.40	30[18]	85.5	12
Biomass	14	71.30	14	71.30	10

Table 3.1: Quota, FiT amount, and duration of PPA from ERO decisions

Source: ERO website

The "per project" capacity limit for admission in the support scheme until 2020 was up to 3 MW[19] for solar (PV), up to 35 MW for wind, and up to 10 MW for small hydro.

On 10 December 2020, ERO issued a decision [22] to terminate all feed-in tariffs (FiT) for further RE projects. All applications received and registered at ERO and accepted under the support scheme that are within RES targets until 2020[20] will be processed according to the legal framework at the time of application. Applications registered as "pending" will not be eligible for feed-in tariffs. ERO also declared that it will undertake actions

[15] MEE 4th Renewable Energy Progress report of the Republic of Kosovo 2018-2019, Prishtina February 2021

[16] Law on Energy, 05/L – 081, OG 24/16

[17] Law on Energy Regulator, 05/L- 084

[18] In 2019, ERO raised quota for solar (PV), from 10 to 30 MW, and offered lower feed-in tariff for the additional 20 MW to 85.5 €/MWh.

[19] Resulting in investors dividing single larger projects into multiple projects on the same location, e.g. single solar PV project of 12 MW was divided into 4 solar PV projects of 3 MW and in that form (as separate projects below 3MW) admitted to ERO for support scheme.

[20] The Consultant understands this as NREAP targets adopted by the Administrative Instruction (Ministry of Economic Development) No.05/2017 on Renewable Energy Source Targets.

that will provide the regulatory basis for the development of projects from RE sources for the targets 2021-2030 through various forms of auctions for tariff premium or similar, based on a competitive process.

In the absence of FiT, the support schemes available to RE generators at the moment are the regulated generator and net-metering prosumers schemes. Of interest for utility-scale RE projects is the former. Obtaining the status of regulated generators guarantees to RE generator the offtake of its entire electricity generation at the prices that are based on the cost of avoided imports.[21] The Consultant did not have detailed information on the hourly energy balances and respective import prices and thus could not calculate the relevant reference price. Up to now, no RE developers have applied for the status of the regulated generator.

As the support scheme to replace the canceled FiT is not established now, there is a legal and regulatory vacuum regarding the renewables support scheme for future RE projects.

It appears that projects under development have slowed down or stopped their activities and are awaiting the new support scheme to reassess the viability of their undertakings.

3.2 Identified RE projects

The map in **Figure 3.1** below illustrates the locations of the identified utility-scale renewable projects. Utility-scale projects are considered with a capacity of 10MW or larger. The project locations are indicative only as the exact locations were not available to the Consultant. Please note that in addition to the identified projects that are assessed in this report, new RE project initiatives and developments can be seen emerging[22].

[21] ERO methodology for calculation of the reference price can be found at: http://www.ero-ks.org/zrre/sites/default/files/Methodology%20on%20calculation%20of%20reference%20price%20for%20RES.ANG.DOCX

[22] For instance, a combined wind power/solar PV project Jasenovik, with 132 MW of wind capacity and 38 MW solar PV capacity, for which the start of EIA public hearing was announced in late April. https://balkangreenenergynews.com/hybrid-power-plant-project-jasenovik-of-170-mw-underway-in-kosovo/

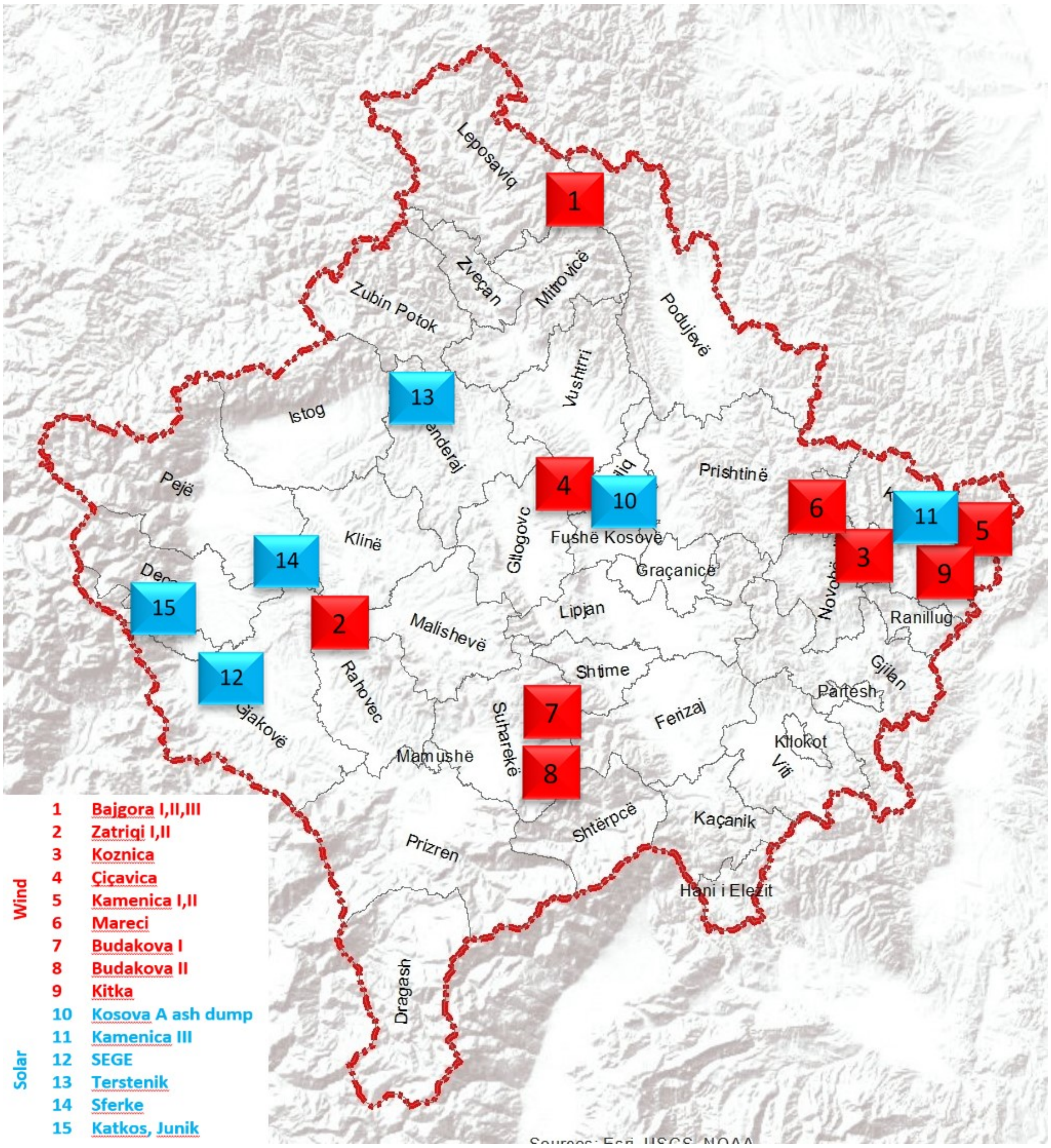

Figure 3.1 Indicative location of identified utility-scale renewable projects.

Source: Consultant research.

A total of 15 utility-scale renewable energy generation projects either in development or in construction have been identified. The total capacity of these projects is 1 062.1 MW. If projects with a capacity smaller than 10 MW are added, then the total renewable generation capacity in development or in construction is 1 336.5 MW across 61 projects in total.

To put the identified RE projects in perspective, we note that the 2020 World Bank study [23] assessed the total technical potential of Kosovo solar PV to be 3 600 MW[23]. The technical potential for wind power was assessed at 1 200 MW[24].

The regulatory provisions limit the eligibility for FiT to solar PV projects with an installed capacity of up to 3 MW. This resulted in several solar PV projects of 3MW being developed adjacent to one another. As the FiT

[23] Assuming 2% of total suitable and available area to be used for solar PV and 2ha/MW land requirement.

[24] Accounting for suitable land, 0.5 km^2 for 1 MW, grid distance issues, wind potential and other factors.

support scheme has been abandoned[25], it is unclear whether in the future adjacent 3MW solar PV projects owned and developed by ultimately the same entity will be formally and technically joined.

Moreover, due to the December 2020 cancellation of the FiT, it remains unclear whether the development of projects which had not yet secured their FiT PPA will be continued. It is expected that an auction scheme for contracts for difference or similar auction schemes will be put in place instead. This scheme is expected to favor larger projects for quicker achieving the future 2030 RES targets. Currently, there are significant uncertainties for developers, and it is unclear which of the projects will continue development after the new renewables support scheme is announced.

	Wind	Solar PV	Biomass	HPP
Utility-scale (projects over 10 MW)				
Number of projects	9	6		
Capacity (MW)	499.1	563		
Estimated generation (GWh)	1 335.2	806.7		
Small projects (below 10 MW)				
Number of projects		22	1	23
Capacity (MW)		123.3	5.2	145.9
Estimated generation (GWh)		158.9	36.4	467.1
Total capacity, MW (small and large projects)	499.1	686.3	5.2	145.9
Total RE capacity, MW	**1 336.5**			
Total generation, GWh (small and large projects)	1 335.2	965.5	36.4	467.1
Total RE generation, GWh	**2 804.3**			

Table 3.2: Review of identified RE projects in Kosovo

The total estimated energy generation of all identified Kosovo RE projects is 2.8 TWh and accounts for cca 47% of current energy demand in Kosovo. Note that the table above does not include the Prosumers category of self-consumption generators, with a capacity from 2kW up to 100kW, which accounts for a total of 4 MW of planned capacity. It also does not include the Pumped Storage Hydro Power Plant Drini/Vermica, which will be assessed in the section related to energy storage.

3.2.1 Wind projects

Within this assignment, the Consultant has identified a total of 9 utility-sized wind power projects. The capacity of these wind power projects sums up to 486.1 MW and their expected annual generation to almost 1 300 GWh. These projects are listed in **Table 3.3** below.

The average capacity factor of these projects is cca 31%. The average reported overnight specific investment cost[26] is 1 463 €/kW[27] based on 7 projects. The overnight specific investment was estimated for the 2 projects

[25] The categorization of technologies namely 3 MW for PV, wind 35MW, Hydro 10, and biomass 14 MW is adopted by the Ministry (under the Administrative Instruction No. 06/2017 on Utilization and Support of Energy Generation from Renewables) whilst the ERO adopted the FiT based on the categorization of technology the Ministry adopted. Therefore, even that the FiT is terminated the categorization formally still remains. Categorization under the Support Scheme means that the RE project would be entitled to sell the electricity generated to the Market Operator based on a PPA, be liable for 25% of the imbalance, have priority in examining the application and are entitled of priority dispatch or be eligible to qualify for premium payments.

[26] Overnight investment cost is the cost if no interest is incurred during construction, as if the construction is completed “overnight”.

[27] All investment costs are provided in 2020 prices.

for which investment cost was not available. Note that these specific investment costs are notably higher than 1 300 €/kW, as reported by Wind Europe Report from 2020 [24]. Within the course of this assignment the Consultant did not have sufficient information on either the Wind Europe report methodology or the cost structure and estimates of Kosovo RE developers in assessing their investment costs and thus can not comment the difference.

Project name/Location	Installed capacity (MW)	Average annual electricity output (GWh).	Overall status of the project
Bajgora/Selac I, II, III	103.4	280	Under construction
Zatriqi/Zatric I, II	64.8	176	In development
Koznica	34.5	96.6	In development
Çiçavica	116.6	296	In development
Kamenica I, II	69.6	184	In development
Mareci	31.2	80	In development
Budakova I	11.0	31.1	Under construction
Budakova II	35.0	98.9	In development
Kitka (addition)	33.0	92.4	In development
Total	**499.1**	**1 335.2**	

Table 3.3: List of identified wind projects (larger than 10 MW) in Kosovo

The capacity of identified wind projects several times exceeds the goals stipulated in the current Kosovo Energy Strategy. Details on the development status of the listed projects are provided in section **4.5**.

3.2.2 Solar PV projects

A total of 6 utility-sized solar projects have been identified with a total capacity of 563 MW and an expected annual generation of 806.7 GWh. These projects are listed in **Table 3.4** below.

Project name/Location	Installed capacity (MW)	Average annual electricity output (GWh)	Overall status of the project
Kosova A ash dump	100.0	162	In development
Kamenica III	30.0	41	In development
SEGE	136.0	190	In development
Terstenik	96.0	134	In development
Sferke	96.0	134	In development
Katkos Junik	105.0	146	In development
Total	**563**	**806**	

Table 3.4: List of identified solar projects (larger than 10 MW) in Kosovo.

The average capacity factor of these projects is cca 16%. The average overnight specific investment cost[28] for Kosova A ash dump project is 777 €/kW while for the other 5 projects 680 €/kW was taken based on World Bank Study from 2020 [23].

Details on the development status of the listed projects are listed in section **4.5** below.

[28] Based on 2020 solar PV costs.

The capacity of identified solar PV projects several times exceeds the goals stipulated in the current Kosovo Energy Strategy.

3.2.3 Hydro power projects

HPP Zhur is the only utility hydro power size project identified in Kosovo. Information on it is provided in **Table 3.5** below. Its characteristics are assessed for comparison with other projects. Nevertheless, HPP Zhur has not been included in the estimate of RE development potential as it does not appear as being actively developed for almost a decade now.

The project is not any longer included in Energy Strategy, nor in KOSTT network development plans.

Project name/Location	Installed capacity (MW)	Average annual electricity output (GWh)	Overall status of the project
Zhur 1	262	342	Unknown status/No recent developments
Zhur 2	43	55	Unknown status/No recent developments
Total	305	397	

Table 3.5: List of identified HPP projects (larger than 10 MW) in Kosovo

The total usable storage of HPP Zhur is 198 GWh. The average capacity factor of these projects is cca 15%. The average overnight specific investment cost[29] for both Zhur 1 and Zhur 2 is 1 400 €/kW and was taken from generic hydro cost estimates provided in World Bank Study from 2020 [23]. Note that a Feasibility study was made for HPP Zhur in 2009. It estimated the total investment for both HPPs at 329.3 mil €, leading to a specific investment of 1 079 €/kW. It has been reported that in 2014-2015 several small HPPs in Albania have been constructed which use water which was envisaged for HPP Zhur. Thus, the generation potential of HPP Zhur is likely now lower.

[29] In 2020 prices.

4. Assessment of RE projects

4.1 Capacity factor

A capacity factor of identified RE projects is calculated as a ratio of expected annual generation and total possible annual generation given the installed capacity. It is an important parameter as RE sources generally cannot achieve the high capacity factors of fossil-fuelled power plants[30]. Thus, more installed capacity is required to yield the same quantity of energy.

To calculate the capacity factor, the information on annual expected electricity generation was used where available. In cases where individual project annual generation data was not available, it was derived from capacity factors based on the following:

- Estimates based on Global Solar Atlas[31] were used for solar PV projects with a known location[32].
- Average observed capacity factors in Kosovo were used to estimate annual generation for solar projects with unknown locations and all wind and hydro power projects without known annual generation.

The range of obtained capacity factors of identified RE projects per technologies is provided in **Figure 4.1** below.

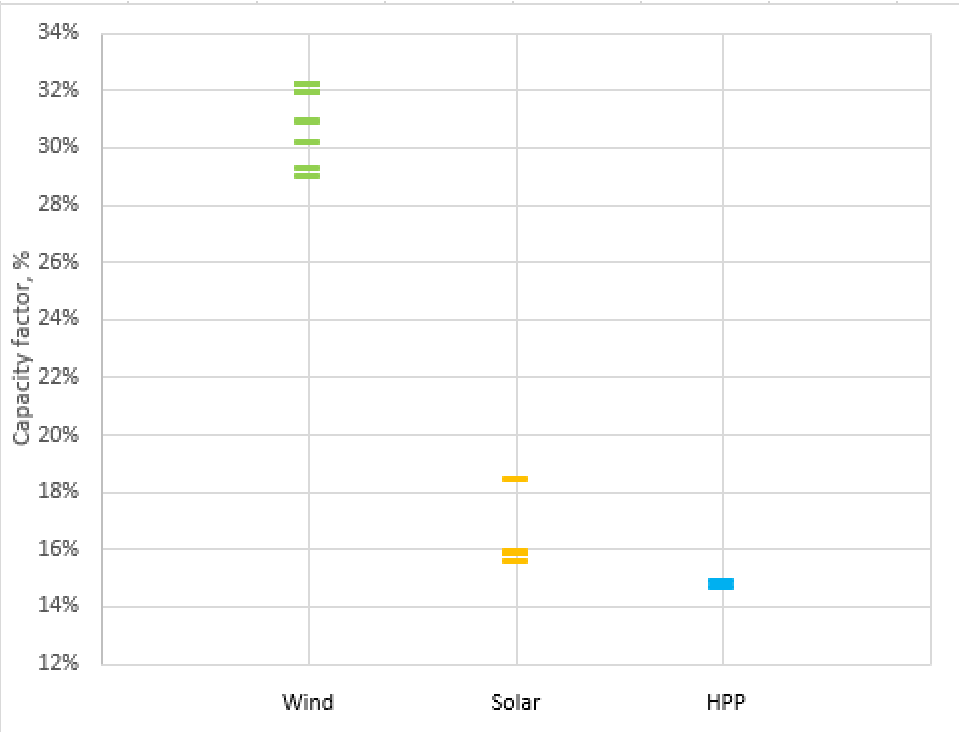

Figure 4.1**:** Range of capacity factors of identified RES projects (larger than 10 MW) per technology

To compare the estimated capacity factors of RE projects in development, in **Table 4.1** below the Consultant provides the observed capacity factors of RE projects in operation in Kosovo (based on 2020 generation data). Note that the observed capacity factor in 2020 for solar projects was notably higher than envisaged for future solar projects as provided in **Figure 4.1**. The difference may be due to 2020 being above average sunny year, or the project already implemented are in better locations than the ones in development.

Project/Projects	Technology	Capacity Factor	Average Capacity Factor
Kitka	Wind	32.4%	32.4%
Ujmani	HPP	20.5%	22.3%
Kelkos	HPP	21.8%	

Restelica 1&2+Brod 2&3	HPP	29.6%	
Led Light Technology PV	Solar	16.2%	19.3%
Onix (Intering) PV	Solar	15.8%	
Birra Peja PV	Solar	20.1%	
Frigo Food PV	Solar	20.0%	
Eling PV	Solar	18.5%	
Solar Green Energy PV	Solar	18.8%	

Table 4.1: Capacity factors of RES projects in operation in Kosovo (based on 2020 generation data)

In **Figure 4.2** the Consultant provides the average unit (per 1 MW of installed capacity) output duration curve for existing Kosovo RE projects in 2020. It illustrates the low output duration curve of solar PV projects, which are unavailable during the night.

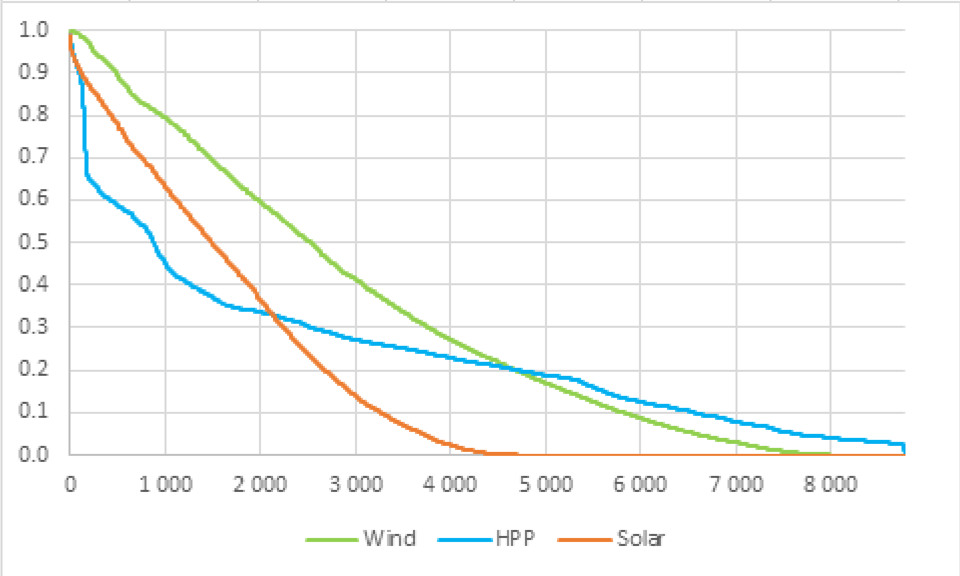

Figure 4.2**:** Output unit duration curve in 2020 for existing renewable energy projects in Kosovo

4.2 Specific investment

Capital investment (Capital expenditure, CAPEX) was assessed either based on typical overnight specific investment cost (€/kWh) or based on the actual project estimated CAPEX data. For some projects, the data on CAPEX has been obtained from ERO [25] and is based on the CAPEX estimates of project developers at the time of application to ERO. These costs were adjusted for price changes, considering the typical investment structure, from the time of application to ERO until 2020. Therefore, CAPEX and specific CAPEX costs are expressed in 2020 prices[33]. In cases where project CAPEX data was not available, generic specific investment provided in World Bank Study [23] was used for the economic and financial assessment. **Figure 4.3** provides specific investment per unit of installed capacity (€/kW) for assessed projects.

[30] According to the information provided in Table 2.2, the capacity factor of Kosovo A in 2019 was 39%, and 56% for Kosovo B.

[31] https://globalsolaratlas.info/map?c=11.523088,8.173828,3

[32] Note that this approach doesn't take into account possible solar tracking or higher efficiency modules.

[33] Key driver for price changes being the decrease of PV module prices according to IRENA study from 2020 [39].

Figure 4.3**:** Specific investment range of identified RES projects (larger than 10 MW) per technology

Note that for several identified solar PV projects the actual CAPEX was not known, therefore the CAPEX estimates were taken from the WB study [23]. HPP CAPEX is provided for reference only and based on generic WB study estimates of 1 400 €/kW. Note that the only utility-scale HPP project in Kosovo, HPP Zhur, was last assessed in a 2009 feasibility study. CAPEX of HPP Zhur was then estimated at 1 100 €/kW. As the 2018 WBIF Regional Strategy for Sustainable Hydropower in the Western Balkans found, several small hydro power projects in the Zhur catchment area, but across the Albanian border, have been developed since 2009. Those HPPs are diverting some of the water flows.

4.3 LCOE of projects

Levelized Cost of Electricity (LCOE) is a useful and frequently used metric of the economic performance of electricity generation units. It is calculated as a ratio of (i) total net cash flows of the project, discounted to present value, and (ii) total electricity generated over the economic life of the plant, discounted to present value.

Cash flows are pre-tax and include only CAPEX and OPEX. Electricity generation is estimated constant over the years for wind, hydro, and biomass projects. For solar PV projects decrease of the output with years has been assumed as 3% after the first year and then an additional 0.5% decrease in each subsequent year.

Operational expenditures (OPEX) of identified RE projects were not available. For economic and financial assessment, those were taken from the World Bank study [23]. Details are provided in **Table 4.2** below.

Technology	Fixed cost, €/kW/year	Variable cost, €/MWh
Solar PV	10.8	0
Wind	38.6	0
HPP	10	5

Table 4.2: Operational expenses values per technology

The following assumptions regarding the economic lifetime of projects were used:

- Wind 30 years
- Solar PV 30 years
- HPP, PSHP 40 years

Those figures are taken from the World Bank study [23].

The discount factor depends on several parameters, including the structure of financing, costs of debt and equity, and tax rate. The Consultant combined its expert estimates and the available data to calculate the expected discount rate.

LCOE of identified RE projects using the discount rate of 8% (to be comparable with the World Bank study [23]) are provided in **Figure 4.4.**

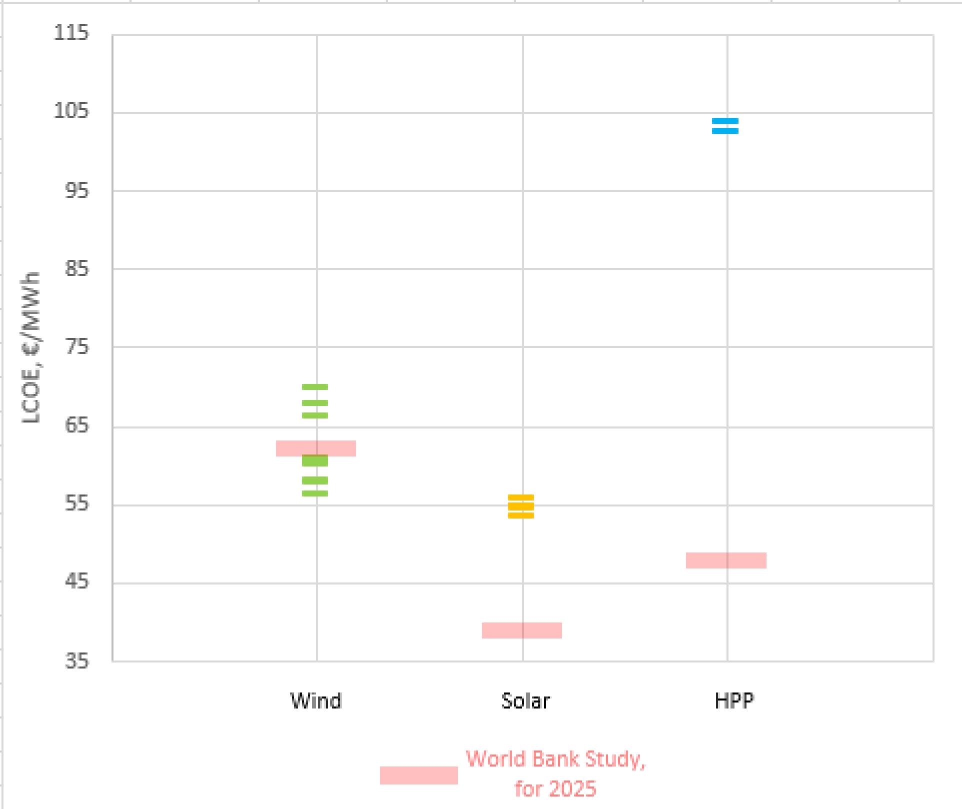

Figure 4.4**:** LCOE range of identified RES projects (larger than 10 MW) per technology, at an 8% discount rate.

Based on available information the Consultant estimated the real WACC of RE projects in Kosovo at 4.7%. It is based on the following inputs: project financing with 30%/70% equity/debt, 12% cost of equity, 4.5% cost of debt[34] and 1.7% inflation[35]. **Figure 4.5** provides the sensitivity of LCOE considering various discount rates.

It should be noted that the LCOE of HPP projects is based on estimates for the HPP Zhur project. Its LCOE is significantly higher than estimated for HPP projects in the World Bank study [23]. This is due to HPP Zhur's relatively low-capacity factor of 14.9%, compared to the overall HPP CF estimate from the World Bank study [23] of 35%.

[34] Estimated cost of debt at IFI's; EURIBOR+5%. Current EURIBOR at cca -0.5%.

[35] Based on IMF data [40].

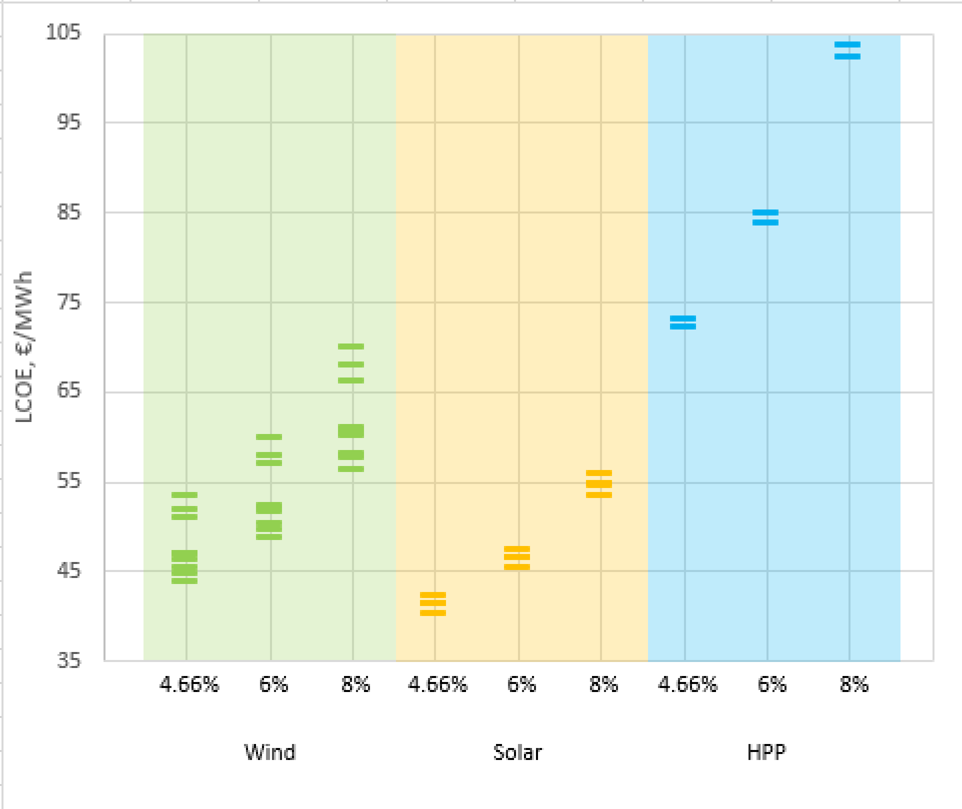

Figure 4.5**:** LCOE sensitivity of identified RES projects (larger than 10 MW) depending on the discount rate.

As both wind and hydro projects have higher specific investment costs (see Section **4.2**), their respective LCOEs are more sensitive to variations in the discount rate.

Figure 4.6 below compares the calculated range of LCOE of Kosovo RE projects with forecasted market prices in the region.

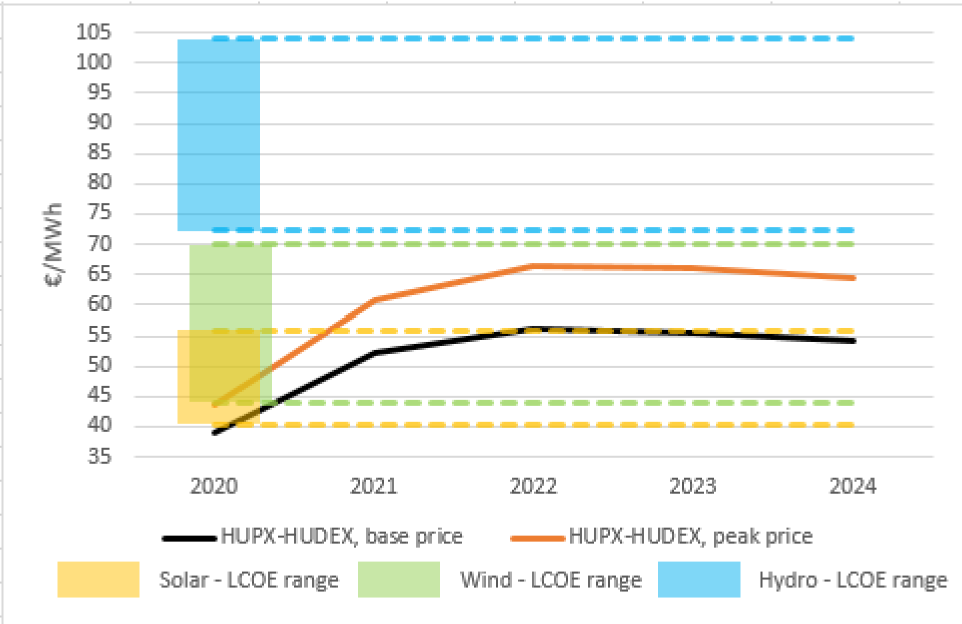

Figure 4.6**:** LCOE range of different RES technologies in comparison to HUPX/HUDEX forecasted electricity prices [13] [26]

Considering LCOE, solar PV projects seem to be market competitive, wind projects are also competitive (except in cases of high specific CAPEX and project WACC close to 8%), while hydro projects (HPP Zhur) do not seem to be competitive purely on energy generation LCOE basis.

Note that the above does not consider the cost of energy storage that would ensure the dispatchability of these RE sources.

4.4 Financial modeling of projects

Besides the LCOE assessment, the Consultant has performed a financial assessment of selected typical renewable energy projects. The model envisaged 30% equity and 70% debt financing, 12% cost of equity, 10% income tax, and 1.7% overall inflation.

The modeling focused on determining the minimum electricity price sufficient to ensure financial sustainability (liquidity[36]) during the loan repayment period (10 years). Results are provided for debt costs of 4.5% and 7.5%.

Minimum electricity price of a typical wind project[37] to ensure its financial sustainability is provided in **Figure 4.7.**

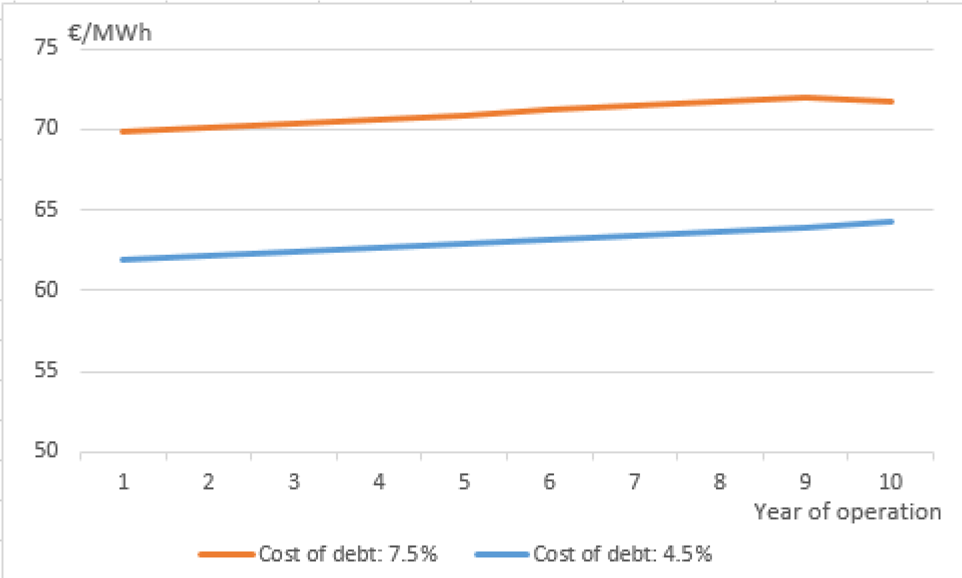

Figure 4.7**:** Minimum estimated electricity price for a selected typical wind project in Kosovo to ensure its liquidity.

Although LCOE of the assessed wind projects in Kosovo is 47-60.8 €/MWh, the electricity price required to ensure the liquidity of the project in the first 10 years of operation[38] is in the range of 62-64.2 €/MWh for the cost of debt of 4.5% and 70-72 €/MWh for the cost of debt of 7.5% for the typical wind project in Kosovo.

Note that the prices in **Figure 4.7** are nominal, i.e. including the inflation. Thus, the minimum required electricity price is increasing to accommodate the increasing nominal OPEX.

Minimum electricity price of solar projects to ensure financial sustainability is provided in **Figure 4.8**. The minimum price to ensure liquidity is increasing due to both increasing of the nominal OPEX and the degradation of solar panels.

[36] Modelled as the minimum level of annual income (i.e. electricity prices) with which the net annual cash flow is at least zero.

[37] Based on the model for WP Zatric I, II.

[38] First 10 years of operation is the assumed debt repayment period.

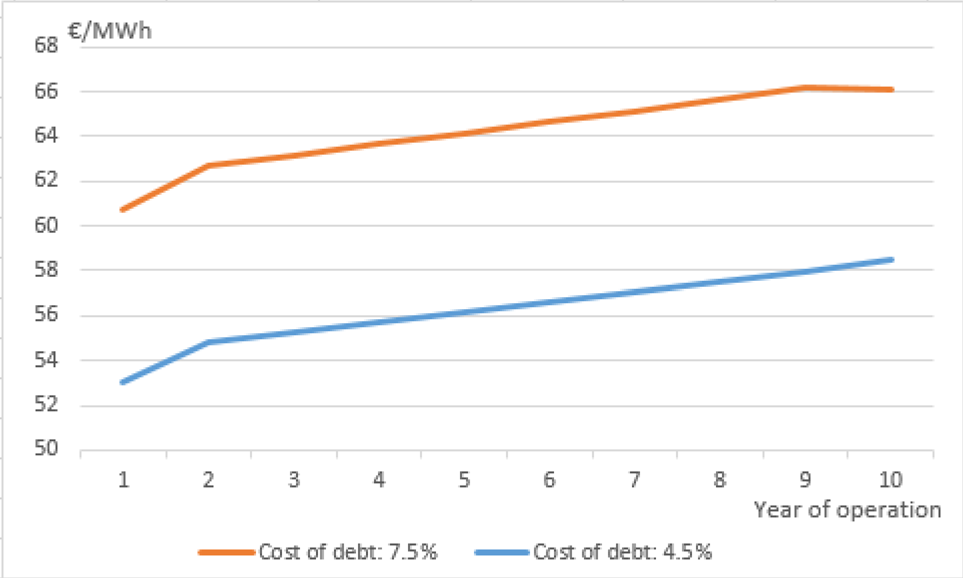

Figure 4.8**:** Minimum estimated electricity price of solar projects in Kosovo to ensure liquidity.

Although LCOE of the assessed Kosovo solar PV projects is 40.5-56 €/MWh, the electricity price required to ensure the liquidity of a typical Kosovo solar PV project is in the range of 53-58.5 €/MWh for the cost of debt of 4.5% and 60.7-66.1 €/MWh for the cost of debt of 7.5%.

HPP Zhur has comparably high specific investment costs. That is reflected in the higher required minimum electricity price to achieve the financial sustainability of the project as provided in **Figure 4.9**.

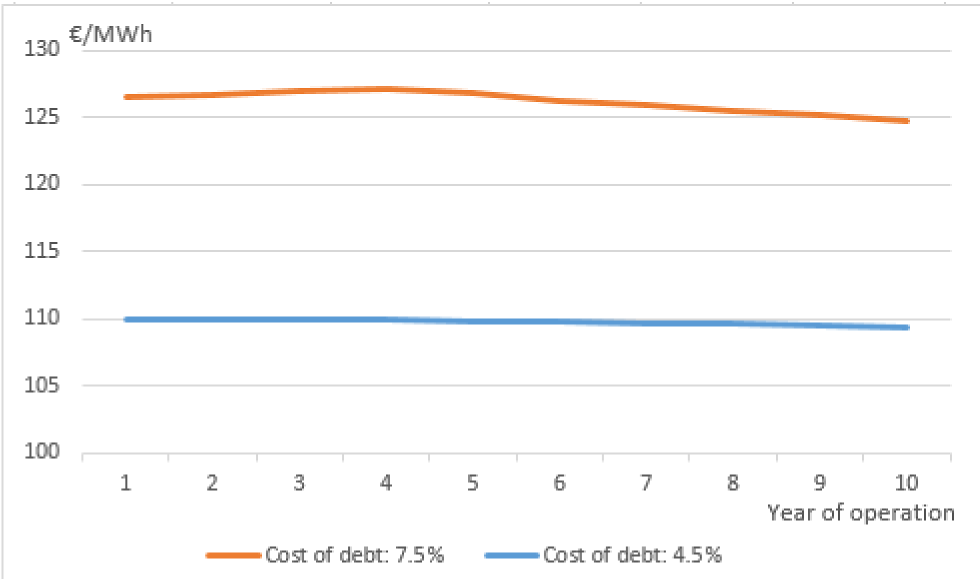

Figure 4.9**:** Minimum estimated electricity price of HPP Zhur to ensure liquidity.

From the financial perspective, notably higher electricity prices (compared to those required to meet LCOE) are required to ensure the liquidity and bankability of identified RE projects. This is notwithstanding that in reviewing the projects the banks will consider P90 generation estimates (estimates of annual generation with 90% probability), and not the inherently higher P50 estimates (annual generation estimates with 50% probability) used throughout this study. Available information indicates that the P90 generation estimate for Kosovo A ash dump solar PV project is cca 12% lower than the P50 estimate for the same project. In essence, when assessing the project bankability, one also needs to consider the project with cca 12% lower revenues than indicated above. The difference between the LCOE required for the project's overall financial sustainability and the electricity prices required to ensure liquidity and bankability highlights the important role of the financing terms including the financing structure, debt repayment period, and the cost of debt. These issues also need to be taken into account when designing the future RE support scheme.

4.5 Maturity

A simplified diagram of the development path for RE projects in Kosovo is provided in **Figure 4.10** below. A more detailed RE project development diagram is provided in **Annex 1** to this report.

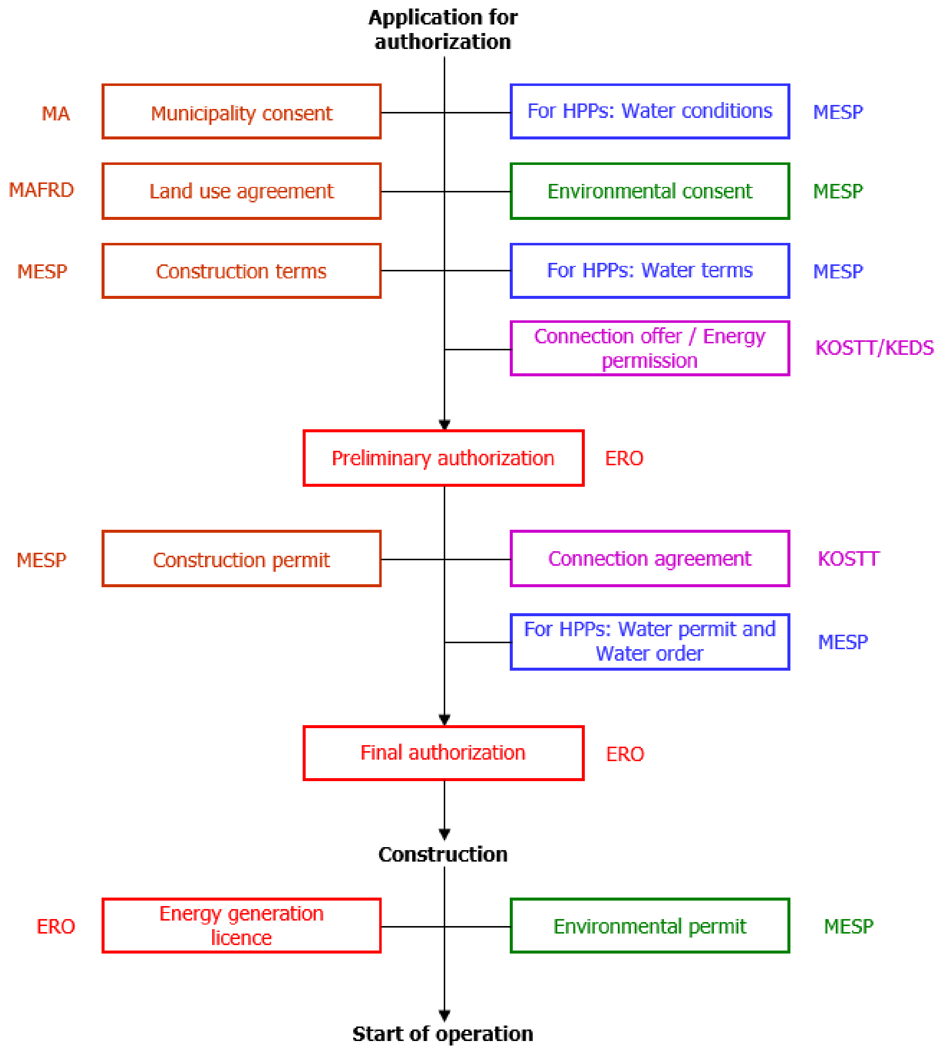

Figure 4.10**:** Simplified development diagram for RE projects in Kosovo

Before the Final authorizations, eligible projects could enter into Power Purchase Agreement (PPA) with KOSTT. Nevertheless, after the described developments in December 2020, new regulation regarding the support scheme is being expected and no new PPA-s are being signed. Therefore, PPA has not been mentioned in **Figure 4.10.**

Key maturity milestones are:

1. Connection Offer and Connection Agreement are issued by KOSTT based on the application submitted by the RE developer. RE developer applies for the Connection Offer, whereas such application should contain the standard planning data and the preliminary project planning data of the developer. The KOSTT reserves the right to specify the voltage level to which a user will be connected or may specify more than one option for connection to the transmission system and with different terms and

conditions. The Transmission Connection Charging Methodology[39] [27] foresees the possibility to undertake a feasibility study for the connection method, as an optional exercise. Based on the (max. 90 days) assessment, KOSTT issues the Connection Offer to the developer, whereas the developer applicant shall inform KOSTT no longer than thirty (30) days from the date receiving the Connection Offer whether it agrees or disagrees to enter into the proposed Connection Agreement. The Connection Agreement shall be signed within thirty (30) days from the date the applicant informs KOSTT of the acceptance of the Connection Offer. The costing of the connection of the new generation capacities is done as "deep connection", meaning the applicant will bear the cost of assets required to connect to the nearest suitable point of connection on the existing transmission system plus any indirect cost arising from works associated with the reinforcement, extension, or reconfiguration of the existing network. The connection applications (Connection Offer and the Connection Agreement) are treated on a first-come-first-served basis. The Connection Agreement shall contain necessary provisions related to the design study, connection responsible party, connection capacity, connection date, connection fee, etc.

2. Environmental consent is issued by the ministry responsible for the environment based on Environmental Impact Assessment Law. Environmental consent is a mandatory prerequisite for issuing a construction permit. The holder of the environmental consent needs to obtain the construction permit or start with construction within 2 years of the environmental consent issuing. The EIA based on which is issued the Environmental consent should be prepared by a licensed company in Kosovo. Environmental permit, verifying that the construction has been performed following the environmental consent, is issued by Ministry responsible for the environment after the construction phase is finished and it is valid for five years.

3. Preliminary authorization is issued by the ERO as a response to the application for authorization based on the Rule on Authorization[40] [28]. The ERO issues the preliminary decision within sixty (60) days from the application date. The preliminary authorization decision is issued once the applicant submits necessary documents, such as general documents that confirm the registration of the company and technical and organizational documents. The preliminary authorization shall specify the necessary documents the applicant shall submit for obtaining the final authorization. The preliminary authorization has a validity of twelve (12) months, with the possibility of extension of this period for additional 6 months. If the applicant cannot submit the necessary documents for converting the preliminary authorization to final authorization, then the preliminary authorization is suspended.

4. For high-risk projects qualified in category III including generation capacity higher than 10 MW, Construction Permit is issued by the Ministry responsible for construction. The Construction Permit is based on the construction terms, which are specific for each project, and defines the criteria for construction. The construction terms define criteria of construction that the developer should fulfill to be eligible to obtain the Construction Permit. The Construction Permit becomes void if the holder of the Construction Permit does not begin construction within one (1) year from the date of issuance of the Construction Permit.

5. A construction permit is required before the final authorization is issued and is issued based on the construction terms issued in advance for that specific project. The construction permit for projects in category III with installed capacity above 10 MW, is issued by the Ministry responsible for the construction, whilst for projects below 10 MW, the permits are issued by the Municipalities. Land usage rights need to be obtained by the developer for the construction permit to be issued. The construction project and permit application should be prepared by a project designer licensed in Kosovo.

6. All energy infrastructure projects need to obtain a Final authorization from ERO before commencing construction. The necessary documents needed for the final authorization are: (i) the connection agreement, (ii) water permit if hydro, (iii) construction permit, and (iv) the dynamic plan on the execution works. The Decision on the final authorization will set the date for the construction of the new generation capacities based on the applicant's dynamic plan. If the applicant cannot complete

[39] https://www.kostt.com/Content/ViewFiles/TransmissionAndConnection/Transmission_Connection_Charging_Methodology_ver_2.9_2018_shhtator.pdf

[40] Rule on Authorization Procedure for Construction of New Generation Capacities from Renewable Energy Sources (Rule ZRRE/Nr. 11/2017 of 27 April 2017)

the project within the deadlines envisaged the authorization is repealed. It should be noted that, according to the ERO Rule on Authorization, the submission of the applications separately is not obligatory. The division of the procedure into two phases (Preliminary and Final authorization) is envisaged originally to ease the application process so the developers can more easily negotiate for financing and prepare necessary documents. Nevertheless, if the applicant has completed necessary studies at an early stage and has obtained all the necessary documentation required by the Rule on Authorization, the Final Authorization can be issued without the need to apply for the preliminary authorization initially.

Table 4.3 below specifies the maturity status of each of identified utility-scale RE projects.

Project name/location	Type	Capacity MW	Environmental and Social	Preliminary authorization	Final authorization	Connection agreement	FiT, €/MWh	Under construction
Bajgora/Selac I, II, III	Wind	103.4	Environmental consent obtained in 2018		Yes	Yes	85	Yes
Zatriqi/Zatric I, II	Wind	64.8	No info on EIA	Yes				
Koznica	Wind	34.5	No info on EIA	Yes		Yes		
Çiçavica	Wind	116.6	No info on EIA			Yes		
Kamenica I, II	Wind	69.6	No info on EIA	Yes		Yes		
Mareci	Wind	31.2	No info on EIA	Yes				
Budakova I	Wind	11	Environmental consent obtained in 2017		Yes	Yes	85	Yes
Budakova II	Wind	35	No info on EIA	Yes		Yes		
Kitka (addition)	Wind	33	No info on EIA			Yes		
Kosova A ash dump	Solar	100	Preliminary environmental evaluation					
Kamenica III	Solar	30	No info on EIA			Yes		
SEGE	Solar	136	No info on EIA			Yes		
Terstenik	Solar	96	No info on EIA			Yes		
Sferke	Solar	96	No info on EIA			Yes		
Katkos Junik	Solar	105	No info on EIA					
Total MW		**1 062.1**		**235.1**	**114.4**	**761.1**	**114.4**	**114.4**

Table 4.3: List of projects larger than 10 MW with their maturity and FiT status

Information on issued Construction permits is not publicly available. However, a Construction permit is a prerequisite for ERO's final authorization, thus the projects with the Final authorization are considered to also have the construction permit. Note that the information on the environmental maturity of projects is provided in Section **4.5.**

Two utility-scale wind projects are in construction with a total capacity of 114.4 MW. Those projects have secured the feed-in tariff. The remaining projects that do have preliminary authorization are on the "waiting list" and can become eligible for FiT only if some of the preceding projects are canceled. Otherwise, all these projects can either wait for the introduction of a new support scheme or enter commercial electricity offtake arrangements.

Connection agreements have been signed with additional 5 wind projects with a total capacity of 288.7 MW and four solar PV projects with a total capacity of 358 MW.

The remaining 301 MW of wind and solar PV projects are in the earlier stages of development.

Although not the focus of this assignment the Consultant reviewed RE projects below 10 MW to create more comprehensive information on the total RE capacity in development. **Table 4.4** below specifies the maturity status of each of identified projects below 10 MW.

Project name/location	Type	Capacity MW	Environmental & Social	Preliminary authorization	Final authorization	Energy permission	FiT	In construction
Alsi (Madanaj, Kusar, Gjakova)	Solar	3	Environmental consent obtained	Yes		Yes		

Project name/location	Type	Capacity MW	Environmental & Social	Preliminary authorization	Final authorization	Energy permission	FiT	In construction
Building Construction (Madanaj, Kusar, Gjakova)	Solar	3	Environmental consent obtained	Yes		Yes		
Merkuri, Venus (Madanaj, Kusar, Gjakova)	Solar	6	Environmental consent obtained	Yes		Yes		
VBS (Madanaj-Rypaj)	Solar	3	Environmental consent obtained	Yes				
Vita Energy (Madanaj-Rypaj)	Solar	3	Environmental consent obtained	Yes				
Abrazen (Madanaj-Rypaj)	Solar	3	Environmental consent obtained	Yes				
EDG (Madanaj)	Solar	3	Environmental consent obtained	Yes				
Solar Gate (Madanaj)	Solar	3	Environmental consent obtained	Yes				
Kodrina, Ylli, Rreze Dielli (Buroj, Skenderaj)	Solar	9		Yes				
Ksol (Sverrk, Pejë)	Solar	3	Environmental consent obtained in 2019	Yes				
Sun Power 1,2,3	Solar	9	Environmental consent obtained in 2019	Yes				
Duka Sonne 1,2	Solar	6	Environmental consent obtained in 2019	Yes				
Perlat (Sverrk, Pejë)	Solar	3		Yes				
Eling (Llabjan, Pejë)	Solar	3	Environmental consent obtained in 2019	Yes				
D-Energy (Pejë)	Solar	9	Environmental consent obtained in 2019	Yes				
BP Solar (Pejë)	Solar	9	Environmental consent obtained in 2019	Yes				
Alpha Solar (Pejë)	Solar	9	Environmental consent obtained in 2019	Yes				
Sun Energy 1,2,3,4,5	Solar	15	Environmental consent obtained in 2019	Yes				
Bejta Comerc	Solar	9						
Energy Bio Ranch	Solar	9						
Led Light Technology (Gjurgjevik/Malishevë)	Solar	0.27		Yes				

Project name/location	Type	Capacity MW	Environmental & Social	Preliminary authorization	Final authorization	Energy permission	FiT	In construction
Rr. George Bush - Fsh. Gracke e Vjeter, Lipjan	Solar	3				Yes		
Ferzaj/Ferizaj	Biomass	5.2						
Kotlina, Hani i Elezit	HPP	4.9			Yes		67.47 €/MWh	Yes
Soponica	HPP	1.3			Yes		67.47 €/MWh	Yes
Soponica 2	HPP	3			Yes^{expired}		67.47 €/MWh	
Ecodri	HPP	9.56				Yes	67.47 €/MWh	
Sharr Pllanina 1	HPP	1.65				Yes	67.47 €/MWh	
Sharr Pllanina 2	HPP	2.2				Yes	67.47 €/MWh	
Sharri	HPP	6.45	Environmental consent obtained in 2014		Yes		67.47 €/MWh	Yes
Shtërpca	HPP	5.03	Environmental consent obtained in 2014		Yes		67.47 €/MWh	Yes
Dobrusha	HPP	9.9						
Peja cascade / Rugova	HPP	40.5						
Peja cascade / Kuqishtë I + II	HPP	4.5						
Peja cascade / Drelaj	HPP	4.6						
Peja cascade / Drelaj II	HPP	4.4						
Peja cascade / Shtupeq	HPP	6.5						
Mal-Erenik	HPP	7.5						
Lepenci	HPP	9.98		Yes		Yes	67.47 €/MWh	
Lepenci 2	HPP	3.3		Yes^{expired}				
Prizren	HPP	10.1		Yes				
Fsh. Radesh K.K. Dragash	HPP	2.99		Yes				
Fsh. Brec & Murgull K.K. Podujevë	HPP	1.59		Yes				
Fsh. Shtrazë K.K. Kaçanik	HPP	0.89		Yes				
Fsh. Segaqë K.K. Podujev	HPP	2.6		Yes				
Fsh. Poslisht	HPP	2.5				Yes		
Total MW		**274.4**		**133.7**	**20.7**	**40.9**	**44.1**	**17.7**

Table 4.4: List of projects smaller than 10 MW with their maturity and FiT status

The projects listed above were obtained from KEDS, which is responsible for connecting smaller projects on the distribution network.

The total capacity of RE projects below 10 MW that are in construction is 17.7 MW. Additional 3 MW of small RE projects have obtained final ERO authorization. The remaining 212.8 MW of small projects are in the earlier stages of development. Projects with preliminary ERO authorizations that did not ensure FiT quota are on the waiting list and may become eligible for FIT in case that some of the preceding projects are canceled. Alternatively, the developers of these projects can wait to see the terms and eligibility conditions of the support scheme being developed or can opt for commercial electricity offtake arrangements.

4.6 Environmental and social

As provided in **Figure 4.10**, the project development procedure envisages the undertaking of the Environmental impact assessment (EIA). Successful completion and appraisal of the EIA results in the project developer obtaining the Environmental Consent. Based on Appendix two of EIA law, wind, and hydro projects above 100 kW of installed capacity need EIA. Solar PV projects are not explicitly listed as needing EIA, thus the developers of solar PV projects above 100 kW need to obtain guidance from the relevant Ministry on the need to conduct EIA.[41].

The Law on Environmental Impact Assessment[42] [29] envisages the applicant/project developer to obtain the Construction Permit or approval for finalizing the project within two (2) years from the issuance of the Environmental Consent, or the preparatory works need to be started. If the applicant does not fulfill one of the above milestones, then the Environmental Consent is suspended, and the applicant should start the application for Environmental Consent from the beginning. Before starting the operation, the applicant needs to obtain the Environmental Permit, according to the Law on Environmental Protection[43] [30].
The Consultant has reviewed the Environmental consents for RE projects obtained from the ministry responsible for the environment.

4.6.1 Solar Projects

The Consultant only obtained the Environmental consents for 19 small (3MW each) solar PV projects. These documents were reviewed, and no significant issues were identified. Detailed information on the EIA status of utility-scale projects was not available.

Most of the solar projects for which the Consultant obtained environmental consents are in the area of Peja Municipality and its surroundings. Information on the precise location of these projects is not available to the Consultant, however, the area where these projects are located does not have the status of a protected area.

Solar PV projects can have environmental impacts in the area where they are located. These impacts may be related to a project interfering with the habitats of endangered plant or animal species. These projects can have an impact on land use and natural ecosystems, depending on specific factors such as topography, area, and type of landscape covered by the development, the distance from areas of natural heritage, or sensitive ecosystems. Environmental consent was not available for any of the identified utility-scale projects. The

Reviewed Environmental Consents typically highlight the following:

- the applicants should take care about air protection measures based on applicable legislation,

[41] The law on environmental impact assessment, in its Annex I stipulates the projects to which the preparation of the EIA study is obligatory. Under Annex I the obligation to prepare the EIA study is envisaged for thermal power stations and other combustion installations with a heat output of fifty (50) MW or more. Therefore, it is visible that projects with a capacity of more than 50 MW should prepare the EIA study. In addition to the above, the law on environmental impact assessment under Annex II of the law foresees the right to examine each project from the Ministry responsible for the environment in a case by case, based on the criteria set by the law, and determine whether such project should prepare or not the EIA study. Annex II foresees a list of projects which shall be examined for the need to prepare or not the EIA study. Despite the above requirements, the Ministry responsible for the environment adopted the Administrative Instruction (MESP No. 01/2017) for the Release of Municipal Environmental Permit, that makes responsible Municipalities issue environmental permits for wind and photovoltaic projects with capacity up to 100 kW, whilst for all other projects above such capacity, it stipulates that such projects are subject to the law on environmental impact assessment. Based on the consultant view, all wind and solar PV projects with a capacity higher than 100 kW should be initially reviewed by the Ministry responsible for the environment which shall stipulate for each specific project if the EIA study is necessary to be developed or not.

[42] Law on Environmental Impact Assessment, No. 03/L-214, Article 25

[43] Law on Environmental Protection, No. 03/L-025, Article 31

- all activities should comply with the bird conservation directive,
- waste management, storage, collection, transport must be done following the provisions of the law on waste,
- environmental accident intervention plans should be prepared for preparedness in case of possible environmental accident or any event that particularly endangers the environment or human health,
- to rehabilitate degraded surfaces those, need to be planted with grasses adapting to the surrounding environment,
- after the final cessation of operation of the solar energy park measures for decommissioning and rehabilitation of its location need to be planned.

4.6.2 Wind Projects

The Consultant reviewed the Environmental consents for two projects currently under construction: Bajgora (Selac I, II, and III) and Budakova (Budakova I and II). Details about the EIA status of other utility-scale projects were not available.

SOWI's Bajgora project (Selac I, II, and III) is in the northern part of Kosovo, Selace, Municipality of Mitrovica. There are no protected areas in this region. This company received Environmental consents during 2018 and in total has 27 turbines with 103.41 MW.

The second project Bondcom's Budakova is located in Budakova Municipality of Suhareka. This project is located close to the National Park "Sharri" but it is not within the protected area.

According to the reviewed Environmental Consents, all these projects have the following obligations:

- to continuously monitor the equipment and ensure the fulfillment of technical requirements,
- establish an environmental management system and have an engineer responsible for the environment,
- notify the Ministry if during the operation there will be any technical malfunction that could have an impact on the environment and the health of the population,
- implement the dynamic rehabilitation plan as provided in the environmental consent,
- after the end of the operation, the operator is obliged to return the location to its original state.

Table 4.5 below provides a list of wind projects for which environmental consents were available and reviewed.

Company	Project Name	Location	Installed capacity	Environmental consent/permit	Date of issue
Bondcom Energy	Budakova I	Budakove	11 MW	Environmental consent	11.12.2017
Sowi Kosova	Selac I	Selac	34.47 MW	Environmental consent	25.01.2018
	Selac II	Selac	34.47 MW	Environmental consent	25.01.2018
	Selac III	Selac	34.47 MW	Environmental consent	25.01.2018

Table 4.5: List of planned wind projects with available environmental consent/permit

All projects listed in the table above are under construction.

According to the Consultant's information, the projects that are not listed above have not completed the Environmental consent process.

4.6.3 Hydropower Projects

The Consultant reviewed Environmental consents for two small HPP projects from Matkos Group. These are located in a national park. Both projects have obtained water permits valid for 20 years.

Matkos Group has applied for five HPP projects on Lepenc River during 2013. Matkos obtained environmental consents for 4 of their projects in 2013 and 2014. One of the projects foreseen in the Brod area did not obtain environmental consent because other HPP projects were planned in the same area. These projects are located within National Park "Sharri".

The environmental consents were granted under the following conditions:

- the facility should not take the required biological minimum.
- to calculate the flood wave in case of dam breach for the river Lepenc to avoid risks and possible consequences such as degradation, erosion, and flood,
- to design the dam to have an outlet to release the accumulated sediments.

Table 4.6 below provides a list of hydro projects for which environmental consents were available and reviewed.

Company	Project Name	Location	Installed capacity	Environmental consent/permit	Date of issue
Matkos Group	Sharri	Sharr	6.45 MW	Environmental consent	08.09.2014
	Shtërpca	Shterrpc	5.03 MW	Environmental consent	08.09.2014

Table 4.6: List of planned hydro projects with available environmental consent/permit

The opposition to hydro projects in Kosovo is increasing in the past period. Local communities, environmentalists, and ombudsperson are requiring more transparency and accountability, related to projects developed in Decani and Shterpce locations (HPPs Lumbardhi II, Decani, Belaja, Sharri, Shterpca). A consortium of 60 civil society organizations in Kosovo sent public letters, expressing their concern over support for the company KelKos Energy and opposing hydro project development in general.

On October 14, 2020, the ERO board decided to suspend the temporary license issued on October 14. 2019 to the company Kelkos Energy for the projects "Lumbardhi II", "Decani" and "Belaja". Then, on November 12, 2020, the ERO issued the generation license for two projects, "Decani[44]" (9.8 MW) and "Belaja[45]" (8.06 MW) for 40 years. The generation licenses are issued after receiving the Environmental permit from the applicant. Based on the publicly available information the Consultant understands that the procedure of issuance of such permits is being investigated by prosecutor authorities.

After discussion on all the pros and cons of hydro projects, in August 2020 the Parliament of Kosovo established the *Inquiry Commission on the process of licensing, operation, supervision, and implementation of hydropower plant permits in the Republic of Kosovo*. The duty of the Commission, comprised of ten parliamentarians from position and opposition political parties, was to investigate the procedure of issuance of environmental consent and permits, and water permits issued for hydropower plants. Due to the dismissal of the Parliament in January 2021, the Inquiry Commission has not finished its work nor published its findings.

For an illustration of the sentiment, the Consultant notes that in April 2021 the Minister of Environment of Kosovo visited the Shterpce Municipality and visited the construction site of the three power plants. After facing the protesting citizens, the Minister noted that the committee will be formed to review the permits issued to hydro-power projects and to assess the legality and justification of the developments.

4.7 Notes on the development outlook of identified projects

Following the assessment laid out above, the Consultant notes the following:

- There are no utility-scale biomass projects in Kosovo.
- Hydro resources are scarce and seem uncompetitive for energy generation. Also, environmental, and social issues related to hydro developments are detrimental to the further development of hydro projects. Hydro capacity could potentially contribute to energy storage capacity and renewables balancing services.

---

[44] https://www.ero-ks.org/zrre/sites/default/files/Publikimet/Vendimet/V_1303_2020.pdf

[45] https://www.ero-ks.org/zrre/sites/default/files/Publikimet/Vendimet/V_1304_2020.pdf

- Solar PV and wind projects represent the majority of RE development potential in Kosovo. Currently, there is 114.4 MW of wind capacity under construction and 947.7 MW of wind and solar PV capacity in various stages of development. The total generation of those facilities, if developed is estimated at over 2 000 GWh per year, a 1/3 of the current electricity demand in Kosovo. Although capital costs are declining, investors in Kosovo don't seem to be ready to expose themselves fully to the market risk but are awaiting developments with regards to the new support scheme. Looking at the technical potential estimated by the World Bank study [23], it should not be an issue to identify additional sites for solar PV and possibly also wind power projects. It appears that no significant environmental issues have arisen related to the development of these projects.

Looking at LCOE only, it may appear that wind and particularly solar PV projects have already reached market parity. However, the issues still facing the developers are the liquidity during the debt repayment period and the unpredictability of renewables output. To be marketable as baseload or peak load, the generation from renewables needs to be supplemented with either energy storage or another dispatchable generation source (such as gas-fired power generation).

5. Energy storage

5.1 Energy storage technologies and projects in Kosovo

Electricity systems with high penetration of renewables such as wind and solar PV generally have a significant need for energy storage to store the energy at times of high output of renewables and return it in the system at times of low output of renewables. The need for storage in the Kosovo energy system is augmented with the fact that its baseload capacity, Kosova TPP, has a limited load-following capability, and thus the system is faced with a lack of electricity during peak periods and with excess electricity during off-peak periods.

Technologies considered in Kosovo for storing electric energy usually are among the following:

- Potential energy (as in pumped storage hydro plants, compressed air)
- Chemical energy (as in batteries, or conversion to hydrogen)
- Thermal energy (as in hot water storages or high-temperature steel storages)

5.1.1 Pumped Storage Hydro Plant

Pumped storage hydro plant (PSHP) project under development in Kosovo, PSHP Drini/Vermica, has envisaged installed capacity of 250 MW and upper reservoir energy storage capacity of 2 GWh, i.e. the PSHP would be able to supply 250 MW for 8 hours. The expected annual generation is 640 GWh of electricity (at the same time, the expected consumption of electricity will be cca 800 GWh, considering the estimated 80% overall round-trip efficiency[46]).

Considering the estimated CAPEX of 460 mln €, the unit cost of storage capacity is calculated to be 230 €/kWh.

To estimate the LCOE of the project, the Consultant has made the following assumptions:

- round trip efficiency is assumed at the level of 80%,
- fixed OPEX is estimated at 10 €/kW/year[47]
- variable OPEX is estimated at 7.5 €/MWh[48]

Project name / location	Capacity, MW	Expected annual generation, GWh	Capacity factor	Storage capacity, GWh	Investment, mil €	LCOE with 4,7% discount rate, €/MWh	LCOE with 6% discount rate, €/MWh	LCOE with 8% discount rate, €/MWh
PSHP Drini/ Vermica	250	640	29.2%	2	460	51.34	59.18	71.68

Table 5.1: PSHP Drini/Vermica with general information

Note that the LCOE provided above does not include the cost of electricity used for pumping. Historically, in power systems with the inflexible thermal generation, pumping took place during nighttime and other off-peak hours, while energy was generated during peak hours. With the increasing penetration of renewables such as solar PV and wind power, this may change. Considering the comparably low-capacity factors of solar PV and wind power plants compared to fossil plants, a larger installed capacity is required to generate the same energy. Also, solar PV generates electricity during peak hours. In power systems with very high penetration of solar PV, PSHP plant would pump the water during the daytime and generate electricity during nighttime. When considering the economics of PSHP, round trip efficiency, estimated at 80%, needs to be considered.

[46] Round trip efficiency means the overall efficiency of the storage cycle, i.e. the efficiency of conversion of electricity to stored energy and efficiency of conversion of stored energy back to the electricity.

[47] In accordance with the World Bank study [23].

[48] 50% higher then in WB study [23], taking into account the OPEX of pumping.

Although not suitable for storing excess electricity from renewables generation, any reservoir hydro also serves as energy storage, as it can be dispatched if there is water in its reservoir. Thus, HPP Zhur with an envisaged reservoir capacity of almost 200 GWh can be viewed with that perspective.

5.1.2 Battery storage projects

There are no known utility-scale battery storage projects in Kosovo. Due to recent developments in battery storage technology and associated cost decreases, the application of batteries for energy storage has gained traction in utility power systems. Batteries are being used for short-term (minute to several hours) energy system balancing. However, the cost of batteries still prevents them to be used for seasonal or even weekly energy storage. According to publicly available data, the world's largest battery system is Moss Landing Energy Storage Facility in California. It is a lithium-ion battery storage system with a capacity of 300 MW/1 200 MWh (it could provide 300 MW for four hours). Currently, the facility is being expanded for an additional 100 MW/400 MWh.

According to the 2020 US National Renewable Energy Laboratory (NREL) [31], the capital cost for 4-hour battery systems in 2020 is at the level of 330 €/kWh. NREL projects that by 2030 this capital cost will decrease to somewhere between 120 and 245 €/kWh.

Round trip efficiency of battery storage based on Li-ion technology is 80% to 90% or even more. Annual capacity degradation is cca 1.5-2.5%.

A 2020 Lazard report[49] [32] concludes that Li-ion battery storage is the dominant technology for short-duration applications (1-4 hours).

5.1.3 Hot temperature steel energy storage

High-temperature steel storage is considered by KEK and KfW in conjunction with Kosova A ash dump solar PV project. The project is in the inception phase (Inception report expected in April 2021). According to publicly available data,[50] the technology has been demonstrated with a 2.4 MWh pilot project. The energy that is stored as thermal energy in steel can be later converted back to 25% electricity in turbines and 70% heat for the needs of the district heating system (5% are declared energy losses). Once completed, an ongoing feasibility study is to provide more details. The Consultant understands this project could store energy on an hourly or daily basis and up to 25% of stored energy could be converted back to electricity in Kosovo A/B steam turbines, thus reducing the coal consumption.

The reported storage cost is 20 €/MWh. Nevertheless, it is not clear how this figure is obtained nor how was the reduction in the value of returned energy (heat has a lower value than electricity) accounted for.

5.1.4 Other thermal energy storage

The Consultant understands that Termokos, Prishtina based district heating operator, has commissioned a study on seasonal district heating energy storage. Details were not available during this assignment.

5.2 Legal basis for energy storage in Kosovo

The Consultant reviewed Kosovo's energy sector laws, including the environmental relevant laws such as the law on environmental impact assessment and the law on construction, to understand if the national legislation foresees the possibility to develop energy storage projects.

---

[49] https://www.lazard.com/media/451566/lazards-levelized-cost-of-storage-version-60-vf2.pdf

[50] https://www.energy-storage.news/news/vattenfall-pilots-high-temperature-steel-with-up-to-48hrs-energy-storage-du
https://lumenion.com/

The 4th Energy Package ("Clean energy for all Europeans"), which includes policies and legislative provisions, aims at contributing to combat climate change and creating a framework that leads to concrete benefits for citizens, job creation, growth, and investments in clean energy, including the energy storage. It includes, among others, Directive (EU) 2019/944 on common rules for the internal electricity market, Regulation (EU) 2019/943 on the internal electricity market. At the EU level, the Regulations are directly applicable to the EU Member States starting from 1 January 2020, while the Directive 2019/944 has to be transposed into national law by December 2020 by the Member States. By energy storage, according to the definition under the EU Directive 2019/944 means, "*in the electricity system, deferring the final use of electricity to a moment later than when it was generated, or the conversion of electrical energy into a form of energy which can be stored, the storing of such energy, and the subsequent reconversion of such energy into electrical energy or use as another energy carrier*".

Even that the law on Energy recognizes storage as energy activity[51], it is unclear whether large-scale energy storage projects can be developed under the current legislation of Kosovo. According to the legislation in force, the authorization is issued only for the construction of "construction of new generation capacities, new systems for the transmission and distribution of gas, including interconnectors, and direct electricity lines and direct pipelines for the transmission of natural gas[52]" and energy storage is not mentioned. It should be noted that the EU Directive 2019/944 requires from the regulators, in close consultation with other relevant national authorities, including competition authorities, to take necessary measures to facilitate access to the network for new generation capacities and energy storage facilities, in particular removing barriers that could prevent access for new market entrants and of electricity from renewable sources[53]. Regulators are also required to monitor investment in generation and storage capacities concerning the security of supply. The Consultant deems that Kosovo should transpose the new Directive (EU) 2019/944 on common rules for the internal market for electricity and the Regulation (EU) 2019/943 on the internal electricity market. This should create the legal and regulatory framework for the development of large-scale energy storage projects. Note that pumped storage hydro projects (PSHP) are treated as hydro generating projects by ERO and therefore eligible for implementation with the existing legal and regulatory environment.

Kosovo as a Contracting Member of the Energy Community has committed to adopt and transpose the *acquis communautaire* adopted by the Energy Community. The Clean Energy Package is still not adopted by the Energy Community, hence it is not yet obligatory for Kosovo since it is not yet *acquis communautaire*.

5.3 Regional energy storage projects

2018 WBIF Regional Strategy for Sustainable Hydropower in the Western Balkans [33] assessed several PSHP projects in the region. Assuming adequate transmission interconnection capacity, storage capacity in neighboring countries could be used for purposes of supporting Kosovo renewables generation.

Basic information on those projects is provided in **Table 5.2** below.

Project name	Country	Installed capacity (MW)	Usable reservoir storage (MWh)	Investment cost (mil €)	The unit capital cost of energy storage capacity (€/kWh)
PSHP Vermica/Drini	KOS	250	2 000	460.0	230
Gornja Drina / RHE Buk Bijela	BIH	600	137 500	376.1	3
Gornja Neretva / RHE Bjelimići	BIH	500	12 626	232.9	18
CHE Vrilo	BIH	66	220	95.9	436
Cebren	MKD	458	305 664	553.0	2

51 Article 3.1 sub-pargraph 3.1 of the law No. 05/L-081

52 Article 43 of the law No. 05/L-084 on the Energy Regulator [17]

53 Article 58 (e) of the EU Directive 2019/944 [41]

RHE Bistrica	SRB	680	69 959	551.1	8
Djerdap 3 - Phase 1	SRB	600	7 708	418.0	54

Table 5.2: PSHP projects identified in Regional Strategy for Sustainable Hydropower in the Western Balkans with general information

The unit capital cost of storage capacity is significantly lower in almost all PSHP projects in the region than in PSHP Vermica[54]. Also, the storage capacities of several regional PSHP projects enable their usage as weekly, monthly, and even seasonal energy storage.

[54] Note that the cost assessment in the Study was performed in 2016. Overall costs may have increased since.

6. Energy system with RE generation and energy storage

In Kosovo, renewable installed capacity are wind, solar PV, and run-of-river hydro, all representing energy sources which are not dispatchable, ie. which output cannot be ramped up or down following the system demand. Most of the RE capacity in development are solar PV and wind projects. Integration of significant new wind and solar PV capacity will require increased system balancing, which may be provided by energy storage or by additional dispatchable capacity.

In terms of storages with significant round trip electric energy efficiency (batteries cca 90% and pumped hydro cca 80%), batteries are generally more suitable for short term (intraday) energy storage, while pumped hydro are generally more suitable for longer-term energy storage (daily, weekly, seasonally).

Solutions as high-temperature steel energy storage or purely hot water storage provide much lower round trip electrical efficiency (25% high-temperature steel, 0% hot water storage). Such solutions are suitable when combined with thermal consumption, i.e.for district heating. Renewable electricity generation combined with heat pumps and heat storage provides options for increased renewable energy penetration and green electrification of the heating sector.

Increased penetration of renewables will come with a significant need for energy storage, both short-term (intraday) and long-term (weekly and seasonal). As discussed above, a key short-term electric energy storage that is planned in Kosovo is PSHP Drini/Vermica.

There are no identified projects that could provide daily, weekly, monthly or seasonal electric energy storage in Kosovo.

In a system with a significant share of renewable (not dispatchable) generation, the following factors need to be taken into account:

- non-dispatchable renewables require a backup energy source to meet the system demand when renewables are not generating or are not matching the system demand. This backup source can indeed be a dispatchable backup source such as natural gas unit, reservoir hydro capacity, or energy storage capacity, which can both supply energy when renewables are not generating but also can store RE output when it is over the system demand. The requirement for backup sources can be hourly, daily, weekly but also on a seasonal level.
- Although not dispatchable, the output of renewables can be predicted, for example, in day-ahead planning. Actual output differing from the prediction requires system reserve, which requires dedicated capacity sources. These reserves are generally needed on minute and intraday levels. This aspect is detailed in Section 7.
- Renewables generally cannot provide ancillary system services such as frequency or voltage control, therefore capacity providing these services is needed.

6.1 Variability of renewables

The assessment provided in this section is based on a simplified model of an energy system consisting of a total of 1 MW of installed capacity, 1/3 of which is wind, 1/3 is solar PV and 1/3 is hydro capacity. Each of these has unit output as was the average output of respective sources in Kosovo in 2020. Modeling is based on the premise that the system should be able to provide baseload output. The conclusions and assessment are intended for illustration purposes. It is not intended to provide conclusive information about the overall level of variability in Kosovo, particularly not with an increasing number of RE projects coming online. However, it is useful to describe the concepts and provide an indication of the variability of RE sources and their interaction.

The output of renewables varies both on short term and on a long-term basis. The short-term (hourly) variability can be considered stochastic since it depends on variables whether it is a cloudy or sunny day or windy or quiet day. Long-term variability (seasonal) is somewhat predictable, as solar PV produces more during the summer than during the winter. Similarly, run of river hydro in climates as in Kosovo tends to yield more energy during snowmelt in spring and during rainfall in autumn. Generally, wind power tends to yield more energy during winter than summer.

Figure 6.1 illustrates the generation variability of renewable energy sources during 2020 in Kosovo. It shows the combined unit output of 1 MW of wind power, 1 MW of solar PV, and 1 MW of hydropower[55] [34]. Variability drives the need for energy storage of renewables.

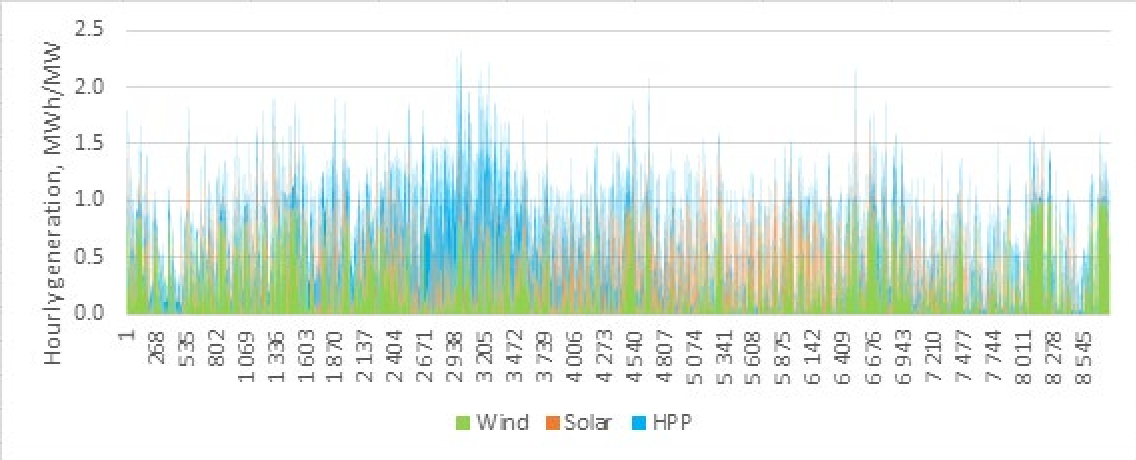

Figure 6.1**:** Hourly generation combined unit output of 1 MW of wind power, 1 MW of solar PV, and 1 MW of hydropower

Another way to look at the variability is to consider the variation of the hourly output of each source from the annual average output of that source. It is shown in **Figure 6.2**, **Figure 6.3,** and **Figure 6.4** for wind, solar and hydro[56].

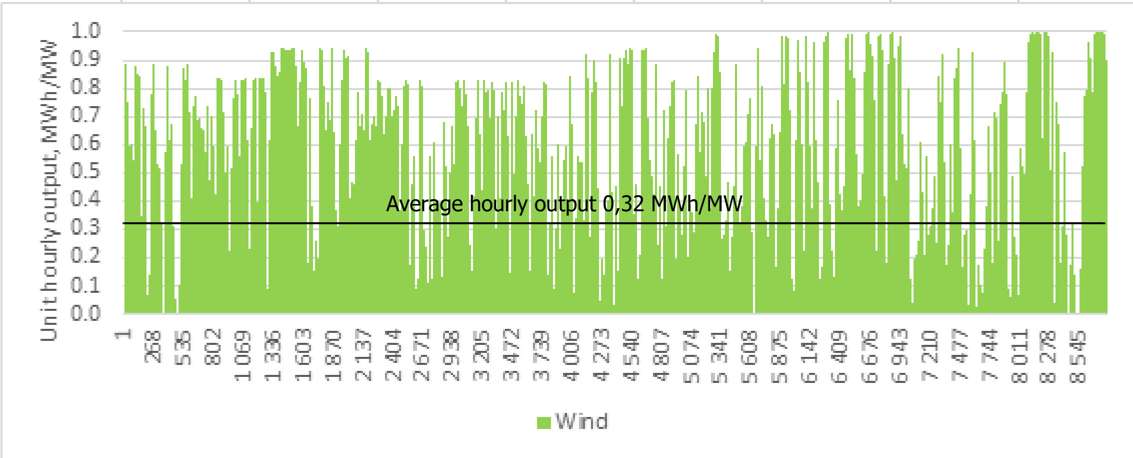

Figure 6.2**:** Variability of unit hourly output - Wind. Based on 2020 wind generation in Kosovo [34].

[55] Based on hourly output of renewables in Kosovo in 2020 as follows:
Wind power – WP Kitka with 32.08 MW installed
Hydro power; Ujmani (35.17 MW) and Kelkos (25.48 MW), Brod&Restelica (10.4 MW)
Solar PV; Led Light Technology (0.09 MW), Onix (0.47 MW), Birra Peja (2.4 MW), Frigo Food (2.4 MW), Eling (0.39 MW), Solar green energy (2.29 MW)

[56] Again, for 1 MW of capacity, based on actual 2020 output of wind, hydro and solar sources in Kosovo.

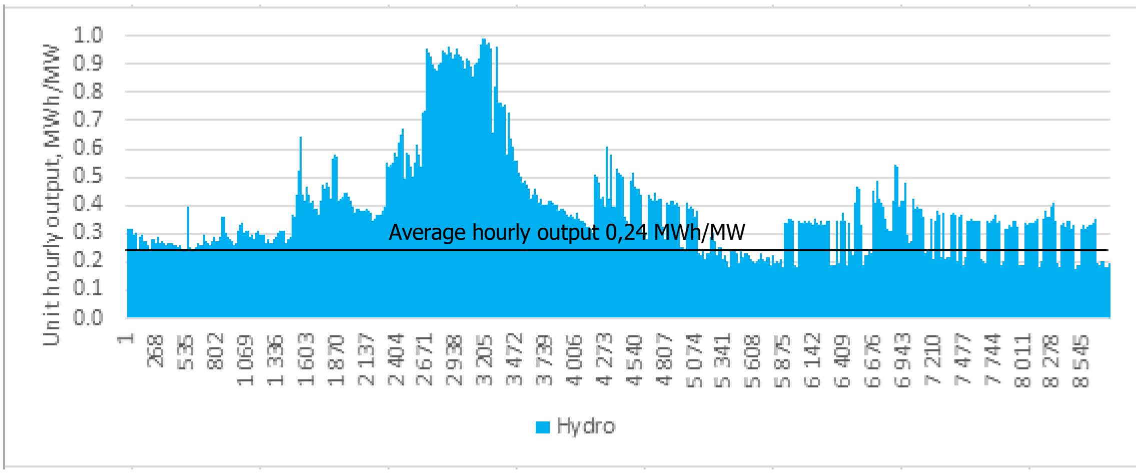

Figure 6.3**:** Variability of unit hourly output - Hydro. Based on 2020 hydro generation in Kosovo [34].

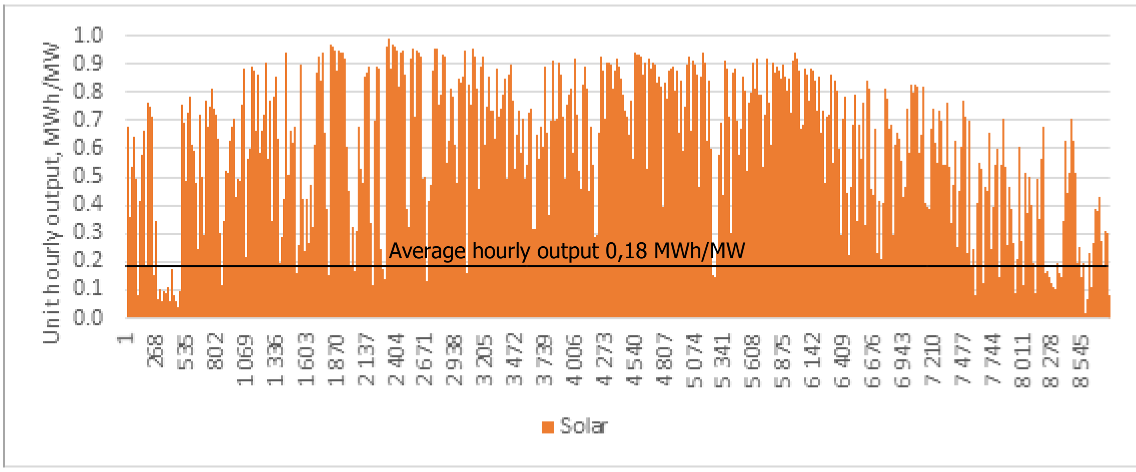

Figure 6.4**:** Variability of unit hourly output - Solar. Based on 2020 solar PV generation in Kosovo [34].

Besides hourly stochastic variability, one can observe the seasonal variability as well, particularly in spring hydro output and in summer vs winter solar PV output.

Combining multiple renewable energy sources reduces the variability, even when the renewables are of the same type (i.e., multiple wind power plants generally have lower variability than a single wind power plant).

This is illustrated in **Figure 6.5** depicting the unit variability of unit output of solar, wind, and hydro combined (each contributing with 1/3 to the unit installed capacity). Note that the variability of combined solar-wind-hydro generation is lower than for each of those sources individually. Combined variability could be even lower if hydro generation were guided with that aim (and not dispatched mainly during peak hours as the analysis below will show). This discrepancy exists since the generation data (including hydro generation) are taken from the actual 2020 generation in the Kosovo power system, not the modeled simplified system.

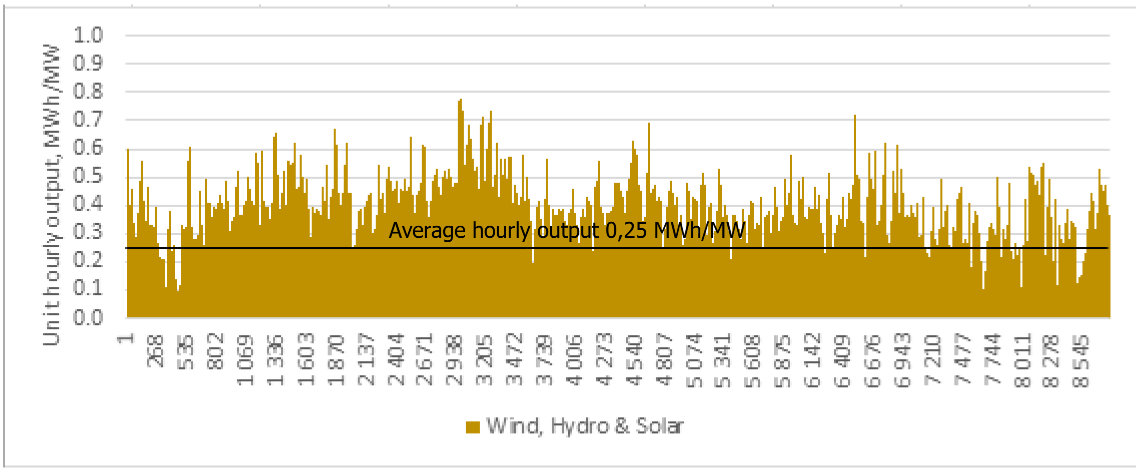

Figure 6.5**:** Variability of hourly output - Wind, Hydro and Solar. Based on the 2020 RE generation in Kosovo [34].

Hourly output from **Figure 6.5** can be represented as a solar-wind-hydro generation duration curve, as provided in **Figure 6.6**.

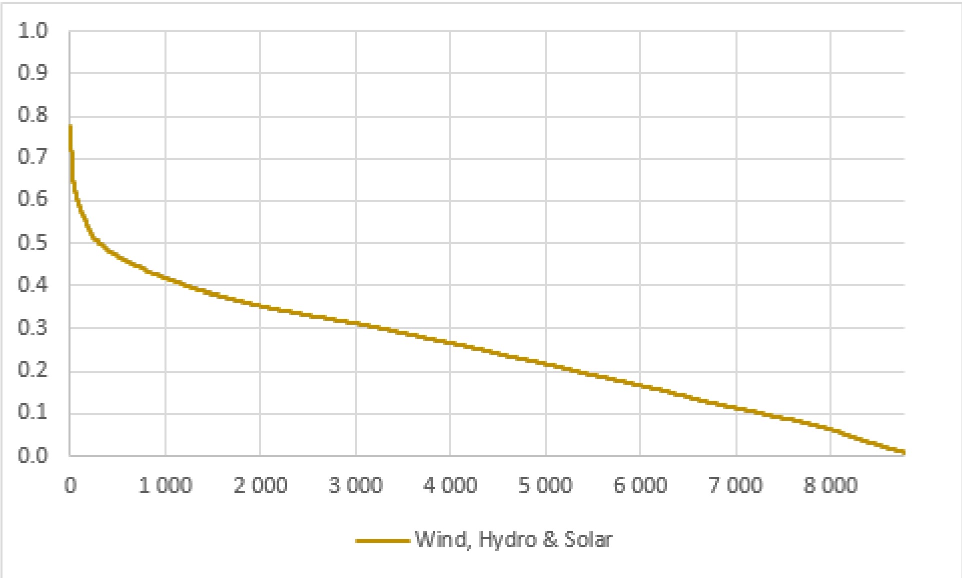

Figure 6.6**:** Combined 2020 Kosovo wind-hydro-solar generation curve

Although the generation duration curve is based on 2020 data and not on longer time series, the Consultant notes that the combined output of installed wind, hydro and solar capacity was greater than 50% of their installed capacity during only 3.5% of the time during 2020. The combined output was greater than 25% of the installed capacity during 50% of the time. This observation can be useful in future planning of the system reserves, particularly in terms of storage for peak generation. As output above 50% of total installed capacity occurs only 3.5% of the time, it may not be feasible to plan for the storage able to accommodate for this surge power output but consider shedding generation at those times instead.

Results of the analysis of typical daily outputs of wind, hydro, and solar in Kosovo (based on 2020 1MW unit output) are provided in **Figure 6.7**, **Figure 6.8,** and **Figure 6.9** below. These figures show the monthly average unit generation for each hour in a day. Results are provided for each of the three considered technologies, based on 2020 generation data in Kosovo.

Hour/Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.331	0.405	0.497	0.320	0.403	0.272	0.272	0.262	0.387	0.367	0.241	0.483
2	0.371	0.423	0.476	0.364	0.395	0.273	0.252	0.241	0.409	0.346	0.250	0.485
3	0.396	0.457	0.451	0.352	0.391	0.261	0.256	0.211	0.431	0.366	0.249	0.458
4	0.394	0.485	0.446	0.336	0.391	0.292	0.283	0.228	0.427	0.386	0.238	0.450
5	0.402	0.515	0.447	0.336	0.391	0.278	0.277	0.268	0.433	0.380	0.228	0.443
6	0.414	0.507	0.458	0.322	0.373	0.226	0.265	0.279	0.415	0.368	0.230	0.425
7	0.392	0.511	0.427	0.311	0.330	0.176	0.244	0.277	0.417	0.375	0.230	0.417
8	0.386	0.473	0.400	0.263	0.296	0.134	0.197	0.247	0.350	0.371	0.227	0.428
9	0.359	0.421	0.364	0.210	0.313	0.114	0.173	0.215	0.263	0.305	0.202	0.451
10	0.336	0.392	0.338	0.204	0.300	0.103	0.126	0.187	0.218	0.280	0.181	0.443
11	0.297	0.381	0.288	0.179	0.299	0.092	0.123	0.147	0.207	0.270	0.154	0.425
12	0.281	0.391	0.275	0.192	0.309	0.108	0.119	0.142	0.206	0.267	0.149	0.408
13	0.247	0.377	0.294	0.215	0.311	0.111	0.136	0.142	0.215	0.253	0.153	0.429
14	0.222	0.388	0.297	0.247	0.329	0.111	0.128	0.151	0.212	0.256	0.164	0.433
15	0.243	0.357	0.315	0.243	0.317	0.168	0.173	0.179	0.255	0.259	0.179	0.445
16	0.250	0.347	0.329	0.269	0.312	0.177	0.222	0.194	0.250	0.317	0.190	0.468
17	0.277	0.351	0.337	0.245	0.354	0.220	0.237	0.224	0.276	0.374	0.204	0.468
18	0.329	0.357	0.378	0.298	0.378	0.249	0.263	0.286	0.370	0.409	0.203	0.474
19	0.332	0.396	0.445	0.371	0.403	0.269	0.352	0.321	0.459	0.431	0.224	0.510
20	0.344	0.435	0.482	0.416	0.403	0.300	0.437	0.331	0.464	0.412	0.236	0.503
21	0.352	0.472	0.484	0.391	0.407	0.303	0.425	0.313	0.432	0.417	0.232	0.529
22	0.343	0.459	0.499	0.367	0.413	0.303	0.359	0.269	0.427	0.409	0.222	0.522
23	0.344	0.433	0.487	0.341	0.430	0.276	0.325	0.279	0.426	0.384	0.226	0.514
24	0.316	0.439	0.461	0.323	0.405	0.263	0.314	0.280	0.410	0.387	0.222	0.499

<0.1 MWh/MW; between 0.1 and 0.2 MWh/MW; between 0.2 and 0.3 MWh/MW; between 0.3 and 0.4 MWh/MW; between 0.4 and 0.5 MWh/MW; between 0.5 and 0.6 MWh/MW; >0.6 MWh/MW

Figure 6.7**:** Average unit hourly generation profile - Wind

According to the data presented above, we observe that, on average, wind power has a somewhat higher generation in winter months and during the nighttime.

Hour/Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.114	0.139	0.264	0.394	0.519	0.230	0.127	0.066	0.042	0.122	0.046	0.048
2	0.114	0.132	0.263	0.391	0.517	0.232	0.127	0.065	0.041	0.123	0.047	0.053
3	0.113	0.133	0.262	0.390	0.513	0.231	0.126	0.064	0.042	0.122	0.054	0.057
4	0.113	0.133	0.261	0.389	0.509	0.230	0.126	0.063	0.042	0.123	0.055	0.057
5	0.113	0.131	0.260	0.386	0.503	0.230	0.126	0.063	0.043	0.123	0.054	0.056
6	0.112	0.131	0.258	0.385	0.507	0.241	0.123	0.060	0.042	0.123	0.054	0.050
7	0.113	0.131	0.256	0.603	0.587	0.384	0.161	0.060	0.104	0.127	0.053	0.048
8	0.111	0.131	0.272	0.631	0.733	0.386	0.391	0.156	0.257	0.239	0.051	0.043
9	0.200	0.186	0.405	0.408	0.656	0.374	0.392	0.158	0.265	0.272	0.273	0.236
10	0.200	0.187	0.390	0.378	0.496	0.232	0.351	0.215	0.213	0.236	0.272	0.270
11	0.263	0.279	0.271	0.371	0.480	0.229	0.349	0.184	0.178	0.231	0.226	0.271
12	0.264	0.281	0.270	0.377	0.473	0.225	0.350	0.119	0.173	0.228	0.226	0.248
13	0.230	0.236	0.273	0.384	0.481	0.224	0.350	0.094	0.162	0.228	0.226	0.246
14	0.233	0.236	0.268	0.388	0.484	0.224	0.133	0.054	0.160	0.228	0.226	0.250
15	0.227	0.237	0.272	0.393	0.486	0.225	0.133	0.052	0.155	0.234	0.227	0.250
16	0.227	0.238	0.274	0.399	0.496	0.229	0.123	0.051	0.155	0.225	0.229	0.240
17	0.225	0.241	0.291	0.428	0.502	0.232	0.117	0.050	0.155	0.222	0.228	0.241
18	0.263	0.288	0.419	0.428	0.652	0.328	0.118	0.156	0.262	0.272	0.229	0.282
19	0.264	0.289	0.419	0.654	0.738	0.336	0.275	0.210	0.308	0.336	0.296	0.283
20	0.224	0.246	0.405	0.634	0.742	0.357	0.278	0.208	0.216	0.266	0.300	0.243
21	0.113	0.140	0.266	0.633	0.740	0.293	0.256	0.209	0.107	0.156	0.074	0.047
22	0.112	0.138	0.265	0.411	0.509	0.265	0.220	0.059	0.041	0.121	0.042	0.054
23	0.113	0.139	0.266	0.407	0.511	0.257	0.218	0.056	0.043	0.125	0.042	0.049
24	0.112	0.141	0.260	0.395	0.520	0.228	0.128	0.066	0.041	0.124	0.042	0.046

<0.1 MWh/MW; between 0.1 and 0.2 MWh/MW; between 0.2 and 0.3 MWh/MW; between 0.3 and 0.4 MWh/MW; between 0.4 and 0.5 MWh/MW; between 0.5 and 0.6 MWh/MW; >0.6 MWh/MW

Figure 6.8**:** Average unit hourly generation profile - Hydro

Although nominally "run-of-river", existing Kosovo hydropower plants seem to have a certain capability of at least partial intraday water storage as they notably generate more during the peak hours compared to the off-peak hours. In terms of seasonality, generation is the highest during April and May, which is concurrent with snow melting and spring rains.

Hour/Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.001	0.007	0.013	0.007	0.001	0.000	0.000	0.000	0.000
6	0.000	0.000	0.001	0.028	0.062	0.074	0.057	0.029	0.011	0.001	0.000	0.000
7	0.000	0.005	0.039	0.142	0.181	0.208	0.195	0.141	0.105	0.040	0.004	0.000
8	0.023	0.093	0.170	0.330	0.351	0.388	0.390	0.330	0.291	0.169	0.061	0.019
9	0.132	0.277	0.345	0.529	0.493	0.563	0.595	0.532	0.491	0.349	0.171	0.096
10	0.279	0.454	0.500	0.643	0.586	0.683	0.728	0.663	0.633	0.495	0.297	0.182
11	0.378	0.549	0.585	0.709	0.619	0.711	0.783	0.706	0.700	0.591	0.407	0.250
12	0.436	0.562	0.606	0.736	0.626	0.662	0.773	0.731	0.737	0.580	0.438	0.289
13	0.442	0.568	0.570	0.710	0.635	0.657	0.750	0.697	0.702	0.551	0.457	0.275
14	0.376	0.514	0.484	0.655	0.588	0.612	0.695	0.642	0.618	0.490	0.390	0.227
15	0.261	0.400	0.393	0.546	0.487	0.523	0.614	0.552	0.500	0.350	0.234	0.136
16	0.108	0.267	0.261	0.404	0.353	0.409	0.451	0.396	0.332	0.180	0.070	0.036
17	0.008	0.076	0.115	0.220	0.216	0.250	0.268	0.216	0.143	0.032	0.001	0.000
18	0.000	0.001	0.012	0.056	0.086	0.111	0.110	0.067	0.018	0.000	0.000	0.000
19	0.000	0.000	0.000	0.002	0.013	0.027	0.021	0.006	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

<0.1 MWh/MW — between 0.1 and 0.2 MWh/MW — between 0.2 and 0.3 MWh/MW — between 0.3 and 0.4 MWh/MW — between 0.4 and 0.5 MWh/MW — between 0.5 and 0.6 MWh/MW — >0.6 MWh/MW

Figure 6.9**:** Average unit hourly generation profile - Solar

In terms of average solar generation, it appears to be complementary to wind generation, with the highest outputs being provided during summer and peak hours.

Combining the outputs of solar, wind, and hydro, with an even contribution of each we obtain the combined average unit hourly generation as provided in **Figure 6.10** below, under the assumption of equal shares of installed capacity.

Hour/Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.148	0.181	0.254	0.238	0.307	0.167	0.133	0.110	0.143	0.163	0.096	0.177
2	0.162	0.185	0.246	0.252	0.304	0.168	0.126	0.102	0.150	0.156	0.099	0.179
3	0.170	0.197	0.238	0.247	0.301	0.164	0.127	0.092	0.158	0.163	0.101	0.172
4	0.169	0.206	0.236	0.242	0.300	0.174	0.136	0.097	0.156	0.170	0.097	0.169
5	0.172	0.216	0.236	0.241	0.300	0.174	0.137	0.111	0.159	0.168	0.094	0.167
6	0.176	0.213	0.239	0.245	0.314	0.180	0.148	0.122	0.156	0.164	0.095	0.159
7	0.168	0.215	0.241	0.352	0.366	0.256	0.200	0.159	0.209	0.181	0.096	0.155
8	0.173	0.232	0.280	0.408	0.460	0.303	0.326	0.244	0.299	0.260	0.113	0.163
9	0.231	0.295	0.371	0.382	0.487	0.350	0.387	0.302	0.340	0.309	0.215	0.261
10	0.272	0.344	0.410	0.408	0.461	0.339	0.402	0.355	0.355	0.337	0.250	0.298
11	0.313	0.403	0.381	0.420	0.466	0.344	0.418	0.346	0.362	0.364	0.263	0.315
12	0.327	0.411	0.384	0.435	0.469	0.332	0.414	0.331	0.372	0.358	0.271	0.315
13	0.306	0.393	0.379	0.436	0.476	0.331	0.412	0.311	0.360	0.344	0.279	0.317
14	0.277	0.379	0.350	0.430	0.467	0.316	0.319	0.282	0.330	0.325	0.260	0.303
15	0.244	0.331	0.327	0.394	0.430	0.305	0.307	0.261	0.303	0.281	0.213	0.277
16	0.195	0.284	0.288	0.357	0.387	0.272	0.265	0.214	0.246	0.241	0.163	0.248
17	0.170	0.222	0.248	0.298	0.357	0.234	0.207	0.164	0.191	0.209	0.144	0.236
18	0.197	0.215	0.269	0.261	0.372	0.229	0.164	0.170	0.217	0.227	0.144	0.252
19	0.199	0.228	0.288	0.342	0.385	0.211	0.216	0.179	0.256	0.256	0.173	0.265
20	0.189	0.227	0.296	0.350	0.382	0.219	0.238	0.180	0.227	0.226	0.178	0.249
21	0.155	0.204	0.250	0.341	0.383	0.199	0.227	0.174	0.180	0.191	0.102	0.192
22	0.151	0.199	0.255	0.259	0.307	0.189	0.193	0.109	0.156	0.177	0.088	0.192
23	0.152	0.191	0.251	0.249	0.314	0.178	0.181	0.112	0.156	0.170	0.089	0.188
24	0.143	0.193	0.240	0.239	0.308	0.164	0.147	0.115	0.151	0.170	0.088	0.182

<0.1 MWh/MW — between 0.1 and 0.2 MWh/MW — between 0.2 and 0.3 MWh/MW — between 0.3 and 0.4 MWh/MW — between 0.4 and 0.5 MWh/MW — between 0.5 and 0.6 MWh/MW — >0.6 MWh/MW

Figure 6.10**:** Average hourly profile - Wind, hydro and solar

Figure 6.11 provides typical daily outputs for January and July. One can notice a resemblance with the daily load diagram provided in **Figure 2.6** in Section **2.1**. Varying the contributions of various sources (wind, solar PV, hydro) and modifying hydro generation timing could provide a closer match to the daily load diagram.

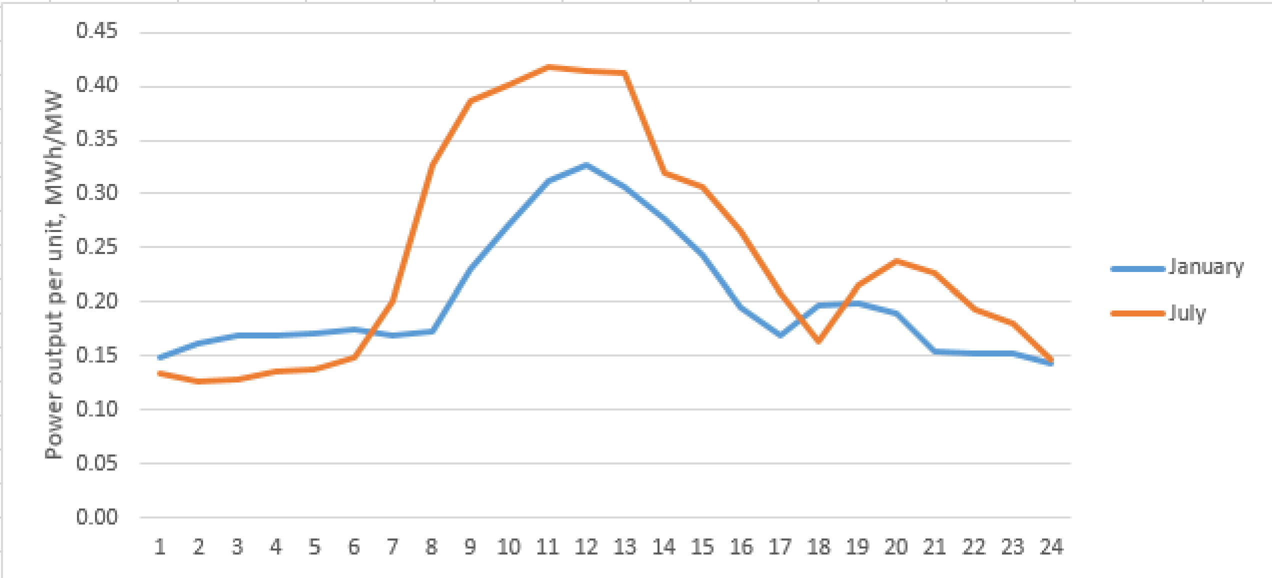

Figure 6.11**:** Typical daily outputs (of combined wind, hydro and solar) for an average day in January and July

One should bear in mind that the output curve above is for a typical day, while actual output in a day could significantly deviate from the typical one. Energy storage is required to accommodate for the difference.

Another aspect of renewable source's variability and the requirement for energy storage (or other energy sources) refers to a seasonal mismatch between the output of renewables and the system energy demand.

The monthly unit output of a system with equal contributions of 1 MW of hydro, 1MW of wind, and 1 MW of solar, according to the 2020 hourly output of Kosovo renewables is provided in **Figure 6.12** below.

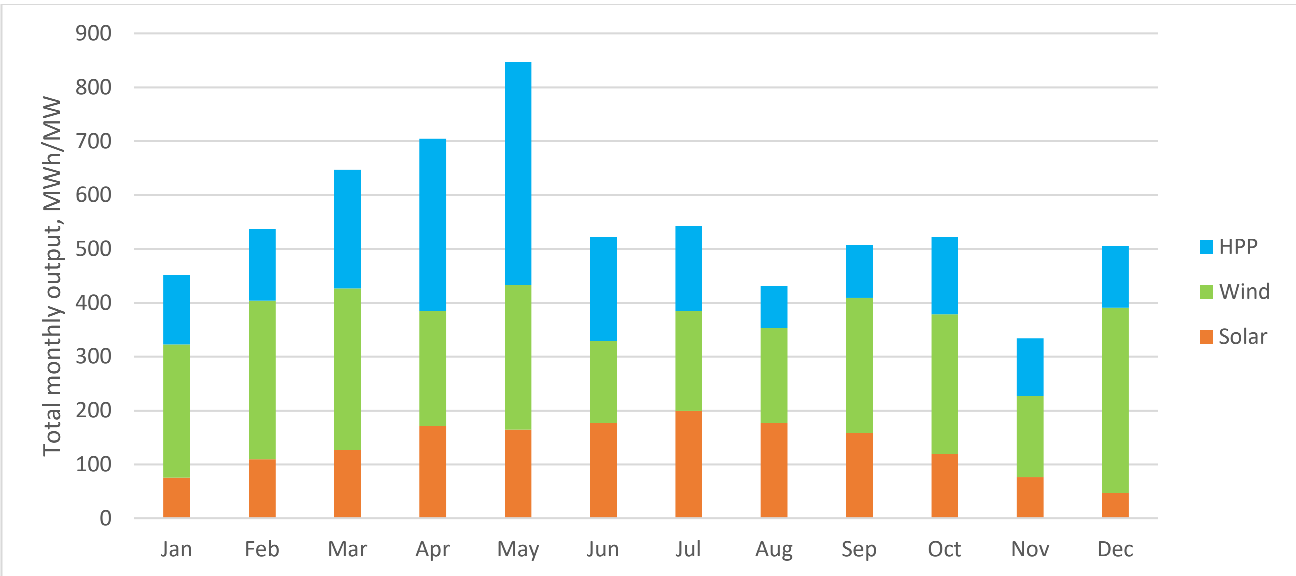

Figure 6.12**:** Total monthly output (per unit) with equal contribution of hydro, wind, and solar (1 MW of each)

Looking on an annual basis, wind output is higher in winter months and lower in summer months, which is in line with the system demand, which is larger during winter months and lower during summer months.

The portion of monthly output generated during peak hours (07-19) is provided in **Figure 6.13.** Off-peak monthly output, i.e. the electricity generated in hours 19-07, is given in **Figure 6.14** below.

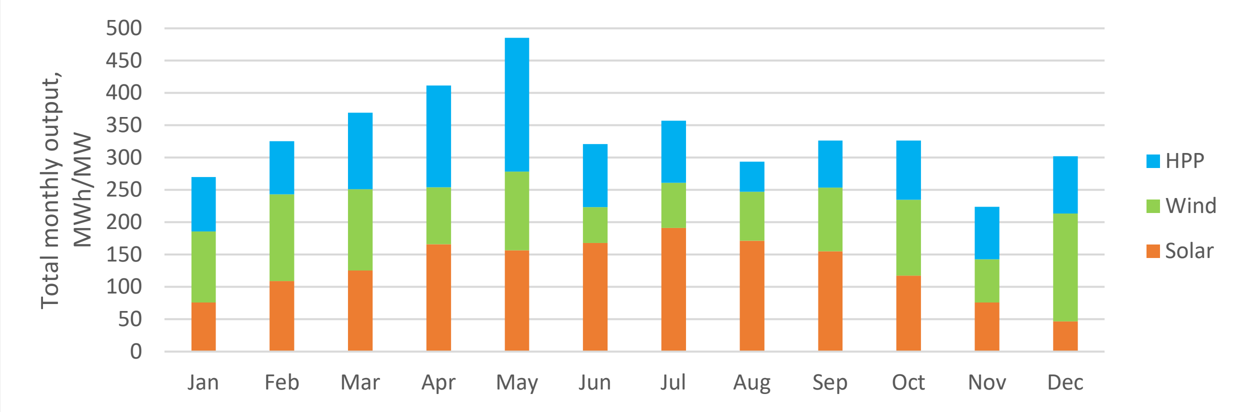

Figure 6.13**:** Total monthly output (per unit) with equal contribution of hydro, wind, and solar (1 MW of each) - peak hours

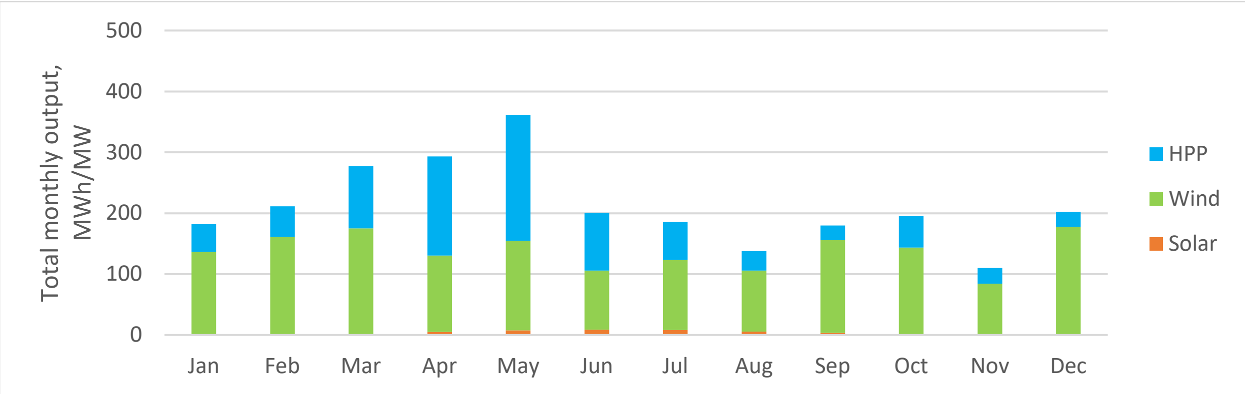

Figure 6.14**:** Total monthly output (per unit) with equal contribution of hydro, wind, and solar (1 MW of each) - off-peak hours

On an intraday level, solar PV output is more suited to meet the intraday load variations.

The analysis of 2020 Kosovo renewables generation data that is laid out in this section indicates that solar and wind generation may complement each other in terms of seasonality. Hydropower, although nominally "run of river", seems to provide a degree of intraday dispatchability.

6.2 Notes on the energy storage

Due to variability of production and inability to be dispatched on demand, systems with a high share of renewables have an increased need for backup energy sources and/or energy storage.

From dispatchable sources, the Kosovo system can use Kosova A and B lignite TPPs and imports. Each of these has its limitations. TPPs are limited with their technical parameters (availability, ramp up and ramp down rates, technical minimum, time to start from a cold start and hot start, etc.). Imports are limited with the interconnection capacity, imports availability, and price.

In planning an energy system with a high share of renewables, part of the energy can be stored as heat (which can be stored at comparably low cost and in large quantities). This heat can then be used seasonally in district heating systems. Smart demand-side management can be considered to reduce the need for intraday reserves and related energy storage. Hydropower, particularly with the ability of at least intraday control of the output, can be valuable and decrease the need for energy storage.

Considering the identified pipeline of RE projects, it is apparent that the implementation of many of the measures mentioned above will become necessary for Kosovo to effectively manage its energy system.

7. Transmission system capability to facilitate the integration of RE based power generation in Kosovo

Integration of RE based power generation into the power system covers two main areas: connection and operation. This section will deal with the capability of the transmission system in Kosovo to connect and facilitate operation of currently planned and foreseeable future new RE generation facilities, especially those planned to be connected directly to the transmission network. The most important aspects of the transmission system capability that impact integration of renewable energy based power generation are:

- Transmission network capacity (internal and cross-border transmission lines and substations),
- Power system balancing,
- Power system control reserves and provision of ancillary services,
- Development and integration of electricity market

In the following paragraphs, these aspects are elaborated in greater detail.

7.1 Transmission network capacity

The transmission network in Kosovo includes all 400kV, 220kV and 110kV lines and all 400/x kV, 220/x kV and 110/x kV substations and switchyards. All other assets in the power system either belong to the DSO, or to the generation plants, or to large industrial consumers for their internal networks. According to the information from the Transmission Development Plan 2020-2029[57] [35], the length of the transmission network in Kosovo is 1,410.5km, out of which 179.5km are 400kV lines, 238.5km are 220kV lines and 892.5km are 110kV lines. In the transmission network there are also 37 substations, out of which 3 substations are 400/x kV, 5 substations are 220/x kV and 29 substations are 110/x kV. All these assets are presented in Error! Reference source not found. below, which represents the transmission system in Kosovo at the end of 2019.

The Transmission System Operator of Kosovo (KOSTT) operates a number of interconnection lines with the neighbouring power systems. These interconnection lines are:

- 400kV
  - Kosovo B – Komani (ALB)
  - Kosovo B – Nis (SRB)
  - Peja 3 – Ribarevine (MNE)
  - Ferizaj 2 – Skopje 5 (MKD)
- 220kV
  - Prizren 2 – Fierza (ALB)
  - Podujeva – Krusevac (SRB)
- 110kV
  - Valaq – Novi Pazar (SRB)
  - Berivojce – Bujanovac (SRB)

Transmission system development in Kosovo is carefully and regularly planned by KOSTT, through the development and annual update of the 10-Year Transmission Network Development Plan (TYNDP), which also includes the Investment Plan for the next 3-year period. This document is developed by KOSTT and is approved by the Regulator (ERO). It includes all known and foreseeable connections for new demand and generation customers, as well as forecasting the refurbishment and upgrading of existing transmission system facilities.

[57] Page 7, subsection 1.2

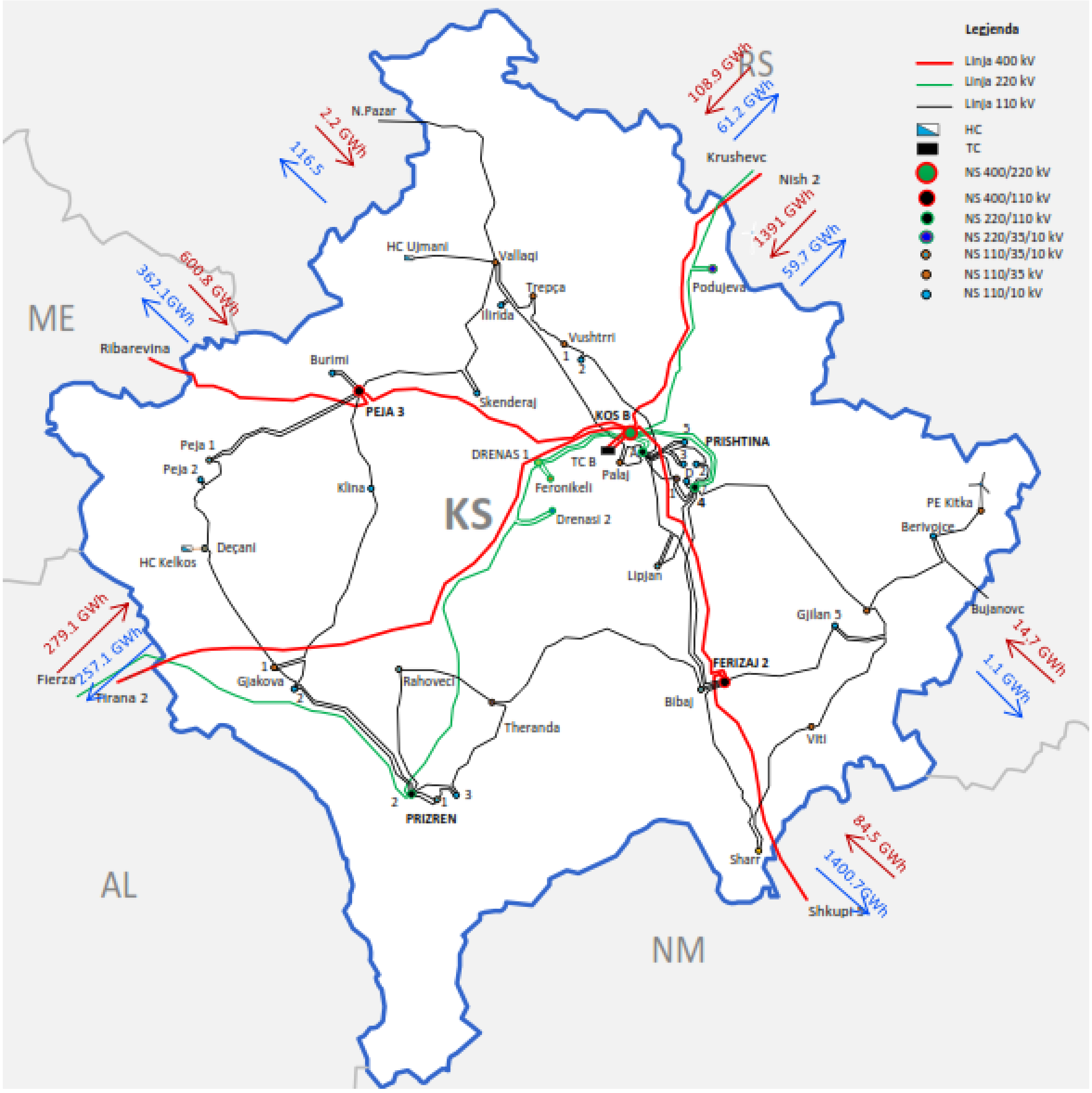

Figure 7.1: Kosovo transmission system, 2019

Kosovo's main 400kV transmission backbone is overdesigned for the Kosovo power system, and these 400kV transmission lines are, in the majority of cases, under loaded. The existing 220kV network is practically limited to a network around Prishtina and TPPs Kosova A and B, plus the interconnection to Albania via Prizreni substation. Most of these connections are expected to be replaced by 400kV connections in the future. The 110kV network is reasonably well looped already, but most of the facilities are rather old and they are gradually being replaced. Most of refurbishment actions relate to the replacement of concrete towers with still lattice ones and the replacement of 150mm^2 conductors (83 MVA loading) with 250mm^2 conductors (114 MVA loading). However, due to the heavy loading of some 110 kV lines, additional system reinforcement will be required, including potentially some additional 110kV cross connections. Limits for transmission line loading, i.e. the settings of the overcurrent protection are defined on a seasonal basis, based on the technical parameters of a particular line, the age of the line and the impact of extreme seasonal weather conditions (low temperature and ice in the winter and high temperature in the summer).

The capacity of existing OHLs, especially in 110kV lines, may be increased by implementing Dynamic Line Rating. DLR implementation may delay or in some cases negate the need for required investments in new transmission capacities.

Based on the TYNDP 2020-2029 [35], KOSTT has conducted studies on the impact of the connection of the above-mentioned applications for connection from RE generation (see Table 4.3), and has determined the optimal configuration of their connection to the transmission network. Some of these projects have concluded connection agreements and are on the waiting list for approval by ERO. The transmission network has sufficient capacities to integrate candidate RE generation capacities, so the only problem for the TSO remains lack of power system control reserves to compensate for variable and unpredictable wind and solar generation output. The TYNDP 2021-2030 [35] determines details of the connection to the transmission network for those RE projects where respective Connection Agreements (CA) between KOSTT and the Investor have been concluded. The main details for connection of the largest planned RE generation plants are given in Error! Reference source not found.:

Power Plant	Capacity (MW)	Connection Point	Connection details	CA
WPP Bajgora/Selac I,II,III	103.4	110kV SS Vushtrri 1,2,3	New 19.35km line 110kV AlCe 240mm^2 between SS Vushtrri and WPP Selaci 1,2,3	Yes
WPP Çiçavica	116.6	In/Out on 220kV OHL SS Kosova B – SS Drenas	New double 0.2km line 220kV AlCe 240mm^2 to existing 220kV OHL SS Kosova B – SS Drenas	Yes
WPP Koznica	34.5	In/Out on 110kV OHL SS Prishtina 4 – SS Gjilan 1	New double 1.4km line 110kV AlCe 240mm^2 to existing 110kV OHL SS Prishtina 4 – SS Gjilan 1	Yes
WPP Kamenica I, II	69.6	NS 110/35 kV Berivojce, Kamenica	Not available	Yes, not in the TYNDP[58]
WPP Budakova I, II	11 + 35	110 kV OHL Theranda- Ferizaji 1	Not available	Yes, not in the TYNDP
WPP Kitka (addition)	33	Connection point of existing WPP Kitka	Not available	Yes, not in the TYNDP
SPP Kamenica III	30	Not available	Not available	Yes, not in the TYNDP
SPP SEGE	136	Not available	Not available	Yes, not in the TYNDP
SPP Terstenik	96	SS Peja 3 400/110 kV with 110 kV line	Not available	Yes, not in the TYNDP
SPP Sferke	96	SS Peja 3 400/110 kV with 110 kV line	Not available	Yes, not in the TYNDP
HPP Lepenci	9.98	In/Out on 110kV OHL SS Ferizaj – SS Sharr	New double 1.2km line 110kV AlCe 240mm^2 to existing 110kV OHL SS Ferizaj – SS Sharr	Yes
PSHP Vermica/Drini	250	220kV busbars in the SS Prizreni 2	Details not available	Yes

Table 7.1: Connection details for large planned RE projects which obtained a Connection Agreement from KOSTT

For other identified RE generation projects, detailed studies have not been undertaken because the projects are less mature. However, having in mind their planned locations, the TSO is confident that from the transmission network capacity perspective there will be no problems in accommodating all these connections. Implementing these connections should not be an issue for the TSO from both technical and commercial points of view. This is because, based on the "Transmission connection charging methodology" [36] for connection to the transmission network, Kosovo applies the so called deep connection costs scheme. This means that the investor should pay for both the connection point infrastructure together with any required transmission network reinforcement. Technical details for each connection of RE generation to the transmission network will be part of the Connection Agreement and agreed upon between the KOSTT and the Investor, following

[58] For all projects where "not in the TYNDP" comment is given, information on CA was provided from KOSTT.

completion of the administrative network connection procedure defined in the "Grid Code – Connections Code" from August 2018.

7.2 Power system balancing

Power system balancing is a main challenge for all system operators. In Kosovo, this task is even more complex since available generation capacities are more than 95% based on relatively old lignite fired thermal power plants, meaning the system has a very low flexibility to respond to changes in demand or to compensate for fluctuations of RE generation.

The maximum load in the Kosovo power system was recorded on 31 December 2019 at 18:00 in the amount of 1 253 MW, which is higher than the maximum load in 2018 (1 203 MW). The chart below shows the average demand, generation, and exchange of the power system in Kosovo during 2019. It is obvious that most of the energy surplus in the power system in Kosovo occurs during the night, while during most of the day hours the lack of energy must be compensated with imports. In the Kosovo power system, there are insufficient capacities for power system balancing in terms of secondary (aFRR) and tertiary (mFRR) load-frequency control. There is only one existing HPP of a sufficient size to provide balancing (Ujmani), which is highly constrained and having water supply as its main purpose. The existing TPPs have relatively low ramp rates (Kosova A - 4 MW/min and Kosova B - 7 MW/min) which are sufficient only for load following, meaning slow changes in the demand. For large fluctuations of the demand and for balancing the fluctuating RE generation output, units with a much faster response to power system balancing signals are required.

The power systems of Kosovo and Albania are highly compatible, since now in Albania all generation power plants are hydropower based (with some minor volume of RE generation from other technologies). Therefore, Albania has a lot of flexible hydropower but lacks base load generation, while in Kosovo the opposite situation exists.

Power system balancing capability is one of the main constraints for the integration of RE based power generation, because of the uncertainty and fluctuation nature of its power output. Accurate forecasting of RE generation is one of the main preconditions for successful power system balancing, and consequently for enabling integration of RE generation at a higher level. A general trend is to significantly increase the accuracy of the RE generation forecast, and to bring the RE forecast closer to real-time. This is one of the reasons why Intra-Day Markets are playing important role in the further integration of RE generation.

It is well known that the accuracy of of a forecast for a portfolio of RE generation plants is significantly better than a forecast for an individual RE site, regardless of the technology. For individual sites, a certain range of accuracy has been achieved, and this is unllikely to improve in the future. The presented spread in **Figure 7.2** is due to the variety of wind regimes and topography of the terrain. For the aggregate portfolio, random errors are reduced because of multiple sites and weather conditions affecting different sites at different times.

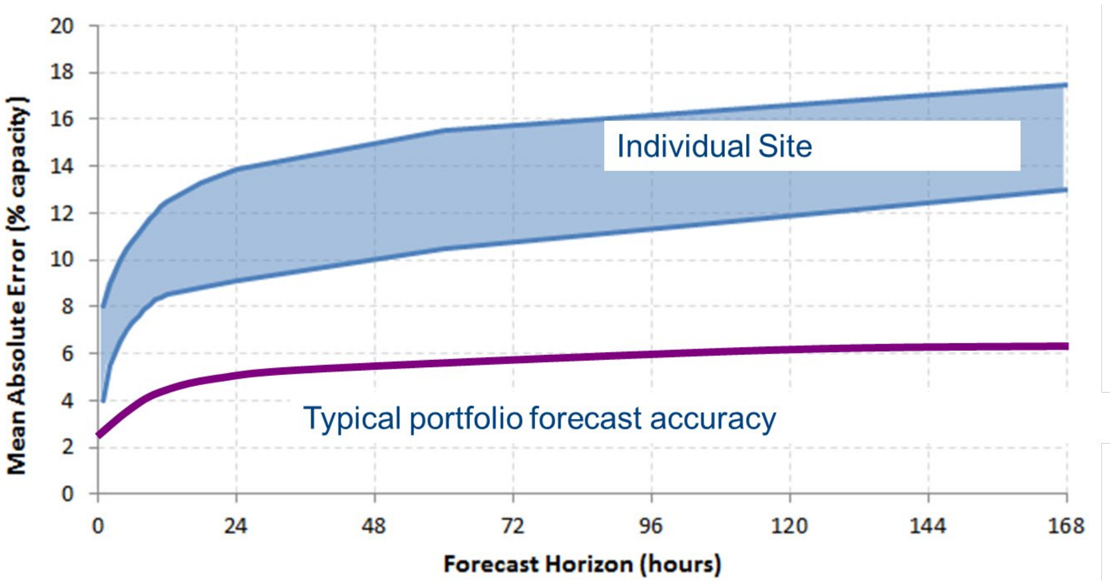

Figure 7.2**:** Typical RE forecast accuracy spread.

Source: DNV

In general, the variability of wind and solar outputs depend heavily on the climatological characteristics of each system. For example, high levels solar radiation and high wind speeds quite often do not correlate on all time scales of hours to months. The peak demand in Kosovo takes place during winter, mainly due to the demand from electric space heating. Naturally, solar PV production is practically always greater during summer, while wind production is higher during winter. Wind production is positively correlated with demand, and there is also a certain complementary (inverse correlation) between wind and solar. The relative deviations from the trend line for PV and wind in total are significantly lower than for the individual sectors. Even on a daily timeframe, the combination of PV and wind power leads to a stabilisation of the generation output. This has been illustrated in the analysis of 2020 Kosovo RE generation provided in section **6**.

For effective power system balancing, long-term planning, operational planning activities and routines are also important. These are the areas where significant improvements will have to be made in KOSTT and the power system of Kosovo, to enable better utilisation of available renewable resources. The following paragraphs review the current situation and provide some proposals for improvement.

Long term planning in the transmission network in Kosovo is reasonably well established. There is a tradition of development of the 10-years network development plans and associated investment plans on a regular basis, and these plans are developed by the TSO (KOSTT) and approved by the Regulator (ERO).

In the TSO there are software tools and skilled experts for doing long-term planning via KOSTT's own resources. In future, KOSTT will need to increase the systems and human resources supporting its long term planning processes, and to develop capabilities to execute more complex planning activities, including a market modelling expert group for translating the long-term generation scenarios into concrete infeed and load time series (8760 h/a). This will be necessary to provide a state-of-the-art transmission grid planning process, as is illustrated below.

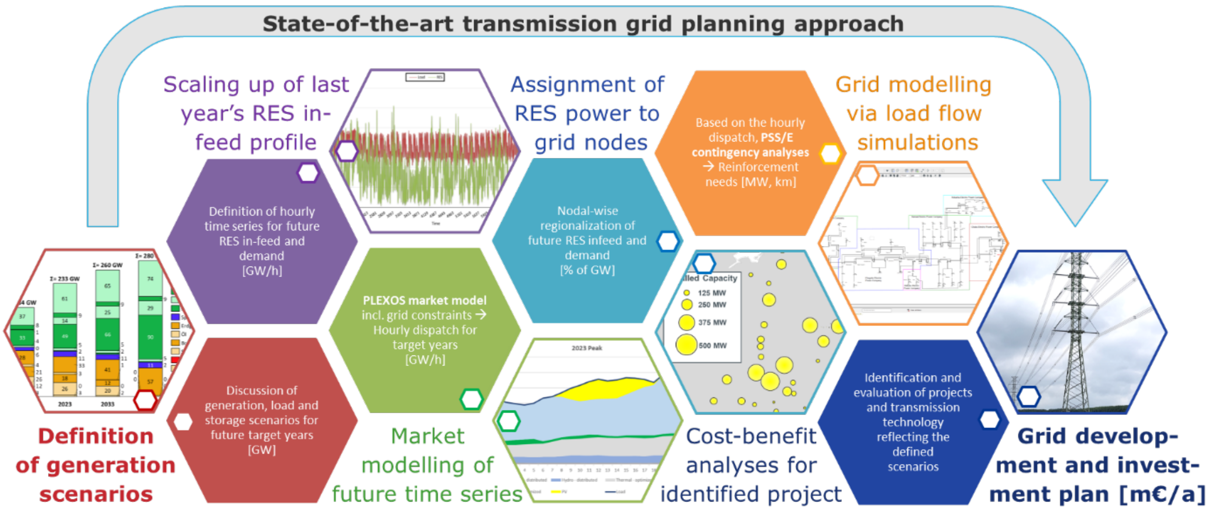

Figure 7.3**:** State-of-the-art transmission grid planning approach (based on the example tools PLEXOS and PSS/E)

Source: DNV

Operational planning aspects in KOSTT are reasonably well covered, starting from planning of outages, through security assessment and congestion forecasting, and ending with a power balance and demand forecast, including the requirement for reserves. The relevant department in KOSTT National Dispatch Centre (NDC) uses all the necessary software tools and has enough skilled experts for doing all operational planning activities. What seems to be insufficient, and will need to be reinforced in the future, is the forecasting of RE generation using KOSTT's resources. The current practice of outsourcing this activity can be practical to a certain extent, specifically while RE share in the overall generation mix is low. As more RE is implemented, this forecasting must be done by the TSO. An upgrade of the SCADA/EMS system that is planned in the TYNDP 2021-2030 [35] must contain a module for forecasting of wind power generation. By acquiring a weather forecast from an outsourced supplier (the public hydro-meteorological institute), KOSTT may start to prepare its own wind power generation forecast using regular updates of weather conditions, wind speed and direction. This service is currently used for forecasting wind power generation. Whilst solar power generation capacities in operation are negligible, the same mechanism (and the same weather forecast supplier) may be used in the future when major planned solar power generation facilities enter operation. Since in Kosovo applies partial balance responsibility for RES (RE generation with the installed capacity above 500kW is responsible for 25% of its imbalance costs), the quality of the generation forecast provided by RE power producers significantly improved. However, once more RE generation is integrated, in spite of their forecasts for power system control must fully rely on the accuracy of the TSOs own assessments of the combined power generation portfolio. So it is important for KOSTT to acquire suitable planning tools, to get all involved operational planning experts and dispatchers acquainted with these tools and to provide training in their use. Having in mind that large scale RE integration is planned, this is now becoming urgent. With this improvement of asset management practise, the existing outage planning aspects of operational planning will also be improved.

The increased dynamics of power system operational planning, in terms of getting closer to real-time, have created new requirements for security assessment and the timeframe for security assessments has moved from week-ahead and day-ahead to the intra-day stage. Accordingly, the provision of reliable data inputs for the Intra-Day Congestion Forecast (IDCF) procedure has become a major challenge. The transmission network in Kosovo is reasonably well equipped with real-time measurements and data recording, collection, and communication (into the control centre), but obviously some new inputs will have to be obtained from field devices. A revision of the data collection requirements from the Transmission Grid Code can help in this direction.

Additional possibilities to improve the balancing capability of the power system of Kosovo could be expected from the following:

- Activation of Demand Side Response (DSR)
- Integration into European Imbalance Netting Process
- Construction of new hydropower resources, especially PSHPs
- Changes in existing legislative and regulatory framework

A basic consideration of each of those factors is presented below, however a more detailed analysis will be required in the future.

7.2.1 Demand Side Response

Demand side response in the transmission network in Kosovo has not been implemented so far in an organised way[59], neither from large industrial consumers nor from the general domestic customers. Large industrial consumers that exist in Kosovo are good potential providers of DSR services to the TSO, especially for upward control which can be delivered either by increase of generation or by decrease of demand. Critical periods for power balance in the power system of Kosovo are at the extreme peak hours which occur quite rarely during the year and it is only during those hours that DSR services are crucial. Improvement in this area can be achieved by changes in the regulatory framework and via the introduction of sustainable DSR incentives. Significant short-term reductions of load can be achieved by controlling the industrial consumers, however the major potential contribution to DSR in Kosovo remains with the household consumers. Relatively low electricity prices (practically below commercial value, similar to all countries in the region) seriously reduce the realistic potential for provision of DSR services. The technical preconditions to introduce DSR either exist or could easily become available, but only further development of the electricity market will contribute to the development of the legal, regulatory and commercial framework to enable DSR services.

Like all other TSOs in the region and in European interconnection, KOSTT is aiming to provide a high quality of all services including electricity supply via the DSO to domestic consumers and to all service providers that run their facilities using electricity (e.g. water pumps, petrol stations, internet providers, etc.). KOSTT is working very hard to minimise cases of unplanned outages and curtailment of electricity supply beyond certain

---

[59] This statement does not apply to a power system defence measures, such as planned, emergency or under-frequency load shedding.

tolerable limits. Development of electricity supply quality indicators over recent years is good evidence of the achieved results. All these requirements create an extremely complex operational environment for the TSO (and for the DSO, too) and push for major investments in the smart grid facilities to increase transmission/distribution network observability and controllability, communication and data transfer infrastructure and enabling security, reliability, and quality of electricity supply to final consumers.

7.2.2 Integration into Imbalance Netting process in Continental Europe interconnection

Obviously, certain actions must be undertaken to modify balancing services provision framework, either through regulated portfolio contracts (already in use in many countries where a single company dominates generation sector) or through some other regulatory measures and/or incentives.

Currently in the ENTSO-E interconnections there is an on-going project for International Grid Control Cooperation (IGCC), the pan-European Platform for the imbalance netting process (IN-Platform), as defined by the Guidelines on electricity balancing (EB GL Art. 22) [37]. Most of the TSOs in Western and Central Europe are already fully participating in this mechanism. Concerning the TSOs in the region, some of them are observers and some of them are non-operational members. The main criterion for participation, in addition to the organisational aspects of load-frequency control inside the power system (which are almost by default operational), is that at least one of the neighbouring TSOs is an operational member of the imbalance netting process. Once regional TSOs become operational members of the imbalance netting process, the general situation concerning power balance in the region and in each individual power system will dramatically change, such that with less reserve much better power balance will be achieved. This will further contribute significantly to quality of power system operations, security of supply and higher integration of RE generation.

Within the EU, the framework for cross-border harmonization and cooperation for system balancing is governed by Regulation (EU) 2017/2195 [37] which is also referred to as the Guidelines for Electricity Balancing, or GLEB [38]. To facilitate the exchange of balancing energy across borders, the GLEB require the definition of a set of standard products for RR, aFRR and mFRR (for direct and scheduled activation) to be exchanged using pan-European platforms. TSOs may request their respective NRA to approve the usage of specific products to fulfil their requirements concerning dimensioning of the balancing reserves. Balancing energy bids from specific products and bids from the integrated scheduling process from TSOs applying a central dispatch system can be converted into balancing energy bids from standard products according to certain rules.

The GLEB foresees the implementation of common European platforms for each of the relevant processes, i.e. imbalance netting, automatic and manual FRR (aFRR/mFRR), replacement reserves (RR). To achieve this goal, European TSOs have established the following implementation projects.

- International Grid Control Cooperation (IGCC) – for imbalance netting process,
- Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation (PICASSO) – for aFRR process,
- Manually Activated Reserves Initiative (MARI) – for mFRR process,
- Trans-European Restoration Reserves Exchange (TERRE) – for RR process.

Currently, these named platforms are being developed according to the GLEB required timeline. The main objective is to identify and implement the most efficient solutions concerning an optimal number of platforms and participating entities, as well as the level of cooperation between the platforms. Initial stages of implementation should include only common activation of the balancing reserve capacity and balancing energy, while procurement will remain at the TSO level till the full harmonization of the rules.

7.2.3 Construction of new hydropower generation plants

Hydropower generation in Kosovo is rather limited, and accordingly is very difficult to rely on new HPPs for improvement of the power system balancing capabilities. A certain contribution may be provided from small HPPs with an installed capacity of 1MW or higher, since these units may provide load-frequency control in several regimes. This effect is even higher when a HPP cascade is concerned. To that purpose, it is good to investigate if Lumbhardi cascade may be convenient candidate for this support. The same applies to planned new HPP Lepenci whose capacity is almost 10MW.

The only HPP development project that could make difference by providing significant contribution to the existing very limited power system control capacity in Kosovo is construction of the PSHP Vermica/Drini due to its size and the fact that it is reversible power plant.

7.2.4 Changes in existing legislative and regulatory framework

Balancing capability in the power system may be improved either by increasing balancing capacity via generation and demand users offering and delivering balancing services, or by reducing the imbalances that occur in the power system by introducing more strict rules for the balancing mechanism in the power system, or by some combination of both.. In practical terms, for the power system of Kosovo, system users will have to accept an increased balance responsibility through the introduction of more severe measures (compensations) for imbalances between planned and actual injections/off-takes into/from the power system. This will also mean introducing gradually full balance responsibility to RE based power generation facilities[60], since at the moment existing RE generators are responsible for only 25% of the balancing cost until the expiry of their FiT PPAs. Also, balance responsibility should apply to all RE generation facilities, regarless if they receive support scheme or not. Full balance responsibility to RE generation may be applied either through the obligation to become part of the balance responsible party (just like the conventional generation plants), or by applying fixed compensation for balancing purposes (certain amount per kW installed or per kWh produced) to all RE generation regardless of their installed capacity. Implementation of these measures will require significant amendments to the existing Market Rules, and most likely to the primary legislation as well.

On the technical side, a practical measure should be introducing an obligation for RE generation above a certain installed capacity to provide defined ancillary services, especially those related to frequency response (downward control) and voltage/reactive power control. These requirements are part of the ENTSO-E Network Code (EU Directive) “Requirements for connection of generators” and their implementation is mandatory for all regional TSOs through the Energy Community framework from July 2021.

7.3 Power system control reserves/ Provision of ancillary services

KOSTT is fully responsible for operations and control of the power system in Kosovo. This task, however, is rather demanding and complex due to the fact that in the power system of Kosovo availability of conventional power system control reserves is extremely limited. The only large HPP Ujmani has serious limitations due to its water supply priorities over electricity generation, while the lignite fired TPPs have limited control capabilities. Small HPPs do not have this facility, neither do other existing wind and solar generation capacities. Moreover, small RE based power plants do not have a balancing responsibility (this is an incentive for RE generation development) which means that instead of correcting they create additional imbalance in the power system.

Starting from December 2020, KOSTT operates as a control area in AK Control block. For the purposes of joint load-frequency control in the control block, KOSTT, OST and KESH (the public generation company in Albania) have signed a coordination/cooperation agreement which includes arrangements for enabling necessary quantities of automatic (aFRR) and manual (mFRR) frequency restoration reserve. Operation in the common control block enables the neighbouring TSOs (KOSTT and OST) to optimise their reserve requirements.

According to the ENTSO-E rules, the required amount of aFRR capacity for the AK control block is +/- 25MW, and this capacity will be provided by KESH from their huge reservoir hydropower plants. Using rule of largest generation outage, the required upward control reserve capacity of mFRR for AK control block would be

[60] For example, within several years current obligation to compensate 25% of imbalance costs may increase to 100%, which is in line with the recommendations of the EU and EnC to equalize status of RE and conventional generation concerning balance responsibility.

370MW (the largest generation unit in Kosovo is 270MW and the largest generation unit in Albania is 100MW). Common mFRR reserve capacity is designed to cover the loss of largest generation unit in the control block, in this case the 270MW unit in Kosovo, and both TSOs are proportionally contributing to this objective. Corresponding shares (contributions) to the upward control reserve from the respective TSOs (control areas) are:

- For KOSTT: mFRR = 270 x (270/370) = 197 MW,
- For OST: mFRR= 270 x (100/370) = 73 MW

According to the control block operational agreement, all these reserves are provided by KESH.

Common mFRR downward control reserve capacity is designed to cover the loss of largest demand unit in the control block, in this case 90MW unit in Kosovo. Correspondingshares (contributions) to the upward control reserve from the respective TSOs (control areas) are:

- For KOSTT: mFRR = 20 MW (provided from Kosovo A and Kosovo B TPPs),
- For OST: mFRR = 70 MW (provided from KESH)

Ramp rates of the existing TPPs in Kosovo are the same for upward and for downward control (Kosovo A-4MW/min and Kosovo B-7MW/min). The main issues concerning contribution of existing TPPs to load frequency control are reduced actual available capacity vs. nominal power output (meaning lower efficiency when operating in a control mode), reduced availability and reliability of individual units due to their age, and finally the planned decommissioning of the Kosovo A power plant (currently foreseen for Q4 2023). Taking all these aspects into consideration, it may be concluded that existing TPPs Kosovo A and Kosovo B theoretically exist as potential providers of tertiary control, but the TSO cannot rely on this service for system control purposes.

Regarding mitigation of RES integration, the control block cooperation agreement will ensure smooth integration of a certain amount of RES capacities (up to 150 MW wind power and 70 MW solar power[61]) in the Kosovo power system. For integration of additional RE generation capacities additional system reserve is needed. Lack of available reserve capacities eliminates the option for organising market-based procurement of ancillary services. Now, and in the following 5 to 10 years, procurement of power system control ancillary services in Kosovo must be based on the regulated contracts and cross-border cooperation agreements.

When discussing power system reserves in the power system of Kosovo, it is important to take into consideration all kinds of reserves (instantaneous - FCR, very fast – aFRR, fast - mFRR and slow - RR). Availability, procurement, and technical requirements for provision of ancillary services for power system control reserve may significantly differ among those types of reserves.

Actions to enable KOSTT access to more power system control reserves are possible in several ways:

- Development of new generation facilities capable to provide system services.
- Development of power batteries with considerable capacity
- Entering into long-term cooperation agreements with cross-border partners (AK control block)
- Joining the European Imbalance Netting Process

In the the following paragraphs, a basic consideration is presented of the expected impact on the power system of Kosovo by the proposed options to provide of more reserves in the power system. Each of these options should be investigated and elaborated in more details, followed by the comparison among individual options and among different combinations of options.

7.3.1 Development of new generation facilities capable to provide system services

This is always the most comfortable and the most sustainable solution, but also the most expensive and most demanding in terms of time for its development. For support of the short-term and mid-term plans for RE generation developments, this is not an option. Development of new generation facilities that are capable of providing system services for power system balancing usually means the development of hydropower plants and gas fired power plants. Construction of gas power plant is quicker when a gas supply infrastructure exists. For Kosovo at this moment, both options are feasible only in the long run. However, taking into account that

[61] Note that identified RE projects in development total considerably higher envisaged capacity.

main target of the European electricity sector is decarbonisation and RE generation development to the extent where they will be the only or at least main source of electricity, plans for the development of new generation facilities in hydropower (to the extent which the natural potential in Kosovo allows) and gas fired power plants should be part of the overall strategy.

7.3.2 Development of power batteries

Battery Electricity Storage Systems (BESS) are definitely important component for the future of power system operations and control. At the moment their prices are still too high for implementation in power systems such these in the Western Bakan region due to the (still) high costs for installation of BESS facilities and low final electricity prices. In addition, investors in RE generation facilities have no incentives to develop hybrid systems consisting of different RE technology generation units combined with BESS: they are not obliged to pay for imbalances (no need to balance their portfolio), they cannot play in the market due to the lack of organised day-ahead and intra-day market in the region, and finally they cannot utilise their facilities for privision of ancillary services. The only potential investor in BESS in Kosovo may be the TSO, under the assumption that ERO justifies such investment. For the short and mid term solutions on power system balancing, following objective to support further development and integration of RES in Kosovo, BESS may be one of the support pillars in this process. The minimum that should be done is a pilot BESS project.

7.3.3 Cross-border cooperation

Cross-border cooperation with the power system of Albania has started and the first agreements on optimisation of control reserves in the common control block have been reached. Agreed participation in the common reserves are much more on the Albanian power system side due to the fact that main power system control reserve provider in Albania (KESH) operates large reservoir hydropower plants. Albania also has very ambitious plans for development of RES, especially solar power generation, so power system control reserves may become an issue in their power system, too. One possible solution may be a probabilistic approach to determination of the desired level of reserves which usually ends up with lower requirements towards currently used deterministic approach based on the coverage of maximum loss of generation and/or demand. Also, cross-border cooperation should be extended to other neighbouring power systems, since all of them have ambitious plans for RES development. Regional cooperation in provision and utilisation of power system control, reserves is an important step towards joining European platforms for power system control reserves which are becoming mandatory for ENTSO-e interconnected partners.

7.3.4 Imbalance Netting (IN)

Imbalance Netting is the cheapest and the most effective solution for reducing of the demand for power system control reserves, and at the same time the strongest support for integration of new RE generation facilities. Therefore, it is of utmost importance for power system of Kosovo and all power systems in the region to join this mechanism (it is not possible to join the IN mechanism independently, all involved power systems have to be interconnected).

7.4 Development and integration of electricity market

As indicated earlier, since 14 December 2020, KOSTT operates as Control Area in the AK (Albania-Kosovo) Control Block of ENTSO-E interconnection Continental Europe. Therefore, KOSTT from 2021 allocates the NTC in the tie lines with neighbouring power systems. In addition to the expected reduction of electricity import prices in Kosovo, this will make certain impact on the development of electricity market, market coupling (first with Albanian power market, followed with integration with the entire region, ending with planned common European electricity market).

Looking at the size of the power system in Kosovo, existing generation capacity, overall demand and structure of the electricity consumers, it is rather unlikely that there is a capacity for creation and operation of the sustainable wholesale electricity market in Kosovo. The same statement can be issued for most of the power systems in the Western Balkan region. However, this does not mean that certain market based mechanisms and activities cannot be established in Kosovo, and also it does not mean that licensed power system users in Kosovo cannot participate in electricity markets and power exchanges in neighbouring or other countries. Recently KOTT and OST signed an agreement on joint activities in creation and operation of the power exchange in Albania, which is in line with the Energy Community program for market coupling[62] in the Western Balkan region.

The power system of Albania is a net importer of electricity with a strong seasonal component and which is subject to hydrology. The fact that the power system of Kosovo is also net electricity importer may look like an obstacle for joint market operation and optimisation of power system control resources. This may be an obstacle in only the rather rare cases of overall energy shortage in the interconnection. In all other regimes, the complementary characteristics of these two power systems are in favour of developing cooperation and coordination to a higher degree of integration. Because the power system of Kosovo is practically entirely TPP based, and the power system of Albania is practically entirely HPP based makes them extraordinarily compatible. Individually, these two power systems each have serious problems in balancing their own portfolio, as well as in facilitating RE generation development. Jointly, these problems still exist, but with significantly less impact. Further coordination in operational planning, forecasting and harmonizing of legislation may additionally improve positive effects of this cooperation.

Electricity market integration at the regional level, as well as electricity market integration at the pan-European level, are of significant importance and will create real benefits, especially for small power systems. Access to power exchanges for wholesale trading in day-ahead and intra-day time slots, as well as to the platforms for acquisition and activation of reserves, are options that can only improve the current position of the power system in Kosovo. Therefore, the necessary investments in highly sophisticated SCADA/EMS and power trading software and hardware solutions are imperative and should be introduced as soon as possible.

[62] Energy Community Secretariat planned to integrate regional electricity markets by coupling neighbouring market areas couple by couple, and after that gradually integrate into a common regional market platform. Kosovo and Albania are one of the regional “market couples” in the first round of integration.

8. Conclusions

With some 1 185 MW of solar PV and wind capacity currently under various stages of development in Kosovo, potentially able to generate cca 2 300 GWh of electricity (approximately 40% of current generation), there is a substantial pipeline of RES project in Kosovo. This pipeline would deliver RES capacity several times larger than what is envisaged under the current Kosovo Energy Strategy (2017-2026). Over 83% of this pipeline is made of solar PV and wind utility-scale projects with over 10MW of envisaged capacity.

The technical potential of RE projects in Kosovo, as assessed by the World Bank at 1 200 MW for wind and 3 600 MW for solar PV, is significantly larger. Thus additional wind and solar PV projects may be added to the development pipeline in the future.

In addition, small hydro projects with a total capacity of 146 MW have been identified. The future development of such hydro projects however is uncertain due to environmental and social concerns and related public opposition.

The identified pipeline is showing signs of increasing maturity with 4 wind projects with total capacity of 114.4 MW under construction (Selaci I, II, III, and Budakova I) and most others (289 MW of wind projects and 358 MW of solar PV) having achieved at least a key milestone such as Connection Agreement made with KOSTT (CA) or Preliminary Authorization issued by ERO (PA). Other projects (96 MW wind and 205 MW solar PV) have not completed these steps and are believed to be in earlier stages of development. The Consultant understands that only projects under construction have completed the EIA procedure and obtained environmental consents. In addition to this identified pipeline, new RE project initiatives and developments keep emerging.

However and from its contacts with developers, the Consultant understands that pipeline movements are currently limited following the recent termination of Kosovo's FiT RES support scheme and the announcement that a new market-based support scheme would replace it, in line with Energy Community requirements. Work is continuing on RE projects that previously secured the FiT. Developers of other projects are waiting for details on the terms of the proposed new support scheme to reassess the feasibility of their undertakings. In principle, the Consultant considers that all of the identified projects can be successfully developed under an adequate market-based support scheme and under the assumption that necessary additional grid investments to be borne by the developers will not be prohibitively high.

Considering Kosovo's large technical potential (1 200 MW for wind and 3 600 MW for solar PV), the limitations to future RE development and deployment are not the dearth of projects. Limitations are more likely to stem from (i) financial feasibility and bankability of these projects in the local context for the developers, and (ii) the limitations of Kosovo's power system in connecting significant additional RE generation and managing their intermittent generation. Based on the available information and the overall environmental impact of solar PV and wind projects, the Consultant does not expect that the identified projects would incur any significant issues in developing their respective EIA's.

Financial feasibility and related risks can largely be addressed with the appropriate support scheme. However, the financial feasibility of RE projects could be challenged by KOSTT's "deep connection costs" methodology which allocates to developers the costs of grid updates necessary to accommodate the connection of new RE capacity. These costs can be substantial. On the other hand, the TSO is comfortable with issuing connection conditions to RE generation candidate projects, knowing that all costs of the grid connection infrastructure and grid reinforcement for new RE generation facilities (except those grid reinforcements already identified in the TYNDP) will be borne by the investors.

The issue of the Kosovo power system being able to cope with significant additional RE capacity can be alleviated to a certain extent with market integration with neighboring countries, particularly Albania. However, investment in additional reserve and backup capacity may still be needed.

The estimated LCOE of identified solar PV projects is comparable to the expected medium-term electricity prices in the region. The situation appears somewhat more challenging for wind as estimated LCOE is comparable to expected electricity prices only at the lower end of the CAPEX and the discount rate range under consideration. However, it should be noted that these calculations do not include potential system costs such as reserve and back up.

The design of the new RES support scheme should take into account these issues as well as liquidity and bankability of projects. As the useful life of RE assets is generally longer than the loan repayment periods, projects competitive on an LCOE basis may still face liquidity issues during the loan repayment period or require excessive equity capitalisation. Further, it should be noted that financing institutions will generally assess bankability based on conservative P90 generation estimates rather than the expected generation estimates (P50).

The Consultant assessed the pattern of current solar PV, wind and hydro generation in Kosovo has created a simplified model based on RES installed capacity split 1/3 solar PV, 1/3 wind and 1/3 hydro and with actual production based on average actual output from these sources in 2020 in Kosovo. The model assessment indicates that solar and wind generation may complement each other in terms of seasonality and that hydropower, although nominally "run of river", seems to provide a degree of intraday dispatchability. In addition, output patterns present interesting similarities with actual demand patterns. Based on such assessment a model could could be developed to assess the magnitude of energy storage and/or back-up capacity that would be required for the desired target contribution of particular RE sources.

From a system planning and system operation point of view, with increasing penetration of RE generation, electrical power systems need additional dispatchable backup and reserve capacity. The current structure of Kosovo's energy generation does not provide significant capacity for either backup or reserve capacity and therefore new dispatchable generation capacity and/or energy storage will need to be considered to facilitate the integration of additional RE capacity in Kosovo's electricity system.

There are several energy storage projects in Kosovo, but none has sufficient scale to provide weekly or even longer-term electricity storage. The only energy storage project with high round trip electrical efficiency is the PSHP Drini/Vermica. Its envisaged storage capacity is 2 GWh, installed power is 250 MW and the expected investment is 460 mln €. This translates into a specific cost of energy storage capacity of 230 €/kWh. Although high, it is lower than the cost of battery storage, which is estimated in the range of 330 €/kWh. The Consultant notes that there are several regional PSHP projects with an estimated cost of storage at the level below 10 €/kWh of storage capacity.

In-depth analysis is required to estimate the required capacity of energy storage to provide for system reserve in Kosovo for a given structure of its electricity system and targeted installed capacity of renewables. If energy storage is also to serve the purpose of providing backup capacity for renewables, its required capacity would need to be significantly higher, depending on the target structure of the Kosovo electricity generation system.

To progress the matter further, the following issues could be investigated:

- Back-up and reserve capacity to enable the integration of additional RE sources
  - Assessment of the required energy storage (for backup and for reserve) for a given structure of Kosovo electricity generation. Assessment of potential storage projects that could serve the purpose.
  - Comparison of the energy storage option with alternatives; reserve/back-up capacity in CCGT or large reservoir hydro.
- Power system balancing study
  - Assessment of possibilities and recommendations for Demand Side Response in Kosovo
  - Integration of Kosovo into European Imbalance Netting Process.
  - Assessment of gaps and recommendations for the legislative and regulatory changes with regards to power system balancing.

9. List of literature

Within the course of this study, the following documents have been referred to in the report:

[1] "Annual Implementation Report 2020," Energy Community Secretariat, November 2020.

[2] "Mechanism of support for RES targets (20 MW solar PV) (In Albanian)," Energy Regulatory Office, May 2019.

[3] "Energy strategy of the Republic of Kosovo 2017-2026," Ministry of Economic Development, 2017.

[4] "Annual Report 2016," Energy Regulatory Office, Prishtina, March 2017.

[5] "Annual Report 2017," Energy Regulatory Office, Prishtina, March 2018.

[6] "Annual Report 2018," Energy Regulatory Office, Prishtina, March 2019.

[7] "Annual Report 2019," Energy Regulatory Office, Prishtina, March 2020.

[8] "Evaluation of Power Supply Options for Kosovo," World Bank, August 2018.

[9] "Transmission Development Plan 2021-2030," KOSTT, October 2020.

[10] "Installed capacities of generation in Kosovo 2020," KOSTT.

[11] "Register of Applications for construction of new generating capacities and Admission to Support Scheme from RES," Energy Regulatory Office, 2021.

[12] "SEEPEX Monthly and Annual Reports 2016-2020," SEEPEX, 2017-2021.

[13] "HUPX Annual Reports 2015-2020," HUPX, 2016-2021.

[14] "IBEX Monthly and Annual Reports 2016-2020," IBEX, 2017-2021.

[15] "Law on Energy, No. 05/L-081".

[16] "4th Renewable Energy Progress Report of the Republic of Kosovo 2018-2019," Ministry of Economy and Environment, Prishtina, 2021.

[17] "Law on Energy Regulator, No. 05/L-084".

[18] "ERO Decision, V_359_2011," Energy Regulatory Office, 2011.

[19] "ERO Decision, V_673_2014," Energy Regulatory Office, 2014.

[20] "ERO Decision, V_810_2016," Energy Regulatory Office, 2016.

[21] "ERO Decision, V_1204_2019," Energy Regulatory Office, 2019.

[22] "ERO Decision, V_1321_2020," Energy Regulatory Office, 2020.

[23] "Energy Efficiency and Renewable Energy Project. Support for Grid Integrated Renewable Energy Generation - Least Cost Renewable Energy Mix," World Bank, November 2020.

[24] "Financing and investment trends - The European wind industry in 2019," Wind Europe, April 2020.

[25] "List of RES projects with overnight specific investment costs (in xlsx format)," Energy Regulatory Office, 2021.

[26] "HUDEX Monthly Report (February 2021)," HUDEX, 2021.

[27] "Transmission Connection Charging Methodology v2.9," KOSTT, Prishtina, May 2018.

[28] "Rule on Authorization," 27 April 2017.

[29] "Law on Environmental Impact Assessment, No. 03/L-214".

[30] "Law on Environmental Protection, No. 03/L-025".

[31] W. Cole and F. A. Will, "Cost Projections for Utility-Scale Battery Storage: 2020 Update," NREL, June 2020.

[32] "Lazard's Levelized Cost of Storage Analysis-Version 6.0," Lazard, [Online]. Available: https://www.lazard.com/media/451566/lazards-levelized-cost-of-storage-version-60-vf2.pdf. [Accessed 2021].

[33] "Regional Strategy for Sustainable Hydropower in the Western Balkans," WBIF, 2018.

[34] "Hourly generation of renewables in Kosovo in 2020 (in xlsx format)," KOSTT, 2021.

[35] "Transmission Development Plan 2020-2029," KOSTT, November 2019.

[36] "Transmission Connection Charging Methodology v3.0," KOSTT, Prishtina, September 2020.

[37] "Commission Regulation (EIU) 2017/2195 establishing a guideline on electricity balancing," European Union Law, 28 November 2017. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2017.312.01.0006.01.ENG&toc=OJ:L:2017:312:TOC. [Accessed 21 April 2021].

[38] "European Electricity Balancing Guideline," ENTSO-E, November 2018. [Online]. Available: https://eepublicdownloads.entsoe.eu/clean-documents/Network%20codes%20documents/NC%20EB/entso-e_balancing_in%20_europe_report_Nov2018_web.pdf. [Accessed 21 April 2021].

[39] "Renewable Power Generation Costs in 2019," International Renewable Energy Agency (IRENA), Abu Dhabi, 2020.

[40] "Kosovo Forecast: Consumer Price Index Growth," CEIC (data provided from IMF), [Online]. Available: https://www.ceicdata.com/en/indicator/kosovo/forecast-consumer-price-index-growth. [Accessed 2021].

[41] "EU Directive 2019/944," The European Parliament and the Council of the European Union, Brussels, 5 June 2019.

Annexes

Annex 1 Institutional Organisational Legal Regulatory (IOLR) Development Diagram

(given under separate cover/file)

Annex 2 Project fiches

(given under separate cover/file)